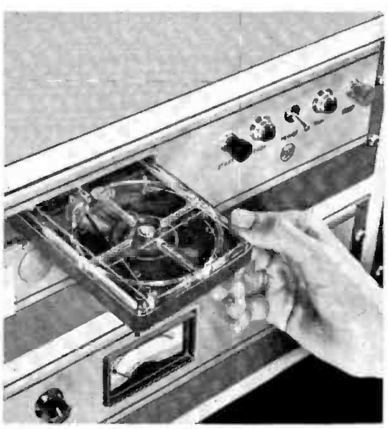
BROADCAST NEWS

TR-22
SOLID-STATE
TV TAPE
RECORDER

Vol. No. 115 Nov. 1962

RCA CARTRIDGE TAPE SYSTEM

Automatically Triggers Playback Units, Tape Recorders, Turntables, and Other Devices



Here's a unique built-in feature! The Recording Amplifier of the RT-7B Cartridge Tape System generates two kinds of cue signals. One is used to automatically cue up each tape, at the beginning of a program, the same as in ordinary units. The other signal, a special Trip-Cue, can be placed anywhere on the tape. This will cause the playback unit to trip and start other station equipments.

You can preset two, or a dozen or more RCA tape units, to play sequentially. You can play back a series of spots or musical selections, activate tape recorders, turntables, or other devices capable of being remotely started. (In TV use Trip-Cue is ideal for slide commercials. Tape announcements can be cued to advance the slide projector.)

You'll like the RT-7B's automatic, silent operation, its compactness, high styling, perfect reproduction. Cartridge is selected, placed in playback unit, forgotten until "air" time, then instantly played. Cueing and threading are eliminated. Cue fluffs are a thing of the past!

Transistor circuitry, good regulation for precise timing, low power consumption, are among other valuable features.

See your RCA Broadcast Representative for the complete story. Or write RCA Broadcast and Television Equipment Building 15-5, Camden 2, N. J.

RCA® THE MOST TRUSTED NAME IN ELECTRONICS

Vol. No. 115 | November, 1962

BROADCAST NEWS

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CONTENTS

As We Were Saying

THE 22's ARE COMING, the TR-22's that is we were saying but no more they've come (off the production line) and gone by the dozens to those stations who ordered early—and waited and waited but never more worth it.

Two NAB's we showed it, and customers ohed and ahed it, while others questioned it and openly doubted we ever could build it. Two winters we labored, and worried a little while ECN's flew like snowflakes and winter passed into spring and spring into summer. September they promised—and almost made it. But oh happy October, start shipping they said.

So here it is (front cover, page 6, page 22)—a thing of beauty and a joy forever—well anyway for a long while. Designed as an engineer's dream, built with the precision of a watch, styled like a Cadillac (Lincoln?). To see it is to want it, and why not.

So how does it work? ABC installed two TR-22's in its new Washington studios in October. Three weeks later ordered 12 more to replace all the present machines in its Chicago studios. QED!

L'ANCIEN. Although this is the November issue, we started writing these paragraphs in October—and October is anniversary month in this industry. Which is by way of explaining all of the talk of October which follows.

Anniversaries are more revered by the old than the young, which looking at the column that follows, gives to pause, as our padutch grandma would say. Okay so we're getting gray is for experience is that which allows us to make new mistakes instead of making the same old why not let the other guy and you read about them first in BROADCAST NEWS.

As We Were Saying

CARL MYERS' FIFTIETH year in "wireless, radio, and television" was the happy reason for a surprise luncheon which the staff of WGN and many of his friends in the industry "threw" for him on October 4. Carl, who is vice president and general manager of engineering and operations of WGN, Inc., is possibly the oldest (in career years) "chief engineer" in the business.

In a recent issue (while commenting on our long association with Carl) we confessed that we didn't know when he started. Now we do. Jack Brickhouse, master of ceremonies at the luncheon, said that Carl's interest in "wireless" began in 1912—at the age of 10. According to Brickhouse it was about then that Carl first took an examination to become a wireless operator. The test required him to draw a two-kilowatt marine transmitter energized by alcohol. He flunked the test—but never forgot the alcohol (sic).

Carl J. Myers, vice president and manager of engineering and operations of WGN, Inc., with the trophy presented to him by friends and co-workers at a luncheon celebrating his fiftieth year in "wireless, radio and television." Bronzed microphone is similar to type in use at WGN in 1925, when Carl became chief engineer of WGN.

In 1919, Carl got his first commercial "ticket." That was the year RCA was born. It was a year before KDKA and/or WWJ. There was nothing for a young "op" to do but go to sea—and so he did—but soon tired of that and turned to the just awakening broadcast field. He was operating his own station, WWAY at Marigold Gardens (Chicago) in 1922, when Charles Erbstein tapped him to build WTAS at Elgin, Illinois, which soon became one of the early radio age's best known stations.

On Christmas Day 1925, Carl became chief engineer of WGN and has supervised the Trib's radio and TV operations ever since. He has played a big part in making WGN one of the finest, most powerful and most progressive stations in the country—and has himself become one of the most revered and respected leaders in the industry.

MONOGRAM'S FORTIETH also bears noting. Spurred by our "Mark of" ads (see last issue) someone called our attention to the first such ad —which appeared in October 1922. The layout and copy (see page opposite) of this historic ad bears a strong resemblance to the series of ads we have run recently. And, since we had never seen this first ad before, we can only assume that our own ads result from a "stream of consciousness" that has been strong throughout all the intervening years. For us that's not hard to believe. In fact it's like what we've been trying to say all the while.

JACK FROST'S THIRTY-FIVE years in broacasting were celebrated last month by his friends and neighbors at a typical valley (San Fernando, of course) open house. Adron Miller, who is manager of our West Coast facility, and who is wont to enliven such occasions by playing his "gitar" in a style best described as banks-of-the-Wabash-hill-billy, sent us a bunch of snapshots. We're not using them (for why, see below). And, we're not quite so impressed as Adron by that 35-year business—possibly because there are still quite a few of us in Camden who started "on test" about the same time as Jack.

But we are mightily impressed by one part of Jack's track record: to wit, the fact that since 1934, he has been (excepting for three war years) our broadcast sales representative in the Southern California area. Only those of us who as field salesmen have played hot line between customers (who should be contented, but aren't)—and Camdenites (who shouldn't be contented, but often are) will fully realize the meaning of this marathon. Many salesmen can sell something once. But only the best are successful in selling, year after year, to the same group of customers —especially a group as discerning and demanding as broadcast engineers. Only a salesman who has gained the complete confidence of his customers can do it. Such confidence is based on knowledge, friendship, honesty and service. Jack has all four—and his customers know it.

BROADCAST NEWS' THIRTY-FIRST also falls this month—which leads to the thought that we, in our own inexplicable way, have a record of survivorship almost equal to Jack Frost's. In October 1931, we put the first issue of BROADCAST NEWS to bed. Through thirty-one years of depression and boom, war and peace, freeze and unfreeze, we have lovingly nursed it to this, its one-hundred and fifteenth issue. Our readers, who by no coincidence are RCA's customers (and fair prospects) have been good to us. We thank them—and wish them thirty-one more years of us.

UHF's TENTH anniversary as a commercial service also could be marked this month—give or take a few days. Actually, KPTV, Portland, the world's first commercial UHF television station began programming on September 20, 1952. We were there—and reported the event fulsomely and breathlessly in our October 1952 issue. Tremulity,* rather than modesty, forbids calling attention to the marked resemblance to things present.

* See Webster's *Fourth.*

RIGHT. Reproduction of first RCA ad in which the now familiar monogram was featured. Ad, which first appeared in the fall of 1922, used copy theme much like that of recent RCA broadcast equipment ads. (See following page.)

RCA

To Protect The Dealer and The Public

A new trademark, a symbol of quality, has been adopted by the Radio Corporation of America. It appears at the top of this page, and soon it will be affixed to all Radiolas, Radiotrons and other products.

The new symbol is more than a trademark. It is the dealer's and the purchaser's guarantee that the apparatus to which it is applied is the result of research conducted by the foremost scientists and engineers; is the product of the most reliable and well equipped manufacturing organization in the country; and is marketed in accordance with methods approved by experienced business men.

Liks the R C A apparatus still on sale, bearing the old symbol — the letters R C. in a circle — the newly marked R C A apparatus will embody the same high standard of quality and will be backed by the same protection which R C apparatus has enjoyed during the past.

The new monogram has been adopted to render apparent, instantly and unmistakably, the products of the Radio Corporation of America. Henceforth, this symbol R C A will appear on all apparatus and Radiolas — from the simplest crysral receiver to the Cabinet type. It testifies to the constant striving of the R C A organization — research engineers, factories and sales force — to produce and sell only the best, and to develop types of Radiolas which will keep pace with the advancement of broadcast reception and which will apply the new discoveries made in the R C A research laboratories.

Teaching the Public What R C A Means Through Advertising

The new symbol R C A will be widely advertised throughout the country. In an art which is so rapidly developing and which offers so many opportunities for the marketing of unreliable apparatus, it becomes more and more necessary to drive home the importance of the highest engineering and manufacturing standards. The symbol R C A is a guarantee that these standards have been insisted upon in the manufacture of Radiolas.

Write for Display Cards

R C A dealers will be supplied wish R C A symbols for store display. By writing to us and stating whether a decalcomania window sign or a wall card is desired, we shall be glad to meet their wishes.

Radio World Wide Wireless Corporation of America

Sales Department
233 Broadway,
New York, N. Y

District Office
10 South La Salle St.,
Chicago, Ill.

OUR APOLOGIES, MESSRS. BRAUN (M). The ink was hardly dry last issue before the mailman started bringing us needling letters about how we had credited FCC service to Warren Braun of WSVA when actually it was Cy Braum, now of JCET who was with the FCC from 1937 to 1953. But we would like you critics to know that neither of these gentlemen, themselves, complained about the mix-up. We take it they have a high regard for each other. And we agree with both of them!

ANYHOW IT'S NICE to know we have readers. We only get "lots of letters" when we make a mistake and you're right we're tempted especially because most of the needles are friendly and in thirty-one years of publishing we never have gotten a real mad one—yet.

FOR WHY Mostly because we do our darndest to keep BROADCAST NEWS from becoming a "house organ." And what's so bad about that? Well, for one thing, most house organs are full of "personals"—some about people you know; but mostly you don't—and who could care less. Like minority programming it doesn't get very good ratings. Also, there's our controller (Ugh!). He has a big axe, especially honed for use on things like house organs. Fortunately, he can't read (anything, that is, but figures). So if we don't use pictures—and none of you J--entlemen tell him—he won't know about this column, and we'll still be here next issue.

Hopefull yours,

The Armchair Engineer

The Mark of Protected Investment

RCA maintains a stock of more than 6 million exact replacement parts—covering RCA Broadcast Equipment built as far back as the early '30's. RCA Replacement Parts Service is open 24 hours a day.

The Most Trusted Name in Electronics

INGLIS NAMED DIVISION V.P. FOR COMMUNICATIONS PRODUCTS

The appointment of Andrew F. Inglis as Division Vice President, Communications Products Operations, RCA Broadcast and Communications Products Division, was announced December 13 by C. H. Colledge, Division Vice President and General Manager.

In the newly-created position, Mr. Inglis will assume overall responsibility for the Division's mobile communications, radiomarine and audio-visual products and will have headquarters at the RCA communications products facility in Meadow Lands, Pa. Also he will continue to be responsible for the engineering and merchandising of broadcast transmitter and antenna products.

The consolidation of engineering, production and marketing activities for communications products under Mr. Inglis recognizes RCA's growth in these areas and is indicative of its plans to broaden the markets they represent.

The products include two-way radio equipment for mobile use, navigation and communications equipment for all types of marine craft, and a line of language laboratories, motion picture projectors and sound systems for educational and other applications.

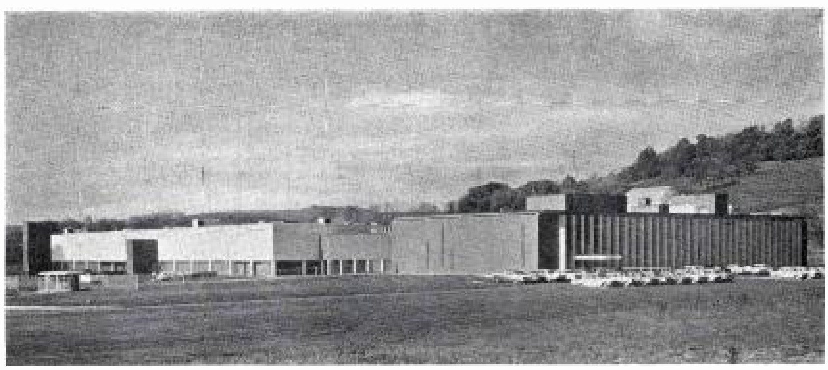
Since joining RCA in 1953, Mr. Inglis has held a number of executive posts with the Division at its Camden headquarters. Most recently he has been Manager, Broadcast Merchandising and Engineering Department, in which his principal responsibility was the development of radio-TV broadcast equipment.

His first assignment with RCA was as Manager, Broadcast Equipment Planning. In 1955 he became Manager of Television Systems Engineering and, three years later, Manager of the Closed Circuit TV Department. Later he was given additional responsibility for the Division's film recording and scientific instrument businesses.

A native of Michigan, Mr. Inglis was graduated from Haverford College in 1941 with a Bachelor of Science degree in physics. He spent a year of graduate study at the University of Chicago, after which he was appointed an instructor in electronics there.

During World War II, he served as a radar instructor with the rank of Lieutenant, U.S. Naval Reserve. Upon his release from active duty in 1946, Mr. Inglis joined Frank H. McIntosh in a Washington, D.C. consulting firm to the radio and television broadcasting industry, and became a partner in 1949.

MEADOW LANDS: MODEL PLANT, RURAL SETTING



With the consolidation of all RCA communications products under Andrew F. Inglis, newly-appointed a Division Vice President, the Meadow Lands, Pa. facility housing most of these activities enters a new phase of operations as an integral part of the Broadcast and Communications Products Division.

Aptly-named, the plant lies on a 64-acre tract bounded by pasture land on which horses, cows and other livestock graze peacefully. But the rural note ends at its commanding concrete columns that rise a full two stories high. Inside, the plant presents an efficiency of layout and a choice of decor that mark it as a model of up-to-the-minute industrial architecture.

Meadow Lands is located about 30 miles southwest of Pittsburgh and was first occupied in March 1961. Since then it has become the engineering and manufacturing center for a broad range of communications products for education, industry and other applications. These include language laboratories, two-way mobile radio systems, marine radio and small craft radar and a line of audio equipment and sound systems.

The Meadow Lands complex is made up of a manufacturing area of approximately 150,000 square feet and an administrative building, which includes the engineering laboratories, of approximately 46,000 square feet. An employee cafeteria, with spacious glass doors through which diners view an outdoor courtyard, connects the two structures.

With Meadow Lands assuming a more important role, and with the recently-expanded West Coast Operations facilities in Burbank, Calif., the Division begins 1963 with an enlarged and more flexible establishment suited to the growing needs of its customers.

NEW TR-2 TV TAPE RECORDER MAKES DEBUT

RCA's newest television tape recorder, the TR-2, which combines high performance standards with compact design and is readily converted to color operation, is scheduled for delivery beginning in January. It is available in two models: three 84-inch racks for studio installations, or four 66-inch racks for mobile applications.

The TR-2 was designed at the Film Recording and West Coast Operations facility of the RCA Broadcast and Communications Products Division (see separate Viewfinder article on the facility's move to new headquarters in Burbank, Calif.). Commercial production is under way at Burbank and Camden, N. J. plants.

The new recorder's design makes liberal use of transistorized circuitry for improved performance and reliability, and for space conservation. Transistorization has been extended to the operation of "switchlock," a standard feature of the new recorder, which prevents picture roll-over when the signal is switched among local sources.

While in the compact class, the TR-2 has the built-in capability to perform virtually all the functions inherent in standard-size TV tape recorders. This flexibility stems from pre-wiring the machine to accept a variety of accessories.

These include such optional add-ons as two speed operation (7½ or 15 inches of tape per second), linelock for lap dissolves, automatic timing corrector to remove geometric errors, and air bearing headwheels for essentially jitter-free operation and longer life.

The basic machine reflects RCA's practice of constantly upgrading its TV tape recording equipment to incorporate the newest developments in the field and, at the same time, to effect savings in weight, space and power consumption over existing equipment.

NOW A WORD FROM HUE: FIVE STATIONS GET COLOR CAMERAS

The trend to local origination of color programming picked up new momentum during September and October when five stations received color TV cameras from the RCA Broadcast and Communications Products Division.

WLEX-TV, Lexington, Ky., took delivery of both live (TK-41C) and film (TK-26) cameras. Other color film camera shipments went to KOA-TV, Denver, Colo.; WDSM-TV, Duluth-Superior, Wisc.; WAVE-TV, Louisville, Ky., and to WNYS-TV, Syracuse, N. Y.

All of the stations are equipped to handle network color shows and, in addition, WAVE-TV previously had purchased live color equipment for local programming.

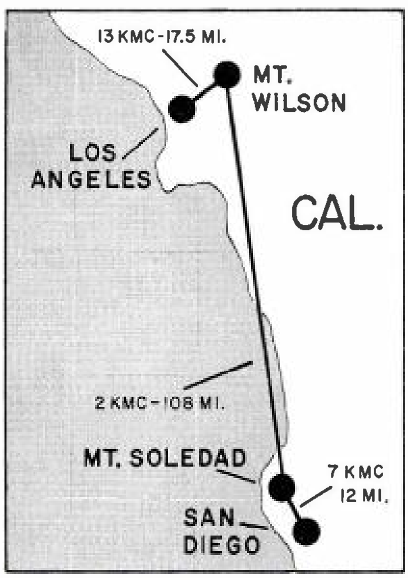
FOR KOGO: THREE HOPS AT THREE FREQUENCIES

KOGO-TV's unique microwave system, which uses a different frequency for each of its three hops, has begun relaying network signals from KNBC, Los Angeles, over a 137-mile path to the San Diego station.

RCA equipment operating in the 2,000, 7,000 and 13,000 mc bands was chosen by LeRoy A. Bellwood, KOGO-TV's Director of Engineering, to avoid frequency congestion and to offset adverse signal conditions in the inter-city path.

Outbound from Los Angeles, the signal is beamed at 13 kmc for a distance of 17 miles to Mt. Wilson in the first leg of the relay. The 13 kmc band was selected to avoid congestion at 7 kmc in the Los Angeles area.

Near the summit of the 5,600-foot mountain, a repeater station relays the signal on its longest hop of 108 miles, of which 40 miles is over Pacific Ocean waters. The second leg uses a 2 kmc frequency to overcome signal propagation characteristics created by the distance spanned and by surface reflections from the water.



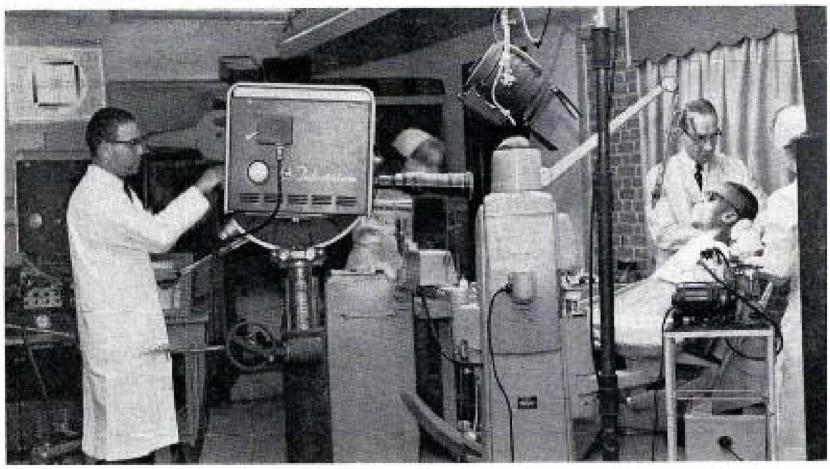
The final leg in the system takes the signal at 7 kmc to the studio. Microwave transmitters and receivers in this section are multiplexed into common parabola antennas at the studio and at Mt. Soledad, the transmitter site, to provide simultaneous sending and receiving service between the two points.

COLOR TAPES MADE AT HALF SPEED IN TESTS

Following a series of performance tests, RCA has announced that its television tape recorders can be operated at half speed (7½ inches of tape per second) for color as well as for monochrome program material.

Early in 1961 RCA had reported the first successful development of equipment for converting its TV tape recorders to two-speed operation. The slower speed was made possible by a new narrow recording head which covers a transverse track on the tape only 5 mils wide, as compared with the conventional 10-mil width. Thus two tracks, or double the volume of video information, are recorded when the tape moves at 7½ instead of 15 inches per second.

Performance tests at Camden, N. J. established the interchangeability of color tapes, recorded at the slower speed, among a group of headwheel panel assemblies. By operating their recorders at half speed, broadcasters and other users realize 50 per cent savings in tape requirements and comparable reductions in storage space and shipping costs.



Camera focuses on troublesome tooth as clinical demonstration is televised at dental school.

SPOTLIGHT FALLS ON BOTHERSOME TOOTH IN DENTAL SCHOOL TV

When the command comes to "open wider, please!" at dental schools these days, it's not necessarily because the dentist is holding a bigger instrument at the ready. It could be that the TV cameraman wants a better shot at a troublesome molar.

At such leading institutions as the University of Pennsylvania's School of Dentistry, television is giving student dentists a bigger, brighter look at teeth under the professor's treatment than they ever got while grouped around the dental chair.

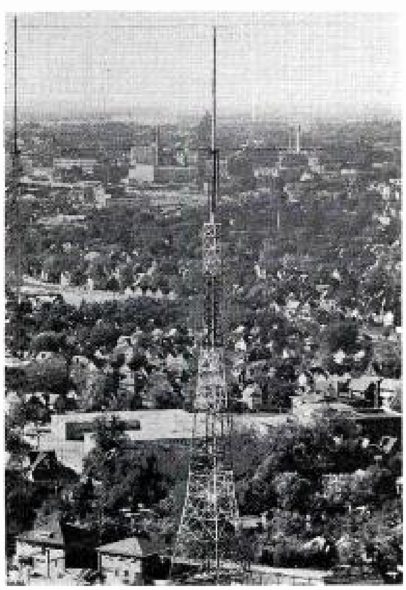
The Philadelphia school, an ETV user for several years, has gone one step beyond most of its sister institutions. In upgrading its facilities recently, it chose broadcast-quality equipment: two RCA TK-15 cameras, one of which is equipped with a 300-mm. lens for closeups. The system also includes a professional switching console and 16 monitors located in classrooms, an auditorium, and the dean's office.

More than 740 people, including the school's 500-member student body, can watch a demonstration or some other form of televised instruction at one time. Demonstrations using patients originate in a brilliantly-lit studio equipped with a full range of dental equipment. A "talk-back" intercom system connecting the studio with classrooms permits students to respond to questions posed by the instructor.

Since the TK-15 cameras feature a variable gamma control, darker portions of the picture can be brightened, and important detail brought out, without sacrificing overall picture quality. In televising dental work near the back of the mouth, this enables the camera to produce pictures that are properly balanced in the black-and-white scale between the white teeth and the darker surrounding area.

Since the school's chief cameraman is also a dentist, he is able to anticipate the instructor's next procedure and adjust his cameras for the overall scene or for close-ups. The system is capable of one-man operation through the use of a remote dissolve lever on one of the cameras.

What corresponds to a network TV "special" occurs after a laboratory examination. A number of technic models or replicas of natural teeth, on which the students have performed dental work, is gathered in the studio. While the class watches on monitors, two students and two faculty members evaluate the work in a side-by-side comparison of the models.



Tower supporting first diplexed antenna system used commercially in U.S. looms over Rochester's skyline.

TWO ROCHESTER TELEVISION STATIONS ARE FIRST ON-THE-AIR FROM COMMON ANTENNA

Two Rochester, N. Y. television stations, WROC-TV (Channel 8) and WHEC-TV (Channel 10), have become the first U. S. TV broadcasters to radiate their signals simultaneously from a common antenna. New to this country but used previously in Canada and Europe, the technique makes use of a diplexed antenna system custom built by RCA.

The common antenna project was planned and coordinated by R. K. Blackburn, Director of Engineering for the Gannett Company, owners of WHEC. He originated the idea for the two-station antenna, worked out the details with RCA engineers, and supervised the installation and test which was carried out in record time.

The system's key element is a broadband diplexer which combines the stations' four signals (two video, two audio) and transmits them at the assigned frequencies. Each station achieves the maximum 316 kilowatts of ERP.

The single antenna project was initiated early this year when WROC-TV shifted from Channel 5 to 8. This was part of a rearrangement of upstate New York broadcasting frequencies in which Rochester and Syracuse grew from two-channel to three-channel TV markets. Under the original frequency allocations, the two Rochester stations had been sharing a 285-foot tower on surburban Pinnacle Hill in a stacked antenna array.

LONG BLUE LINE OF TR-22 TV TAPE RECORDERS LEAVING CAMDEN

In mid-October RCA's new TR-22 television tape recorder, as trim a piece of broadcasting equipment as ever graced a studio, began moving out of the Camden plant in volume. As the first vans pulled away, Camden's engineering-production-marketing team could barely contain its pride. Enthusiasm swept through the ranks of engineers, a body of men not usually given to superlatives. Wrote two of them who had had a big hand in the recorder's development: ". . . the styling, performance and reliability of the TR-22 are destined to set the standards of excellence in television tape recorders for many years to come." (See article on page 22.)

The first two TR-22's for commercial use have been installed in the ABC-TV network's glossy new Washington, D.C. facility for news programming, while the first unit for non-commercial operation was put to work at the Navy Photographic Laboratories, also in Washington, in the production of training films.

Meanwhile, RCA's factory force, at work on a two-shift basis, tackled a backlog of orders. And, on the marketing front, new orders and a flood of inquiries arrived from customers in this country and overseas. The TR-22, the recorder of great

When Miss New Jersey came to see the first TR-22 off, somebody decided it should be a package deal.

expectations, had become the latest "go" item in RCA's product line.

Behind the machine's sleek exterior lay a number of engineering advances that enable it to make trouble-free, error-proof tape recordings and to play them back at a quality level previously unknown to the industry.

With its total solid-state design, the TR-22 represents savings of approximately 50 per cent in weight, floor space and power consumption over standard multi-rack machines.

As with other RCA broadcast equipment, the TR-22's design preceded from a careful consideration for human engineering—or how best to make the machine and its operator a smoothly-working, efficient team. For example, a series of studies determined that the 45-degree angle was best for the tape transport. Control positioning also underwent careful scrutiny, leading to a decision to separate controls for record functions from those for playback. This is extra insurance against accidental erasure of valuable program material.

But the human engineering aspects are merely indicative of the painstaking thought and planning that betoken the finest TV tape recorder ever produced. As its engineers conclude, after describing in detail what makes the machine tick, "the TR-22 is a television tape recorder not likely to be surpassed for many years to come."

TK-60 CAMERAS ARRIVING IN TV STUDIOS

RCA's newest 4½-inch I.O. television camera, the TK-60, made its debut in early November. The camera's introduction caps a 10-year period in which the company built and shipped more than 2,000 TV cameras of the image orthicon type.

The new camera offers simplicity of operation, remains stable for long periods and is productive of the highest quality pictures. Its advanced features represent five years of development work, plus a two-year period in which these features were proven out in commercial broadcasting and in TV production studios.

This "on air" experience both affirmed the original design concept and suggested areas for improvement. The improvements were built in, the Camden facilities were geared up for a volume production run and, by mid-November, deliveries began on a regular basis.

Among the first customers, MGM Telestudios, Inc., planned a coming-out party for the TK-60 at its New York City studios, just two stories above the teeming "crossroads of the world"—Broadway and 42nd Street. The TV production firm has ordered four of the cameras.

In inviting leaders of the advertising fraternity to watch the new camera at work, both live and on tape, George K. Gould, Telestudios President, wrote: "The TK-60 creates a tape picture of dramatically-new pictorial quality. It is capable of reproducing faithfully an expanded and controllable contrast range permitting the fullest latitude in dramatic and artistic lighting. The development of this new camera has particular importance in the field of TV commercial production where picture appeal can be translated into over-the-counter sales."

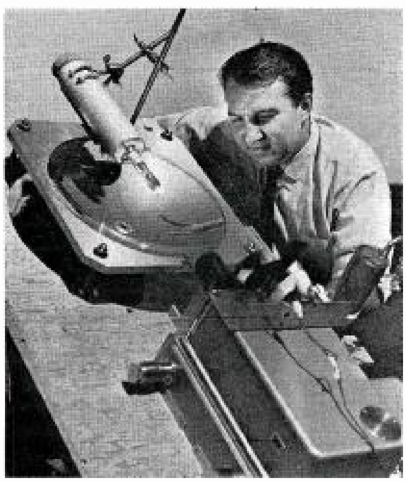
TK-60's handsome styling shows to good advantage in this camera view of newest monochrome camera.

'SUN-PUMPED' LASER SHOWS PROMISE

A new "sun-pumped" laser, the first man-made device capable of using sunlight directly without converting it to another energy medium such as electricity or heat, has been developed by RCA Laboratories.

The solid-state laser was used in laboratory experiments to convert natural sunlight into a continuous beam of coherent infrared radiation. RCA scientists said the experiments open up the possibility of placing sun-powered lasers aboard future space satellites to produce intense light rays for use in communications, tracking and geodetic measurements of the earth.

The apparatus used in the experiments included a 12-inch hemispherical mirror for



At RCA Laboratories, experimental laser is focused to produce a continuous beam of infrared radiation.

focusing the sunlight, a laser employing a calcium-flouride crystal and a spectrometer for detecting the laser's output. The laser was kept in a bath of liquid neon and emitted continuous radiation at the infrared wavelength of 2.36 microns when exposed to about 50 watts of radiant power from the sun.

Lasers comprise a new family of electronic components which convert the many frequencies of ordinary light to a narrow, highly-directional and extremely powerful beam of only one frequency. Such light is said to be "coherent" and one day may be used to carry communications, perform delicate eye and brain surgery, drill or machine refractory metals and track interplanetary space probes.

EUROPEAN TECHNICAL GROUP HEARS COLOR TV STORY DURING VISIT TO CAMDEN PLANT

Europe's mounting interest in color television was underscored last month when a group of key TV engineers from eight European countries paid a day-long visit to RCA's Camden, N. J. plant. They heard a status report on color TV in the United States and watched demonstrations of the newest broadcasting equipment.

Members of the European Broadcasting Union's technical group, the visitors included representatives of broadcasting interests in West Germany, Great Britain, France, Netherlands, Denmark, Austria, Italy and Portugal. They were in the U.S. for a series of meetings with networks officials and other broadcasting industry leaders.

At the Camden meeting, Dr. George H. Brown, Vice President, Research and Engineering for RCA, traced color TV's growth in this country and outlined its future prospects. Technical sessions covered color cameras and tubes, TV tape recorders, transmitters, receivers and kinescopes.

LATCHSTRING OUT AT NEW BURBANK HOME OF OUR WEST COAST OPERATIONS TEAM

On November 1 freshly-painted RCA monograms went up at 2700 Olive Street in Burbank, California, marking the one-story building there as the new home of the Film Recording and West Coast Operations facility of the Broadcast and Communications Products Division.

The new quarters are double the size of the old ones at 1560 North Vine Street, Hollywood, giving Manager Adron M. Miller and his engineering, production and marketing groups approximately 30,000 square feet of floor area.

The facility was established two and one-half years ago as an expansion of the former RCA Film Recording Products Department, long a familiar part of the Hollywood scene. Since then it has enjoyed steady growth and now includes the essentials of a Western branch headquarters of the Camden home office, providing many Division services to West Coast customers on an "around-the-corner" basis.

The larger quarters were required for the facility's increased work load and to provide space for future growth. As a supplier of equipment and services to the West Coast motion picture and TV industries, the facility designs and produces film sound recording equipment, television film recorders, television tape recorders, TV mobile units and large custom audio systems. In addition, it maintains a complete television systems engineering group which provides system design and assembly as well as installation supervision and checkout.

New home of RCA's Film Recording and West Coast Operations facility in Burbank, California, contains approximately 30,000 square feet of floor area, houses marketing, engineering and production groups.

Frank Marx (R), Pres., ABC Engineers, and Charles Colledge, V.P., RCA Broadcast and Communications Division, load up one of ABC's new total solid-state TR-22's.

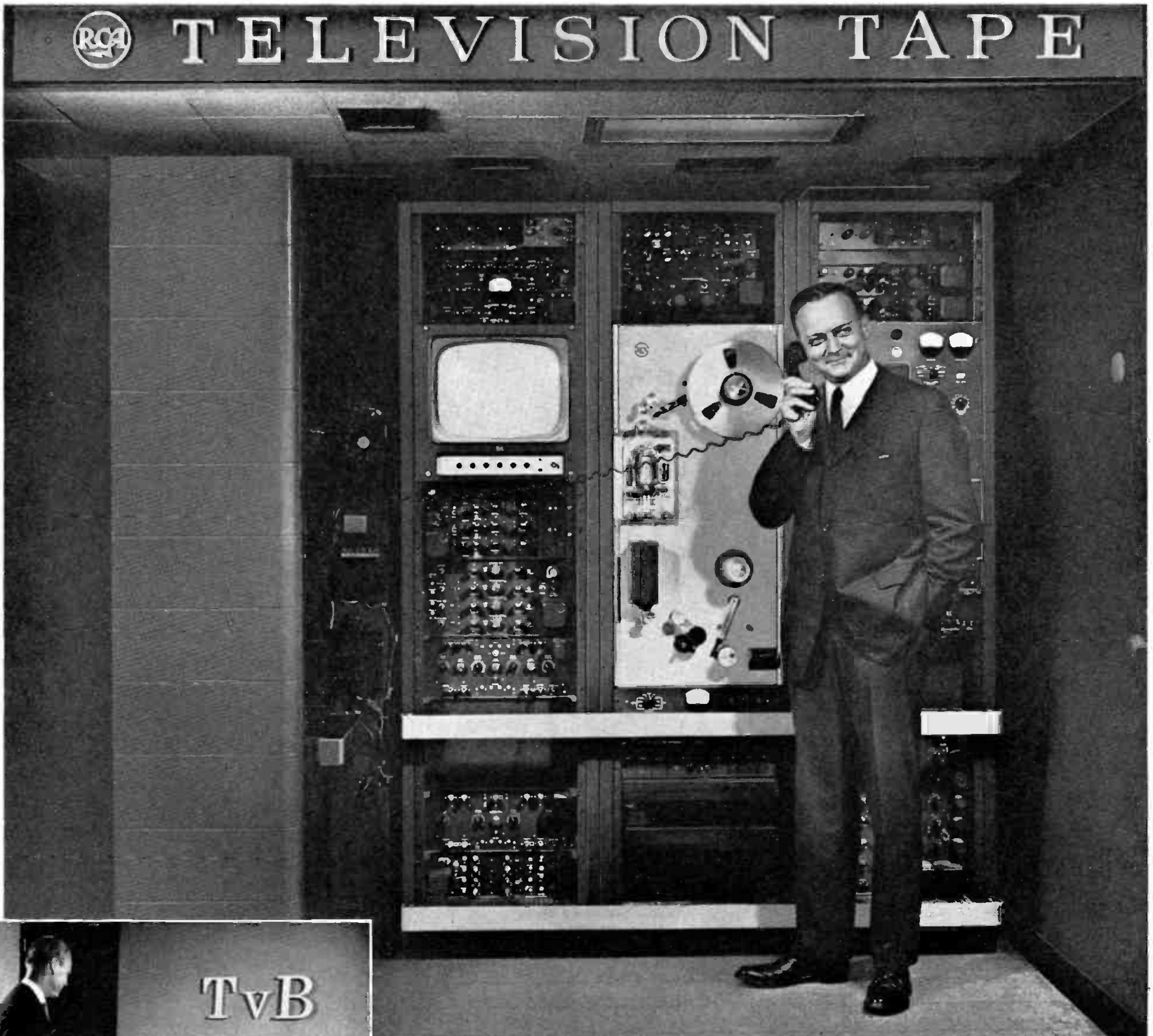


FIG. 1. Through a picture window facing the reception lobby, visitors get a full vista of TvB's salesmachine . . . an RCA TRT-1B Television Tape Recorder. It is here that members bring their tapes to be played.

TvB's SALESMACHINE

RCA TV Tape Becomes a Prime Sales Tool At the Television Bureau of Advertising

What started out as another member service of TvB has grown to be a promising television sales tool—the installation of RCA TV Tape.

When the Television Bureau of Advertising moved its headquarters in mid-1960, included in its plans was the installation of an RCA Color TV Tape Recorder. The new tape facility became an up-to-the-minute service, whereby member stations could present tapes of their commercials, programs and services to their representative and to advertisers and agency personnel in the New York City area. Use of the tape recorder has now expanded into other areas for making tape, areas that stimulate stations to more professional efforts and assist in selling to advertisers.

Successful TV Selling Tool

The service was an immediate success. Now members could demonstrate rather than merely talk about "hot" new local shows and the selling ability of local personalities. Via tape, member stations were speaking up for themselves, showing off their services—even bringing the stories of their markets to the advertisers for evaluation. Via tape, stations and their representatives became still closer friends. The personality of the station could come alive, and the reps selling job could be based more on actual demonstration and less on hearsay. TV tape had become a high level television selling tool.

Bonus Benefits Result

Mr. Norman E. Cash, president of the Bureau, and Mr. George Huntington, vice president and general manager, had planned the tape facility primarily to provide playback services. However, other latent selling potentials of tv tape soon became apparent. A feed from Channel 4 in New York City, for example, permitted direct recordings in color and black-and-white on the TvB machine. On occasions when the recorder was not being used in playback, TvB personnel would collect a sampling of commercials as they appeared on the air. This sampling has grown into a substantial library of taped commercials, categorized in product groups.

The tape library includes the well known Kraft food commercials in color. These, and others, have been invaluable to the Bureau staff and members in their discussions with prospective advertising groups. The tapes also serve as how-to-do-it source material, as research tools, and as visual evidence of the selling impact of the television medium.

Sales Films Transferred to Tape

From its film library of more than 2500 commercials, sales films and other presentations, the Bureau selected its promotional color film "The Exponential" to be transferred to color tape. The film-to-tape transfer service was provided by Reeves Sound Studios on their RCA color tv tape recorders. At that time more than 150 member stations were equipped with tape recorders—15 of these stations with color machines.

This experimental transfer proved highly successful. Tape equipped stations could demonstrate the effectiveness of television by means of television. In the months that followed several other sales films were transferred to tape for member use.

FIG. 2. Television becomes an important part of informal conferences in TvB executive offices. Tape pictures, to dramatize sales points, are available on the color receiver shown here.

FIG. 3. Headquarters for TV tape presentation is the spacious conference room. Accommodating 30 people, the room can be divided to handle two separate groups when desired.

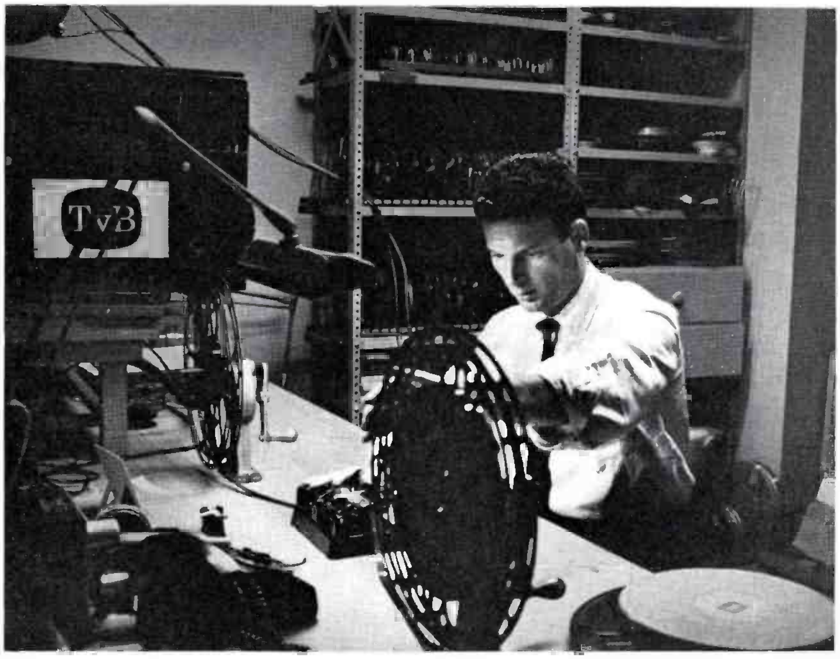


FIG. 4. Film editing and storage facilities are quartered here. The film library includes more than 2500 commercials, sales films and other film presentations.

Member Exchange

In less than a year members were making widespread use of the tape facilities, screening local tapes for national advertisers. KPRC, Houston, screened its coverage of Hurricane Carla to agencies and station people in New York as an example of the station's excellent public service production facilities. KSD-TV, St. Louis used the tape service to thoroughly indoctrinate their new representative firm with station policies, programs, personnel, and sales potential. WCAU-TV provided their sales tape, "The Pepsi Cola Story" to show to agencies, advertisers, and other members.

Tape duplicates of a number of these local offerings are made available for the use of members. Sales results have been impressive. For example "The Pepsi Cola Story", used to sell Philadelphia area Pepsi bottlers, has evoked extreme interest and actual sales in such widespread fields as local auto dealers and a potato chip firm.

Several other tape presentations can be directly linked to sales successes, both large and small. For example, one station reported a $30,000 sale . . . another, $6,000 . . . one representative's sales totalled $150,000 . . . a station group sold $65,000 worth of television—all through the use of the TvB Salesmachine.

Members also exchange fashion show tapes demonstrating one of the roles of tv in department store merchandising. Available to help stations crack local department store accounts are fashion shows of Macys, Denver Dry Goods, Alexander's, Orbach's and others. A TvB-produced fashion composite includes samples of the best of the member offerings.

Tape Clinics

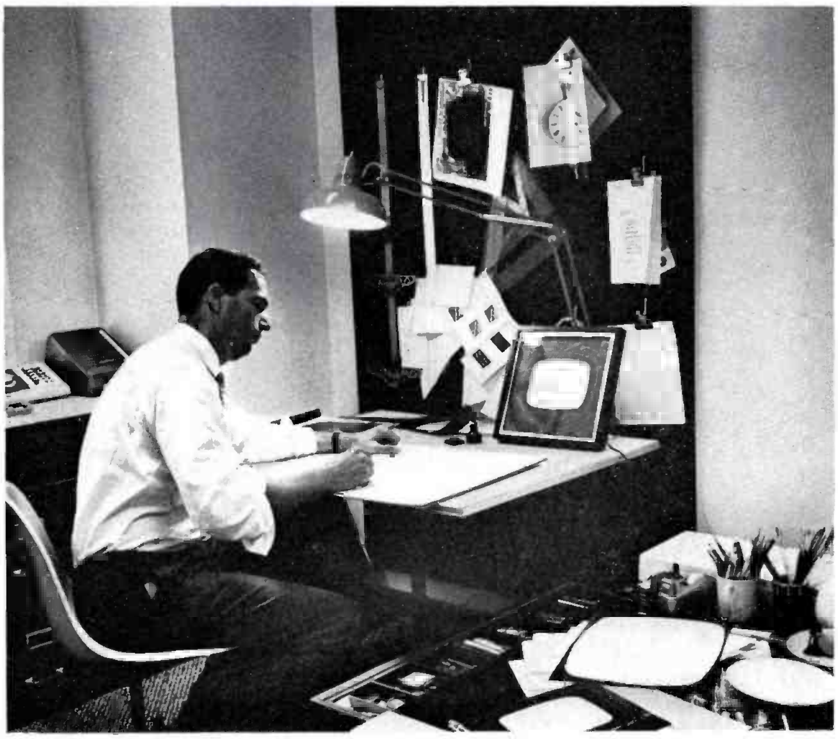
Since effective selling via tv is paramount to keeping advertisers coming back for more, the Bureau set up a tape clinic service to help stations keep abreast of the latest selling techniques in commercials and programs. Members are invited to send in tapes for confidential evaluation by staff members and other qualified experts.

A special feature of the tape recorder, the cue track, makes possible a spontaneous critique. Reactions, suggestions, tips on lighting, copy, pace, visual material are recorded on the cue track as the tape is being played. Upon return to the station, the resulting tape speaks for itself with an expert, honest appraisal of the presentation.

Expanding Use of Equipment

For more than a year the playback facility of the RCA recorder paid back generously—however the recording facilities had just begun to be tapped. The only recording source was an off-air feed. It would take camera chains and a studio to make recordings and fully use the other half of the equipment potential.

FIG. 5. A well equipped art department, located on the premises, is a source of visual material used for tape, film and printed presentations.



Early in 1962, the Bureau acquired a used TK-10 studio camera chain which was installed along with film origination equipment. The conference room and two executive offices were cabled up to accept the camera feed. TvB was now ready to record their own tapes.

Taping TV Success Stories

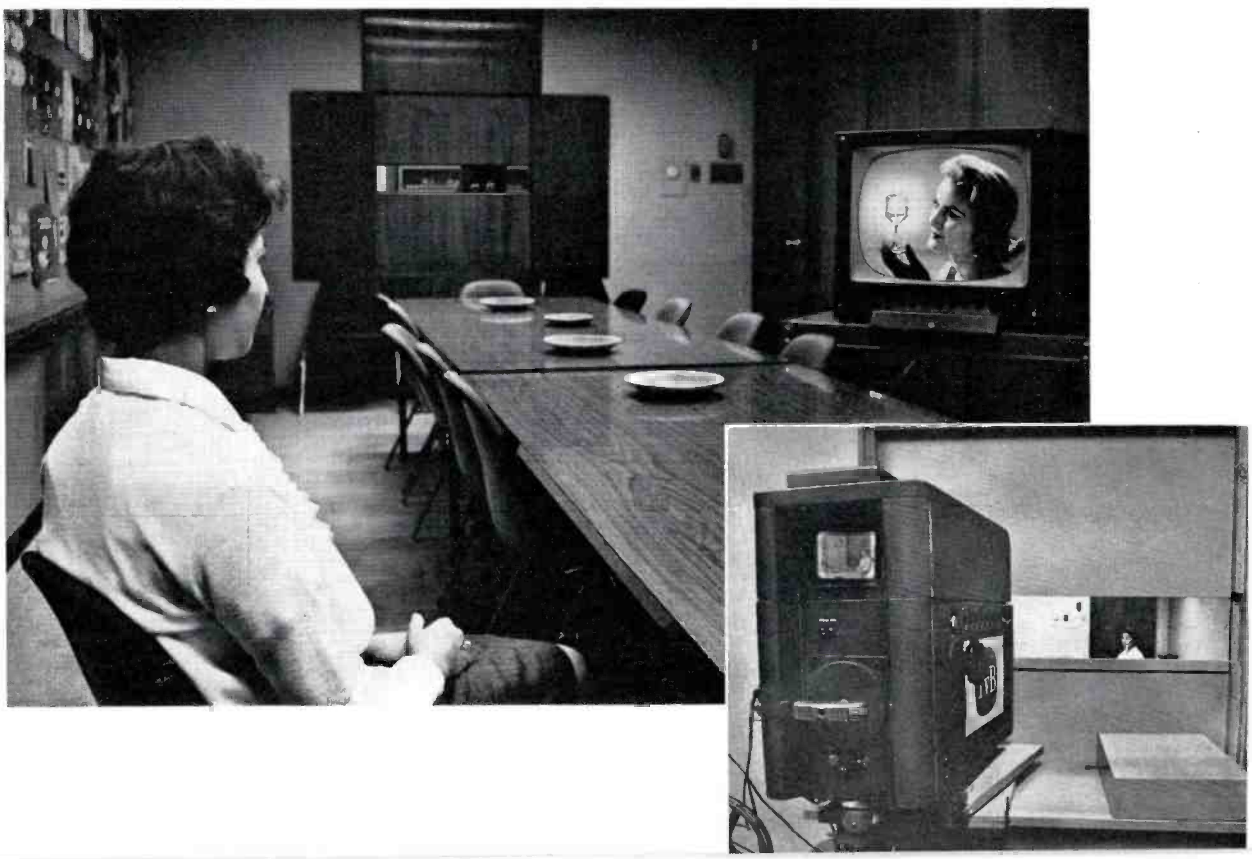
Every TvB working day includes dozens of consultations with television and advertising practitioners. From these sessions comes material for tv success stories, the reports of profitable use of the new medium. Some of the most important of these are the most fleeting in nature. The printed word, the prepared sales chart or the well-rehearsed film dramatization never seems to capture the firsthand enthusiasm of the story teller as he relates his experiences.

Equipped with camera and tape, TvB could now take advantage of the spontaneous reports of some of the nation's leading advertisers and agencies. The tv success story could come "alive" on tape.

An example of this kind of production is a half-hour tape documenting the success the American Gas Association has had with television . . . why and how they use the medium, and the way commercials prepared for the network programs are used by local gas companies throughout the country. Copies of this tape were made available

FIG. 6. A scene while taping "Sales Reports From Five Salesmen." Salesmen from five member stations relate their most memorable sale.

FIG. 7. In this research project a TV camera makes a tape record of responses as the young lady watches a series of TV commercials.



for member use. At least one member station reported a direct sales as a result of screening to a local gas company. This company is now using television as its *prime* advertising medium.

Another example is a tape interview with the Phillips-Van Heusen Director of Advertising explaining how and why spot tv was used in 155 markets.

Sales Training Tapes

What are the sales points that open up accounts new to tv? What arguments are most effective with local retailers?

The answers to these questions are a constant quest of TvB. They provide the fuel for member sales tools and sales training aids. Now, on tv tape the experiences of top-notch tv salesmen can be shared with those still climbing the ladder of success. The use of sales tools can be explained by their originators. Even the pros get a chance to practice their presentations and see themselves on tv tape before taking to the road.

A recent tape includes a panel discussion by five station sales managers and TvB's Bill Colvin. The subject: "Sales Reports from Five Salesmen". Each participant related how he had prepared for and closed a particular television sale, showing examples of the visual presentation materials he had used. This tape is available for member rental, so that it may be screened and studied by the station's sales staff.

How-to-do-it Tapes

How a store's newspaper ads can be translated directly to tv with a minimum of fuss and feathers is the subject of another tape currently being shown to retailers across the country. This tape demonstrates scissors and paste conversion, with the newspaper artwork providing the basic visual elements. Copy lines are supered over art to emphasize the audio message (the newspaper ad's basic copy theme).

The tape shows the commercial in its simplest form and goes on to illustrate further use of typical television techniques —how to use the zoom lens, slow pans, fades, dissolves and supers to get effect of motion on the artwork; how to add a musical score; how to prepare miniature sets; and how to integrate motion picture film. TV tape uniquely drives these points home by using the television screen to show not only how it's done, but also to provide the impact of the final, polished results.

Viewer Research Tool

Currently in progress is a viewer research project to determine viewer response to television commercials. The tv tape recorder and live camera are playing a key role in this project.

A single tv viewer (selected from a group that represents a sampling of people from many walks of life) is placed alone in a room with a tv set to view a selected group of commercials. Unknown to him, a tv camera is focussed on him, recording on tape his every response—squirm, smile, grimace, yawn. A precise timing reference is kept to synchronize playback of the tape recorder and a film camera chain on which the commercials are originated. The subject is interrupted at planned intervals, and then allowed to return to his viewing.

Several days later the viewer is tested on subject matter contained in the commercials. His score is checked against his tape to compare his attitude at the time the sales points he recalled were presented. Particular attention is paid to reactions during and following the scheduled interruptions. The tapes thus provide a vast amount of data for repeated study and evaluation.

USING TELEVISION TO SELL TELEVISION

In the Bureau's own words:

"TvB is the association of commercial television created to expand and improve the use of television as an advertising medium. For this most complex, fastest maturing, most rewarding medium, expanding and improving its use is equally complex, must be equally foresighted.

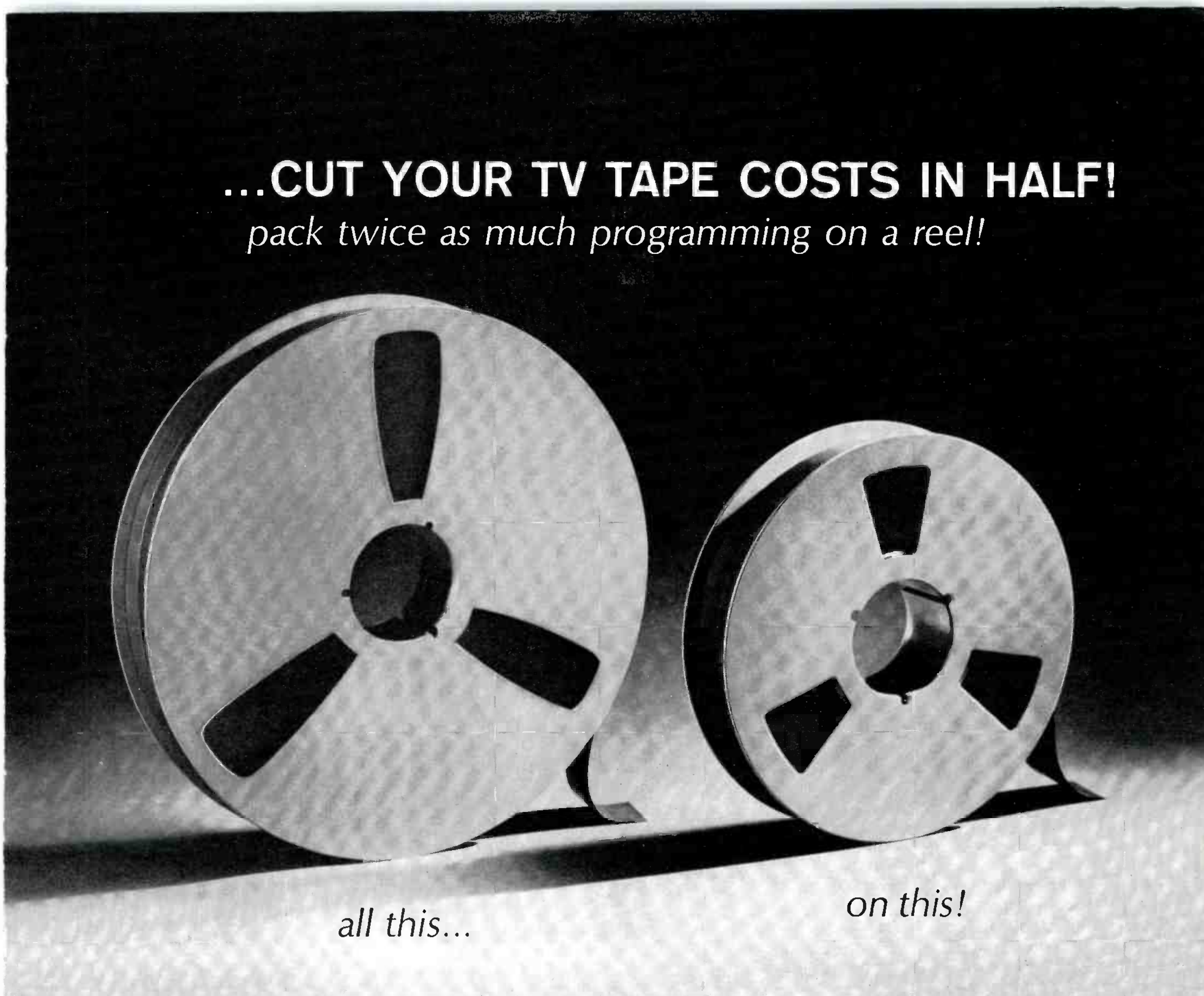
"For several years advertisers have responded to the salesmanship of television almost as rapidly as the public responded to the way of life around the television set. Other advertisers await the day when they consider themselves ready to use television. New products from long-standing television advertisers naturally go first to television.

"To these already-sold customers, TvB often provides proof of economic feasibility, audience selectivity, time availability. But it's seldom that simple.

"Even those who realize the inherent values of television may have problems with buying it, producing commercials, justifying costs, determining audiences, merchandising their buys. There are still advertisers, especially at the local level, who either do not understand the complexities of television or feel they cannot use it. To these, TvB offers its greatest help—consultations, presentations, new research, continuing services, new services.

"This is our job . . . and RCA TV Tape, our salesmachine, helps us do it better."

FIG. 8. Norman E. Cash, TvB President, relates the big job TV tape is doing for members in providing playback services, in stimulating the use of television with more professional results and in helping with sales of TV time and facilities on both national and local levels.



Photography Courtesy Reeves Sound Studios, Inc.

Now for color—as well as monochrome—this RCA development enables you to operate any RCA recorder at full or half speed

- **Permits 50% Cost Reduction in Tape Inventory**
- **Reduces Tape Storage Space**
- **Cuts Tape Distribution Expense**

This new engineering advance, available only for RCA TV Tape Recorders, combines all the benefits of standard quadruplex recording with the savings of half-track recording. It provides for tape speed to be switchable from conventional 15 inches per second to half speed at 7½ ips.

Since this new approach uses quadruplex recording, tapes are interchangeable with other standard machines. Regular 2-inch tape is used. Standard editing techniques are employed. There are no picture discontinuities. And there is no discernible difference in resolution. *You get the same high quality, the same color fidelity, that you are now getting from RCA recorders.*

HOW IT WORKS: A new RCA headwheel assembly and capstan motor make it possible to use half-track recording and to cut tape operating speed in half. The new recorded track is only 5 mils wide as compared with 10 mils for conventional recording. As a result, twice as many tracks can be recorded on the same length of tape—permitting twice as much programming to be packed on a standard reel.

See your RCA Broadcast Representative for complete details. Write RCA, Broadcast and Television Equipment.

RCA® The Most Trusted Name in Television

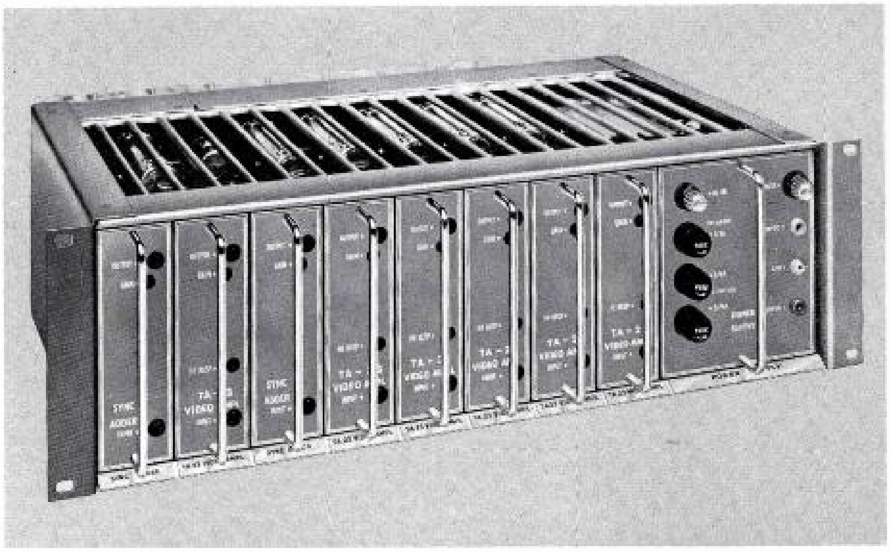


FIG. 1. Eight amplifiers and a regulated power supply are accommodated in this compact 5¼-inch rack-mounting frame.

TRANSISTORIZED DUAL-OUTPUT VIDEO DISTRIBUTION AMPLIFIER

TYPE TA-23

Requires 1/5 the Mounting Space . . . Features 1/20 the Heat Dissipation of Comparable Tube-Type Amplifiers

A new video distribution amplifier, completely transistorized, is now available to meet the most stringent specifications of video distribution systems—both monochrome and color.

The compact unit has application wherever video DA's are used. A number of amplifiers may be bridged across a common input signal source for multiple channel distribution service with excellent isolation between output circuits. Other valuable applications are its use for distributing color sub-carrier signals in color tv systems and as a level recovery amplifier following an equalized cable.

The new TA-23 uses transistors and semiconductor diodes exclusively as active elements. Power consumption is approximately 2 watts per amplifier. Eight units and a regulated power supply can be mounted in a rack mounting frame only 5¼ inches high. Due to the low heat dissipation and free flow of air through the amplifiers, frames fitted with amplifiers may be stacked one above another for maximum utilization of mounting space. The amplifiers operate within specifications over a free-air temperature range of 0 to +131 degrees F.

The circuit is constructed on an etched wiring board mounted to a steel plate which serves as a chassis and also as a shield between adjacent amplifiers. The plug-in connector has a positive snap-action retention feature, which secures the amplifiers but permits easy withdrawal and insertion. The gain control and a high-frequency response trimmer are accessible through the front panel, which also includes one input and one output test jack. In addition, one input and two output test jacks are located at the rear of the amplifier frame.

A single amplifier mounting frame accommodates eight amplifiers and their common plug-in power supply. Power and signal circuits within the frame are factory-wired. Signal circuits are wired to standard UHF-type coax connectors at the rear of the frame. At the front top and bottom edges of the amplifier frame are surfaces for identification labels which are supplied with each plug-in unit. Since the frame also accommodates plug-in units other than the TA-23, it is desirable to identify the positions in the frame as to type of unit and an identifying number for each position.

The amplifier is designed to produce a video level of 1.0 volt composite or 0.7 volt non-composite at its output, using any input voltage from 0.45 to 1.1v composite or 0.32 to 0.79v non-composite. Seven db of gain reserve with continuously variable gain control is provided to compensate for attenuation of a line equalizer which may be inserted ahead of an amplifier.

When distributing continuous color sub-carrier, an output level of 2.0 volts peak-to-peak and a frequency as high as 4.5 megacycles can be accommodated. Frequency response is flat within ±0.1 db from 1 cycle to 10 megacycles, regardless of gain control setting. The response at 20 megacycles is no more than 1.0 db down, and at no frequency is it above mid-band values. A square wave with .01 μsec rise time at the input can produce a 1.0 volt peak-to-peak square wave at the output with less than 1 percent overshoot observable on a .01 μsec rise time oscilloscope. Low-frequency tilt is less than 1 percent on a 60 cycle square wave.

Differential gain and phase are maintained at less than 0.5 percent and 1/3 degrees, respectively, for any average picture level from 10 to 90 percent. These results are obtained through the use of negative feedback. No operating-point adjustments are necessary, and EIA type transistors are used throughout.

Ac coupling is provided at the input, and a unique protection circuit completely protects the unit from continuous positive or negative faults up to 300 volts. Normal operation is automatically resumed when the fault is removed (no fuse used). The output is also ac-coupled, thus eliminating dc at the output—without requiring any dc balancing adjustments.

An input resistance greater than 7500 ohms is maintained, independent of whether power is on or off. The inherent shunt capacity at the amplifier input is isolated by a pair of coils leading to two separate input connector contacts, thus permitting loop-through connections to multiple amplifiers. The coils and capacity comprise a T-section filter with an image impedance of 75 ohms, thereby presenting a negligible discontinuity in a 75-ohm line. A variable capacitor is provided on the amplifier for trimming the image impedance to precisely match a given cable in critical applications. The T-section filter has a "cutoff" frequency greater than 130 megacycles, thus assuring negligible effects in the video band on amplitude and phase characteristics.

A unique switching arrangement at the plug-in connector bridges the two input coax connectors together when the amplifier is extracted. Thus, there is no interruption of the signal fed to the second input coax connector—and following amplifiers—when an amplifier is removed or inserted.

The output impedance is 75 ohms ±2 percent at 3.58 megacycles and is maintained within 75 ohms ±5 percent to above 8 megacycles. All spurious and extraneous signal effects, such as hum, noise, and crosstalk between amplifiers are 60 db below one volt, or better.

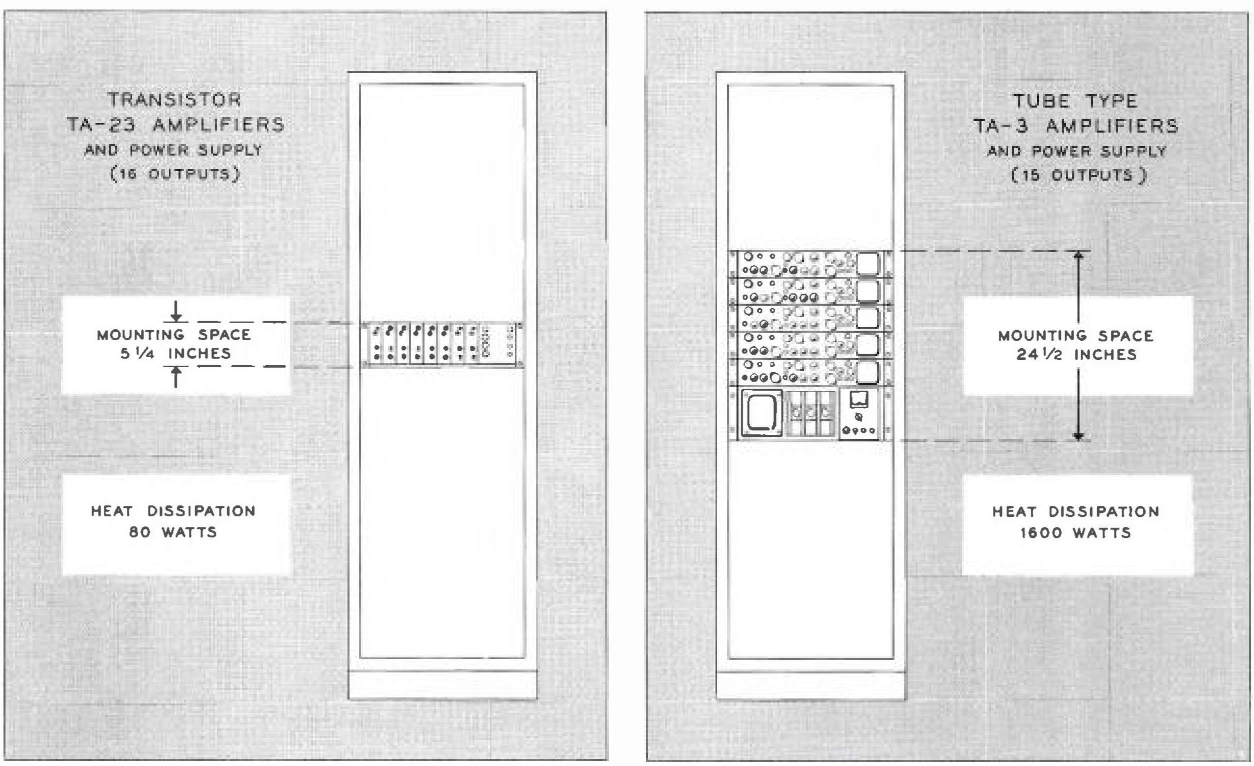
The power supply module furnishes two well-regulated voltages, +39 and −39 volts. The unit uses a regulating transformer and transistor series regulators, with "zener" diode references. Either 58 to 62 cycle power at 98 to 129 volts or 48 to 52 cycle power at 182 to 260 volts can be utilized. The entire input voltage range and frequency range for either of these connections can be accommodated without changing taps.

A sync adder is available for use with the TA-23 to add synchronizing signals to a non-composite video signal. The sync adder is in the form of a plug-in module similar to the amplifier and occupies the same amount of space in the mounting frame. It is normally connected in series with either output of the TA-23. It may be connected in series with the amplifier input for addition of sync to both of the amplifier output signals. Provision is included to inhibit the sync addition function by means of a diode gate circuit which is remotely controlled by an external source of dc bias voltage, normally supplied from a video switcher.

A module extender permits servicing a TA-23 amplifier or sync adder under operating conditions. The unit to be serviced is removed from the mounting frame and inserted in the extender which plugs into the mounting frame. All components are then accessible.

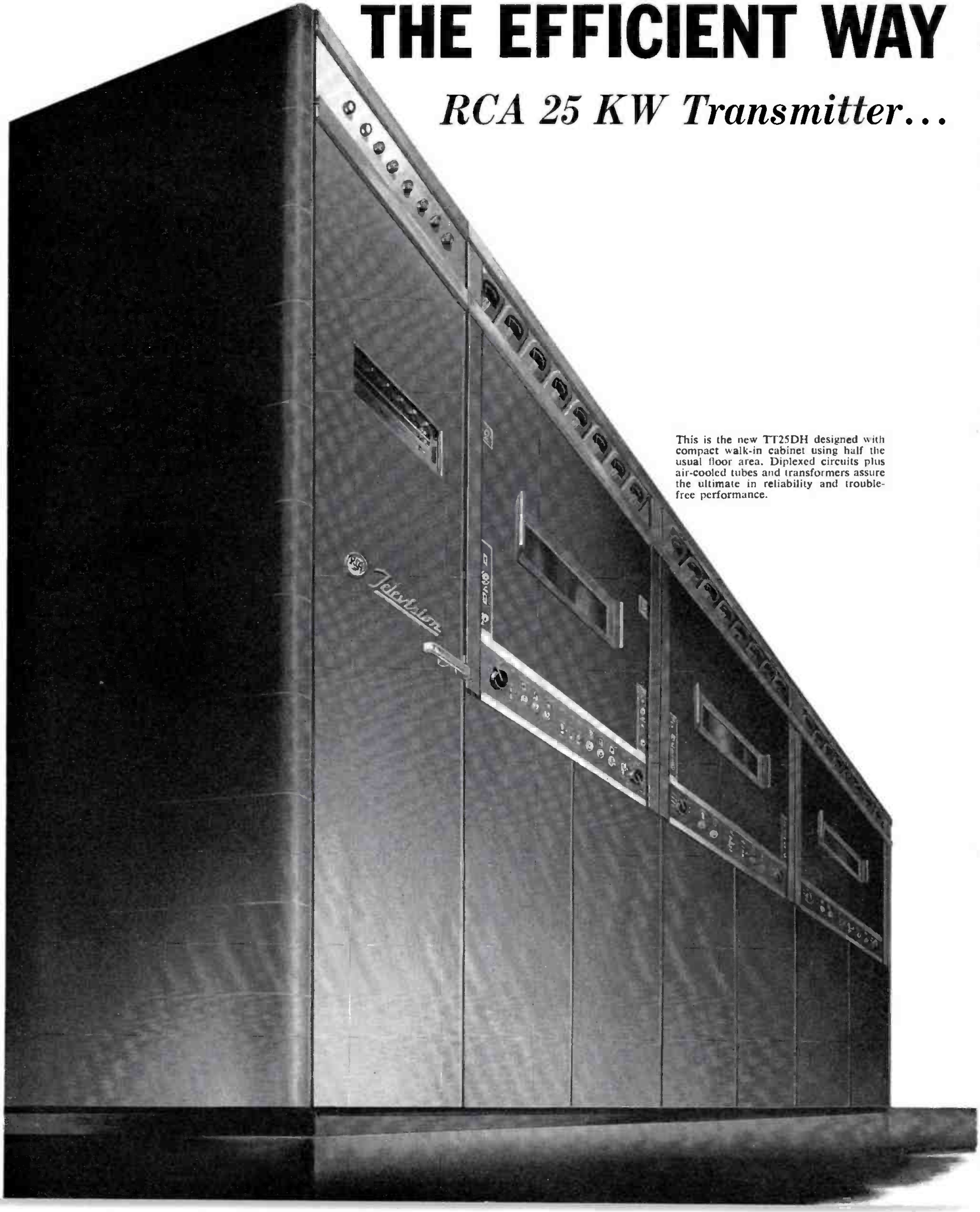
The TA-23 Video Distribution Amplifier is an outstanding example of transistorization of RCA tv studio equipment. Its design combines latest circuit techniques with the time-proved matched video system concept. It can be used in a variety of applications for both monochrome and color tv—improving the reliability and performance of the television distribution system.

FIG. 2. New TA-23 transistor distribution amplifiers mount in 1/5 the space . . . feature 1/20 the heat dissipation of comparable tube-type amplifiers.



THE EFFICIENT WAY

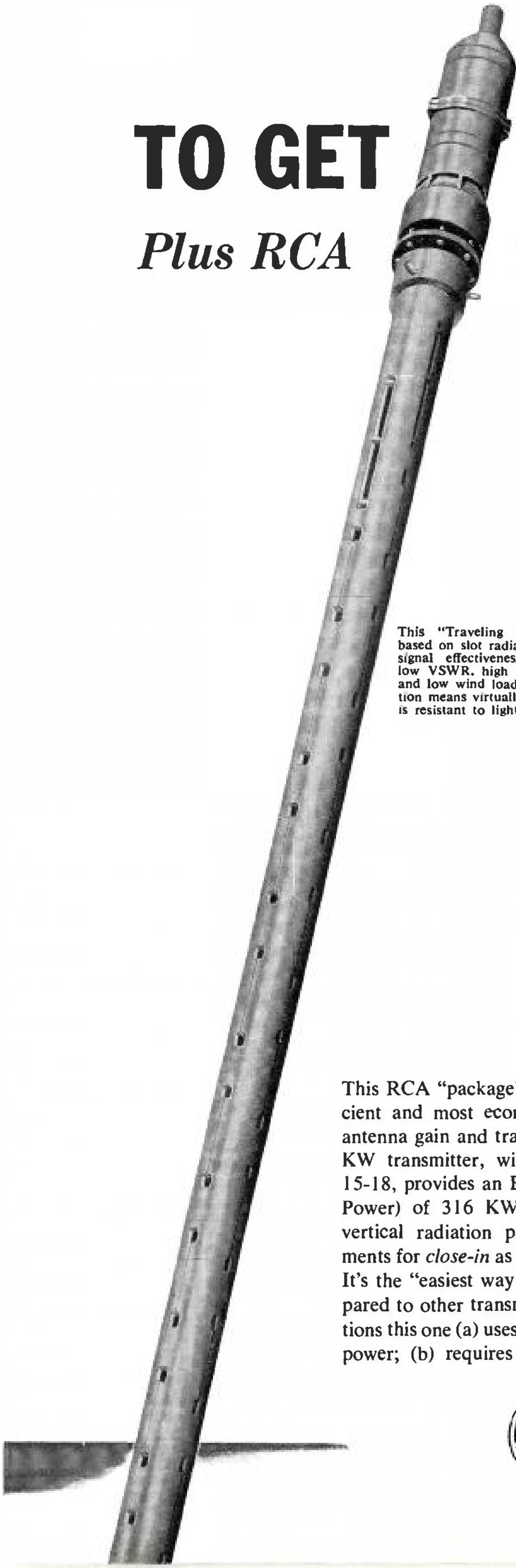
RCA 25 KW Transmitter...



This is the new TT25DH designed with compact walk-in cabinet using half the usual floor area. Diplexed circuits plus air-cooled tubes and transformers assure the ultimate in reliability and trouble-free performance.

TO GET 316 KW ERP!

Plus RCA Traveling Wave Antenna



This "Traveling Wave" antenna design based on slot radiators results in improved signal effectiveness, excellent circularity, low VSWR. high power handling capacity and low wind load. Simplicity of construction means virtually no maintenance and it is resistant to lightning damage.

This RCA "package" provides the most efficient and most economical combination of antenna gain and transmitter power. The 25 KW transmitter, with an antenna gain of 15-18, provides an ERP (Effective Radiated Power) of 316 KW. A carefully designed vertical radiation pattern satisfies requirements for *close-in* as well as *far-out* coverage. It's the "easiest way to get 316 KW." Compared to other transmitter-antenna combinations this one (a) uses only half the transmitter power; (b) requires only a fraction of the usual floor space; (c) cuts operating costs in half; (d) requires lower capital investment. RCA offers single-source supply, undivided responsibility, and matched equipment. RCA supplies all hardware—arranges for installation, if desired. And RCA is on call for service 24 hours a day.

Your RCA Broadcast Representative is ready to help you work out the best proposition to fit your requirements. Call him, or write RCA, Broadcast and Television Equipment.

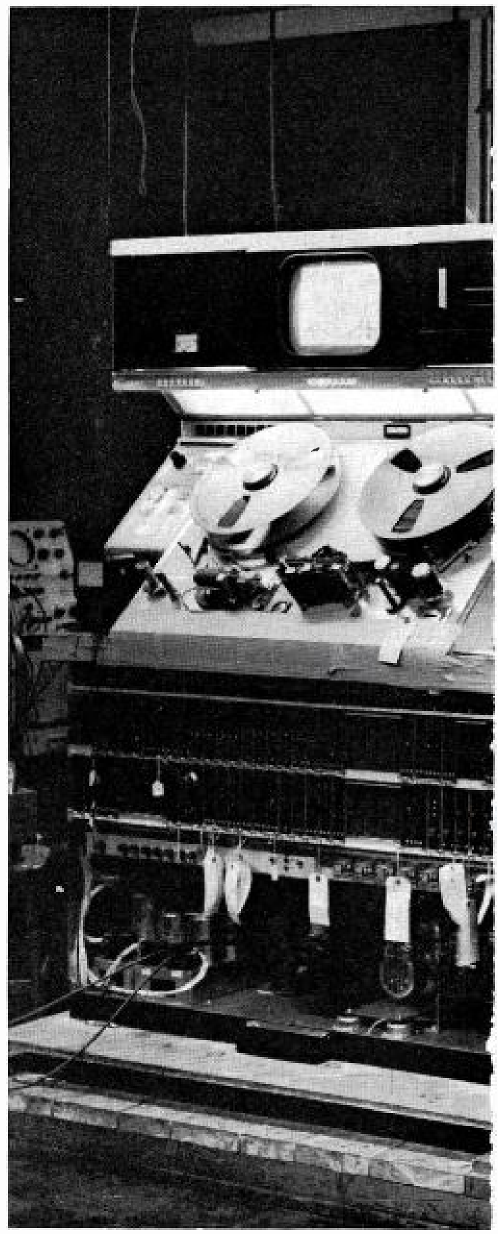
RCA®

The Most Trusted Name in Television

THE TR-22

. . . A DELUXE, ALL TRANSISTOR TELEVISION TAPE RECORDER

by A. C. LUTHER and R. N. HURST
Broadcast and Television Engineering



With TR-22 TV Tape Recorders now rolling off production lines, the broadcaster may now purchase the finest television tape recorder ever built. Beautifully styled and engineered for reliability, this self-contained, completely solid state recorder opens new vistas to the broadcaster in the making of trouble-free, error-proof tape recordings, and in the high-quality reproduction of recorded tapes. In short, the styling, performance, and reliability of the TR-22 are destined to set the standards of excellence in television tape recorders for many years to come.

Self-Contained Console

Careful attention has been paid to the external appearance of the machine, with the result that the TR-22 is an equipment which will enhance the appearance of any installation. Moreover, this beautifully-styled console is self-contained—there are no external racks or accessories. All electronics, all pumps and blowers, all dc power supplies—everything required for high-quality recording and playback—are neatly packaged in one single console.

FIG. 1. The first TR-22 TV Tape Recorder off production lines is inspected by Frank Marx, President, ABC Engineers, and C. H. Colledge, Vice President, Broadcast and Communications Products Division, RCA. The American Broadcasting Company is installing two of these recorders in its Washington, D.C. News facility.

Accessibility is enhanced in this type of construction by the use of plug-in modules for all electronic circuitry. Further, by careful arrangement of all mechanical devices, almost all normal operation and maintenance can be accomplished from the front of the machine.

The console contains its own self-contained blower system for forcing filtered cooling-air around all components. This serves further to assure reliable, long-life performance.

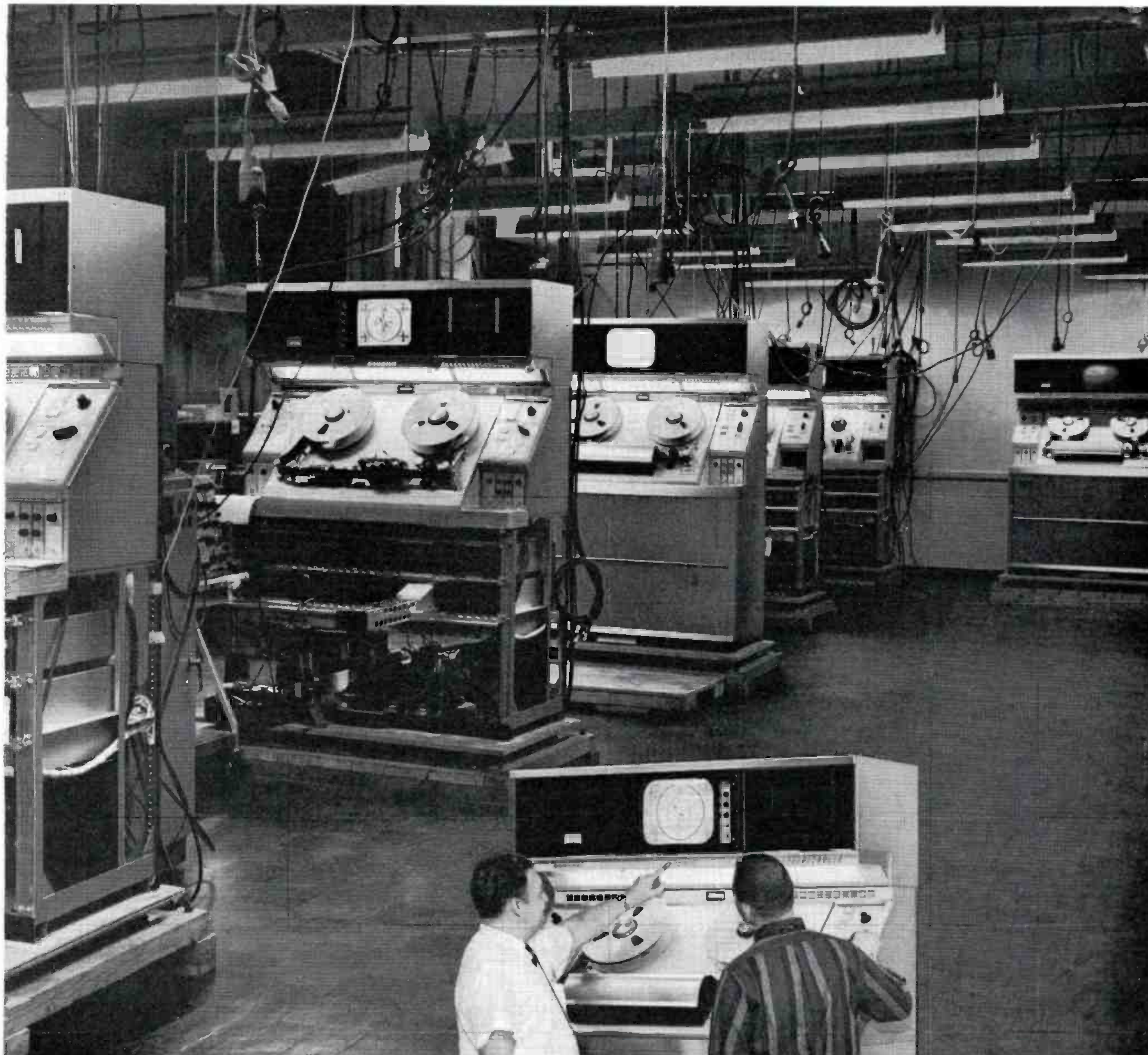
Any air noise which might come from this blower is effectively muffled by thorough sound-proofing of the entire console. This sound-proofing also deadens noise from pumps, motors and solenoids, making the TR-22 a quiet machine which is, therefore, more pleasant to operate.

All-Transistor Circuitry

The advanced circuitry of the TR-22 uses semiconductors to perform all circuit functions necessary to the recording and playing back of television tapes. The only vacuum tubes in the entire recorder are found in the monitor and cathode-ray oscilloscope. Several advantages are gained by this total transistorization. First, there is extremely rapid warm-up time. Although the conservative specifications call for a warm-up period of 5 minutes, it has been repeatedly demonstrated that, as a practical matter, the TR-22 will playback an excellent picture less than five seconds after it is turned on—from a cold start!

Second, is the all-important consideration of reliability. Increasing numbers of broadcasters are discovering that transistor circuitry, unhampered by the finite life expectancy of hot cathodes, will operate month after month, and even year after year, with surprisingly little attention.

A prerequisite to such reliability is careful, conservative engineering, executed to extract from transistorization all the extended-life potential of semiconductors. Using only well-specified transistors and diodes, and preceding each practical circuit realization with thorough "paper" design, RCA engineers have produced a composite circuit in which each of the 750 transistors



and 350 diodes in the TR-22 is known to operate conservatively and reliably over the specified temperature range.

A third advantage of transistorized equipment is the ease and safety of servicing low-voltage equipment. A fourth advantage—decreased floor space requirements—is particularly important to the chief engineer who must get the maximum utilization of his available plant facilities. Other advantages include such features as: decreased power consumption, decreased air conditioning requirements, and increased portability.

FIG. 2. First of the TR-22's to be processed through factory tests prior to delivery to TV installations in the U. S., Canada and abroad. Below first TR-22 passes rigid factory test with flying colors.

1 FIG. 3. The monitoring deck of the TR-22 includes high quality 14-inch picture monitor (center), TO-2 precision waveform monitor (right) and audio monitor (left) including speaker and VU meter.

2 FIG. 4. The tape deck slopes at a 45-degree angle giving the operator maximum convenience, comfort and accessibility for routine control and operating functions.

"FOUR MAJOR AREAS"

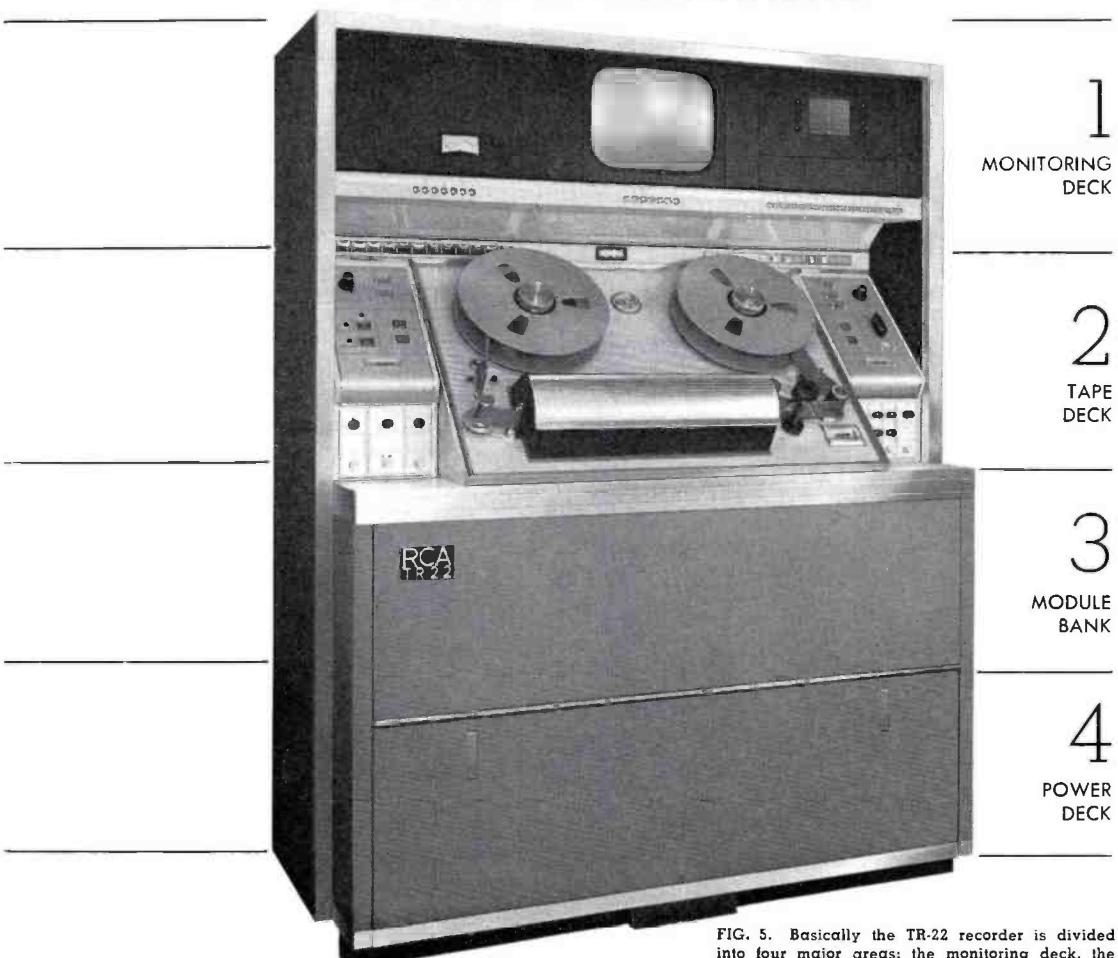


FIG. 5. Basically the TR-22 recorder is divided into four major areas: the monitoring deck, the tape deck, module bank, and power deck.

General Description

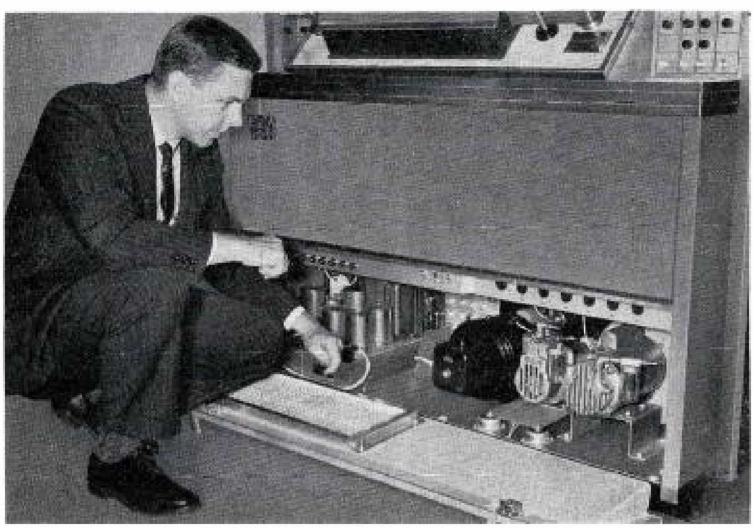
Basically, the machine is divided into four major areas: The monitoring deck. the tape deck and operational area. the module bank or electronics area. and the power deck.

At the monitoring deck. along the top part of the machine, are located (from left to right) the audio monitoring facility. the video monitoring facility, and the waveform monitoring facility. Directly below the monitoring area (again left to right) are the RECORD control panel. the tape transport, and the PLAY control panel. Below these are located 44 transistorized modules (visible only when the front-panel door is opened) which contain the circuitry for video and FM processing and for all the servos required by the machine.

Removal of the panel below the module bank reveals the power deck, which contains the power supplies, the headwheel blower. the vacuum and pressure pumps, the air bearing pumps and the main cooling blower.

3 **FIG 6. The module bank or electronics area houses 44 modules which contain circuitry for video and FM processing and for all the servos required by the machine.**

4 **FIG. 7. Removal of the console base panel reveals power supplies. the headwheel blower. vacuum and pressure pumps. air bearing pumps and the main cooling blower.**



Human Engineering

One of the salient features of the TR-22 is the close coupling achieved between the machine and its human operator. This situation is brought about by careful attention to the many factors involved in *human engineering*. The result of such care is a machine which is extremely easy to operate, with a consequent reduction in the possibility of operator errors.

Human engineering studies, made in the earliest phases of design, revealed that a 45 degree angle is optimum for the tape transport. The accuracy of these studies is borne out by the ease of loading and threading immediately apparent the first time one changes reels and puts the recorder into operation.

Other studies located the proper positions for operating controls, and pointed out the wisdom of separating the record-function controls and the play-function controls. This minimizes the possibility of accidental erasure of valuable program material, or any similar mishap. In the TR-22, these controls are separated by the entire tape transport panel.

Monitoring facilities, as a result of the same studies, are located at eye-level and ear-level, with the pushbuttons controlling these functions just below the respective monitors. In this manner the operator can see at a glance whether he is monitoring input. output, or some internal point.

Just above the tape transport, on the left. are located several red warning lights. Their primary purpose is to prevent the operator from making a faulty recording. These lights flash to warn the operator of such things as loss of a video-head record-current or the failure of a servo. Although these faults could also be located by a check-out procedure using the monitoring facilities included in the machine, the continuously operating warning system is far better assurance against the loss of valuable recording time or loss of irreplaceable program material.

To the right of these red warning lights is a row of white lights called *mode lights*. These lights provide a continuous visual indication of the mode of the machine—that is, whether the servo system is in *tonewheel* or *pixlock* mode, or what type of pre-emphasis and FM deviation standard is being employed. Although these factors could be determined by a careful check of the machine, controls providing the operator with a continuous means for checking his machine modes (by flicking his eyes across a row of lights) is much more reliable, foolproof, and faster.

Human Engineered ... For Easiest Tape Operations

Among the human engineering features introduced in the TR-22 are a 45-degree angle tape deck for ease in loading reels and threading tape. Recording and playback controls have been separated to minimize errors. Monitoring facilities are located at eye and ear levels with the pushbuttons controlling their functions located immediately below each of the monitors. Also a series of warning lights, which operate continuously, prevent faulty recording. These features and others make premium performance standard in the TR-22.

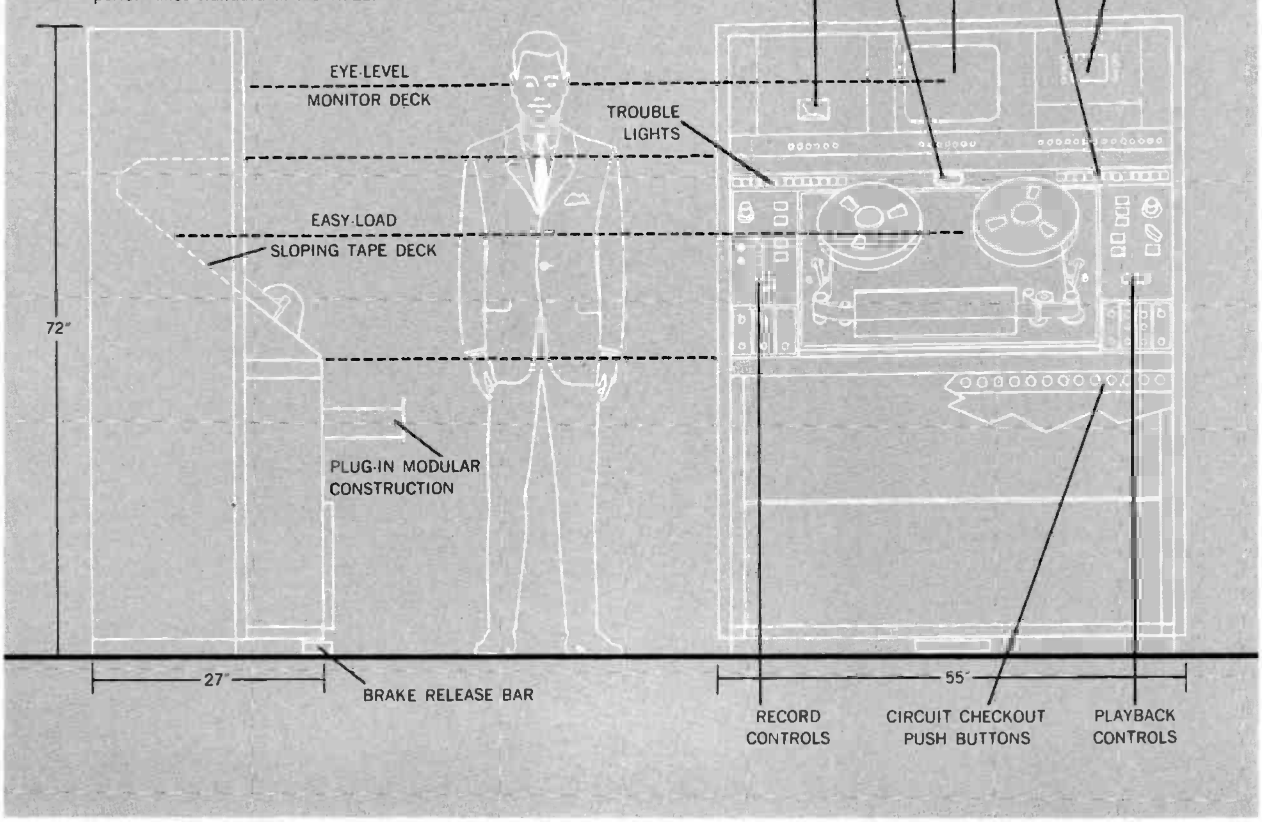


FIG. 8. A high quality 14-inch picture monitor and newly-designed waveform monitor are located at the operator's eye level. Pushbuttons at the base of monitoring facility expedite check-out, keep the operator informed of what he is looking at.

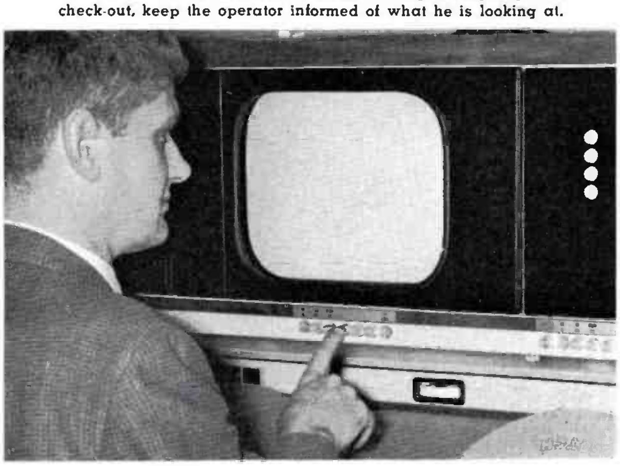
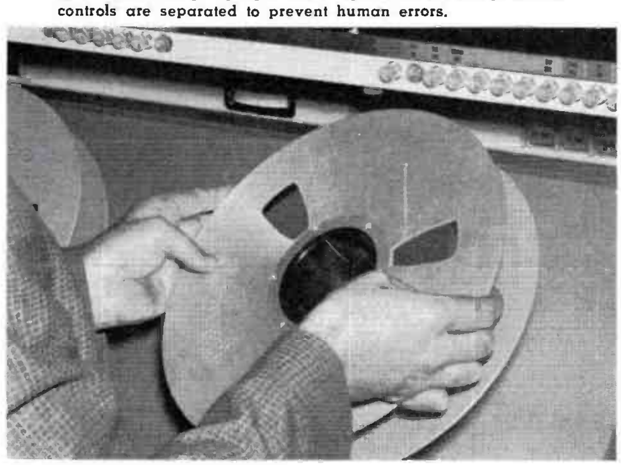


FIG. 9. Sloping design of the tape deck simplifies the loading of reels. The reels slip on and off with ease to facilitate editing, splicing, handling of programs and spots. Record and playback controls are separated to prevent human errors.



Major Sub-Systems of the TR-22

A more thorough understanding of the new recorder may be obtained by dividing its functions into five sub-systems: (1) The Video System, which includes the FM system and the signal processing as well as the video circuits themselves; (2) The Audio/Cue System, which includes erase and bias generation; (3) The Servo System—capstan, headwheel, and guide—; (4) The Control System; and, (5) The Mode and Warning Systems.

1. VIDEO SUB-SYSTEM

The video sub-system includes four groups: (1) The *Modulator Group*, where the incoming video is modulated in the FM format which is recorded on the tape; (2) The *Record/Playback Group*, where the FM signal is recorded on tape or played back from tape; (3) The *Demodulator Group*, where the FM signal is converted back to video; and (4) The *Processor Group*, where the demodulated video has the synchronizing and blanking components regenerated and re-inserted. Since each of these groups is more or less complete in itself, each may be considered separately.

Modulator Group (Fig. 13)

Video input to the TR-22 is brought first to the video input module (No. 103). Here, level control is provided, and the video is distributed to the picture monitor, the CRO, and the rest of the machine by a 3-output distribution amplifier included in the module. This module also contains a sync separator, which strips sync from the incoming video and sends it to the modulator for clamping. Also, during recording, this sync is used as a reference for the servos.

The main video output of the video input module is sent to the FM standards module (No. 205). Here it is pre-emphasized by the proper amount to make a standard recording. The operator can choose the proper pre-emphasis for the particular type of recording he wishes to make by means of a 5-position switch on the front panel of this model. See Fig. 12. One of the positions selects the proper pre-emphasis for a monochrome recording; a second, the pre-emphasis for color recording. The remaining three positions provide room for future standards or for any special standard which the TR-22 owner may wish to add to his machine.

This same 5-position switch also selects, automatically, the proper deviation standards for the type of recording being made. Moreover, it automatically sets up the playback post-emphasis standards to agree with the selected pre-emphasis standard. Since this switch controls the all-important pre-emphasis, post-emphasis, and deviation of the machine, its position is indicated on the mode lights in the upper right-hand corner of the operating area.

FIG. 12. A five-position switch on the front of the FM standards module selects proper pre-emphasis for monochrome or color recording or for any special pre-emphasis desired.

FIG. 13. Modulator group block diagram. Incoming video is modulated in the FM format, which is recorded on the tape.

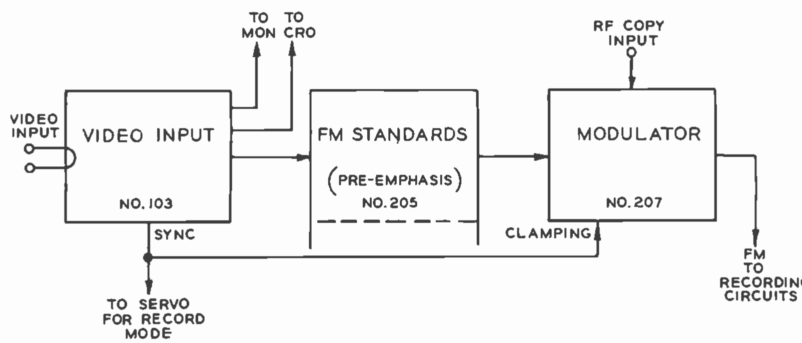
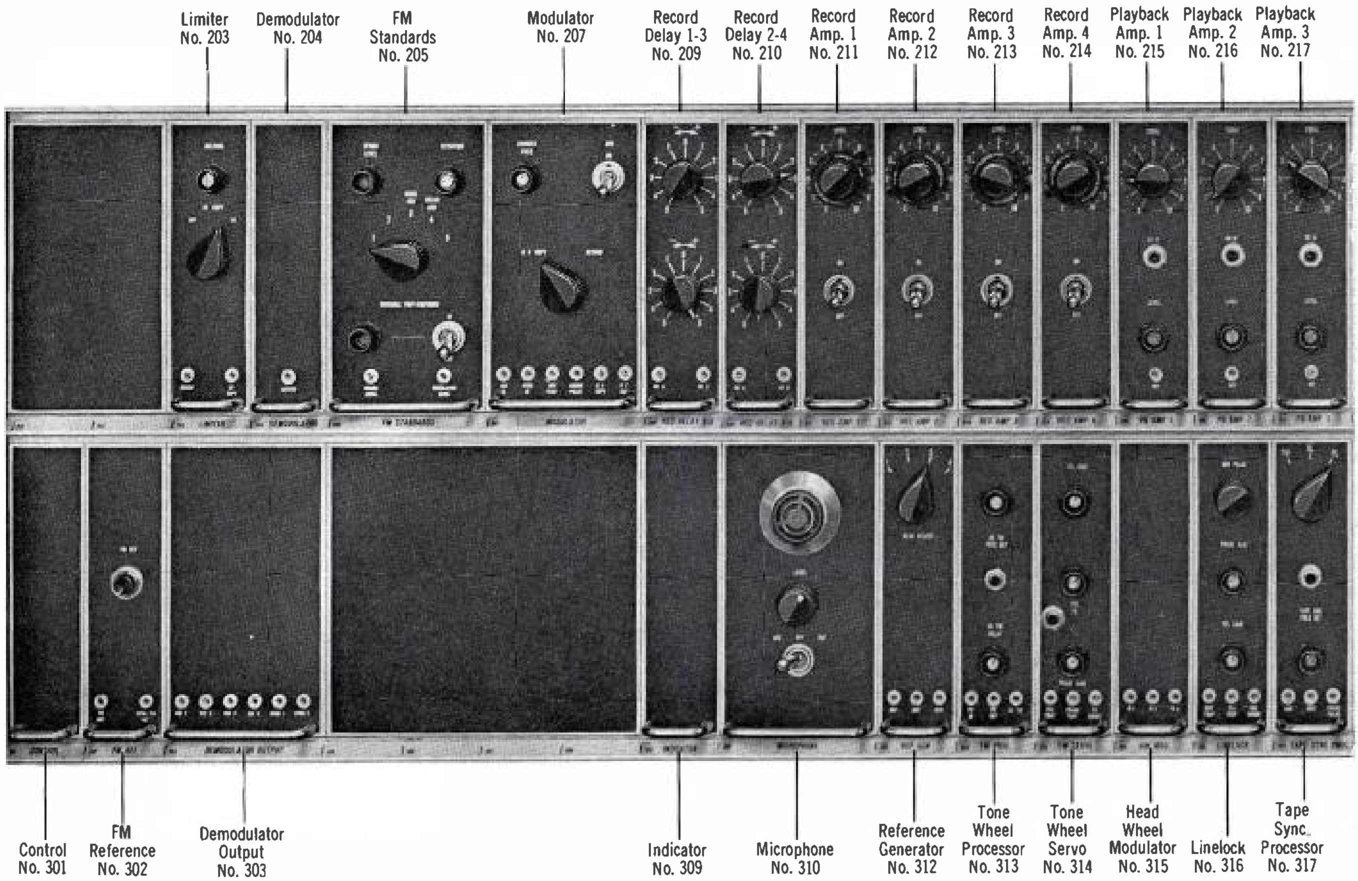


FIG. 10. Frequently used controls: play, standby, stop, etc. are located at the natural extension of the operator's arm. Less frequently used controls are beyond the operator's reach so that they cannot be disturbed during normal operation.

FIG. 11. A single protective cover shields the video headwheel assembly and the audio, erase, cue and control track heads. This slides back against the tape deck for easy threading . . . from a natural and comfortable position.



TR-22 Module Bank . . . Description of Functions

Limiter—No. 203
FM signal is converted to push-pull, passed through several stages until overall limiting characteristic of at least 55 db is achieved.

Demodulator—No. 204
Accepts signal from limiter. Contains demodulator and output filter circuits.

FM Standards—No. 205
Video input is pre-emphasized to make a standard recording. A five-position switch selects proper pre-emphasis for monochrome, color, or other special standards. Post-emphasis for the playback signal is also provided.

Modulator—No. 207
Clamps pre-emphasized video at the sync-tip level to modulate a capacity-diode-controlled heterodyne-type modulator. Circuitry included for rf copy facility.

Record Delay 1-3—No. 209
Record delay amplifiers for heads 1 and 3. Adjustable delays are introduced to compensate for head quadrature errors.

Record Delay 2-4—No. 210
Record delay amplifiers for heads 2 and 4. Adjusable delays are introduced to compensate for head quadrature errors.

Record Amplifier 1—No. 211
Output from record delay amplifier No. 1 is increased in level to a value sufficient for recording on tape.

Record Amplifier 2—No. 212
Output from record delay amplifier No. 2 is increased in level to a value sufficient for recording on tape.

Record Amplifier 3—No. 213
Output from record delay amplifier No. 3 is increased in level to a value sufficient for recording on tape.

Record Amplifier 4—No. 214
Output from record delay amplifier No. 4 is increased in level to a value sufficient for recording on tape.

Playback Amplifier 1—No. 215
Gain circuit and equalizer amplifier for correcting variations of frequency response in Channel No. 1.

Playback Amplifier 2—No. 216
Gain circuit and equalizer amplifier for correcting variations of frequency response in channel No. 2.

Playback Amplifier 3—No. 217
Gain circuit and equalizer amplifier for correcting variations of frequency response in channel No. 3.

Playback Amplifier 4—No. 218
Gain circuit and equalizer amplifier for correcting variations of frequency response in channel No. 4.

Playback Delay 1-3—No. 219
Playback delay amplifiers for heads 1 and 3 for correcting head quadrature errors in playback.

Playback Delay 2-4—No. 220
Playback delay amplifiers for heads 2 and 4 for correcting head quadrature errors in playback.

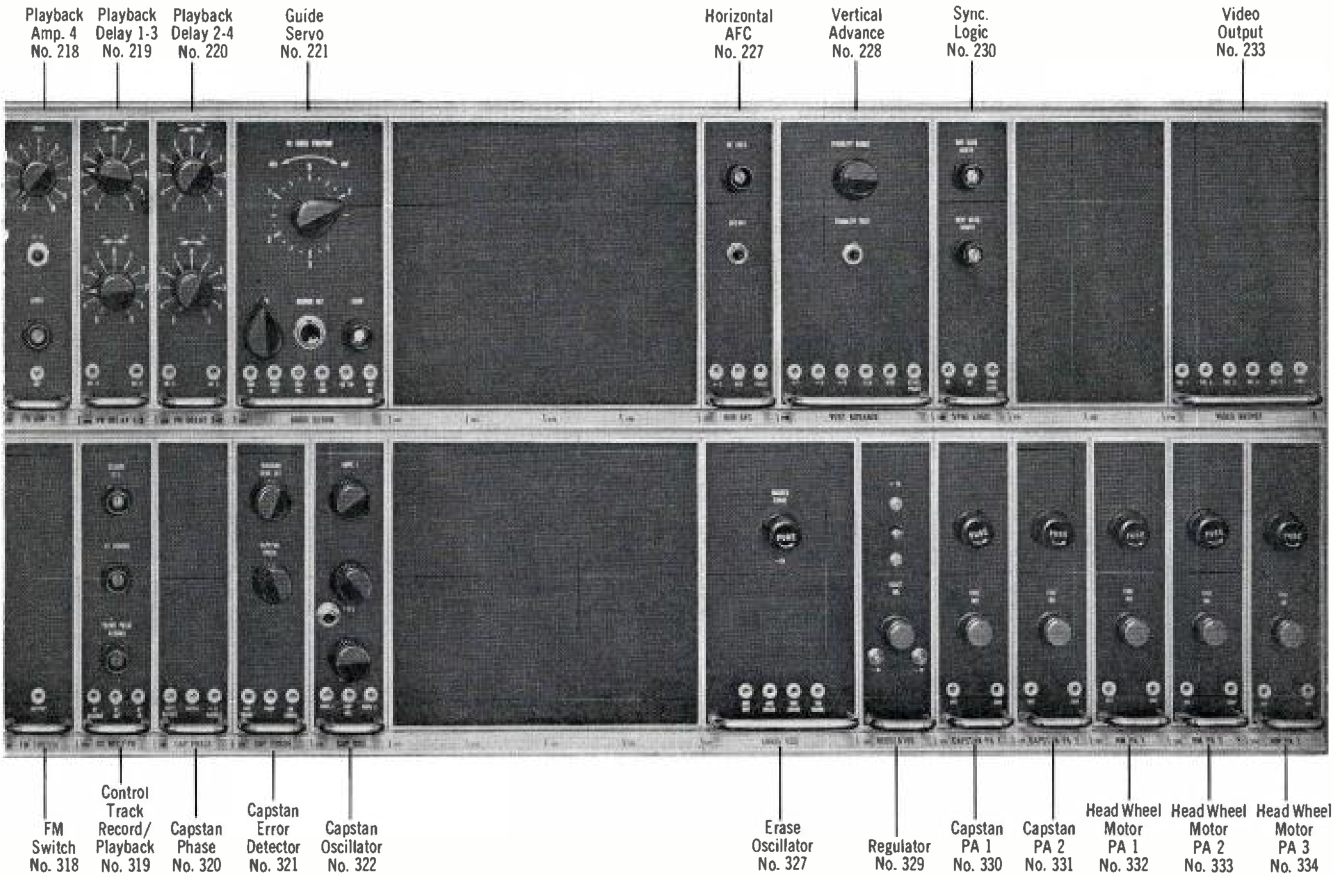
Guide Servo—No. 221
Controls position of the guide to produce skew-free pictures. Functions in automatic, manual, record, and record-set modes of operation.

Horizontal AFC—No. 227
Tape sync from the demodulator output is used to control the frequency and phase of a multivibrator. This, in combination with other circuits, generates a new horizontal sync, front porch, and blanking.

Vertical Advance—No. 228
Special circuitry counts out the number of pulses in a field, to determine very accurately the position for regenerated vertical blanking.

Sync Logic—No. 230
Generates horizontal and vertical blanking; combines them into composite blanking. Combines tape sync and regenerated horizontal sync into composite regenerated sync. Generates a start pulse which phases the counting of the vertical advance circuitry.

Video Output—No. 233
Two sending-end-terminated line drivers distribute video within the machine. Three sending-end-terminated line drivers provide outputs from the machine.



Control—No. 301
Part of control system. Provides inhibit logic and time delays.

FM Reference—No. 302
Provides two reference frequencies keyed in from crystal oscillators. References are introduced on alternate vertical blanking intervals and represent precise sync-tip and peak-white frequencies.

Demodulator Output—No. 303
Separates tape sync from the tape signal. Provides line drivers to feed unprocessed video to monitoring circuits and to processing amplifier.

Indicator—No. 309
Senses machine performance and lights trouble indicator in the event of malfunction.

Microphone—No. 310
Houses microphone and mike-cable reel, with microphone amplifying circuits. Permits operator to record on either audio or cue tracks.

Reference Generator—No. 312
Processes local sync to produce horizontal-rate reference, field-rate reference and frame-rate reference.

Tone Wheel Processor—No. 313
Shapes the tonewheel pulse and also provides 960-cycle switcher drive.

Tone Wheel Servo—No. 314
Derives error signal controlling the headwheel motor in the tonewheel mode of operation.

Headwheel Modulator—No. 315
Amplitude-modulates the headwheel motor-drive sine waves. Gives wide-band three-phase output.

Linelock—No. 316
Provides line-by-line lock-up in the Pixlock mode.

Tape Sync Processor—No. 317
Processes tape sync to produce horizontal-rate reference, field-rate reference and frame-rate reference.

FM Switch—No. 318
Switches between heads during playback, connecting the head scanning the tape to the output.

Control Track Record/Playback—No. 319
The 240-cycle control track signal is amplified, filtered to produce a clean 240-cycle sine wave, clipped, and shaped into a pulse.

Capstan Phase—No. 320
The preceding pulse feeds a chain of binary counters which divide the pulse frequency by eight to produce a 30-cycle output pulse.

Capstan Error Detector—No. 321
A phase detector which compares incoming pulse to the local frame pulse and produces a d-c voltage proportional to the magnitude of the phase error.

Capstan Oscillator—No. 322
D-c error voltage controls the frequency of the oscillator which supplies the drive frequency for the capstan motor. Tape speed is thereby synchronized to local reference.

Erase Oscillator—No. 327
Supplies 87.5 kc erase and bias current to the audio and cue heads.

Regulator—No. 329
Provides regulated voltages to operate the transistor circuitry of the machine.

Capstan PA 1—No. 330
Power amplifier for one of the two phases required by the capstan motor.

Capstan PA 2—No. 331
Power amplifier for one of the two phases required by the capstan motor.

Head Wheel Motor PA 1—No. 332
Power amplifier for one of the three phases required by the headwheel motor.

Head Wheel Motor PA 2—No. 333
Power amplifier for one of the three phases required by the headwheel motor.

Head Wheel Motor PA 3—No. 334
Power amplifier for one of the three phases required by the headwheel motor.

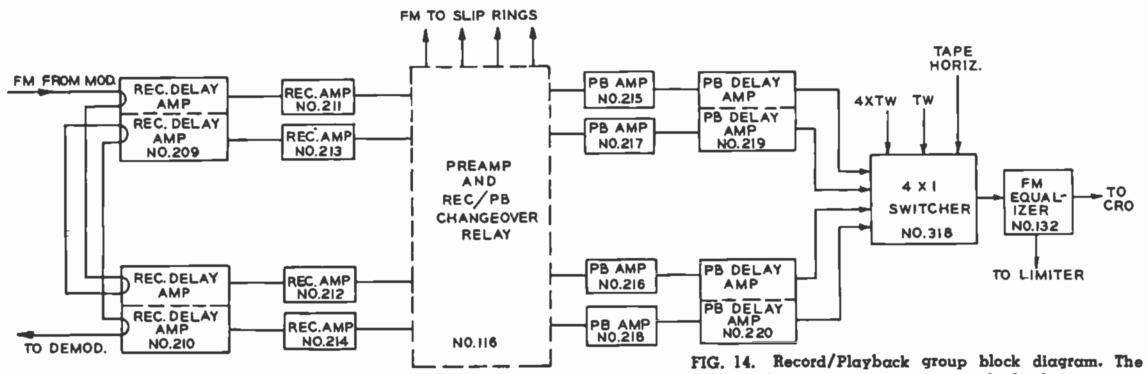


FIG. 14. Record/Playback group block diagram. The FM signal is recorded on tape or playback from tape.

The pre-emphasized video is now passed to the modulator module (No. 207). Here it is clamped at the sync-tip level and used to modulate a capacity-diode-controlled, heterodyne-type modulator. Circuitry included in this module provides an RF copy facility.

Record/Playback Group (Fig. 14)

The frequency-modulated video signal is recorded on the tape via the 4 video heads on the headwheel. The signal from the modulator feeds the four record delay amplifiers, where adjustable delays are introduced to compensate for head quadrature errors. The output from each record delay amplifier feeds a record amplifier, which increases the level to a value sufficient for recording on the tape.

The output of the record amplifier is at a relatively low impedance, suitable for driving a cable to the preamp unit, which mounts directly behind the headwheel panel. Transformers in the preamp unit serve to match the signal to the higher impedance level of the heads themselves. The outputs of the transformers connect to the heads through the head-transfer relay.

On playback, the head transfer relay connects the output from each head to a playback preamp circuit, mounted in the preamp unit itself. Here a low-noise transistor amplifier brings the playback level up to a point suitable for coupling to the playback amplifiers.

The playback amplifiers contain a gain circuit and an equalizer amplifier, adjustable by a front-panel control, for correcting variations in frequency response in the individual channels. Following the playback amplifiers are the playback delay amplifiers, for correcting head quadrature errors in playback.

The outputs from the playback delay amplifiers feed the 4 by 1 switcher unit. It contains circuits for selecting the output from the correct head under the control of pulses from the tonewheel processor (No. 313) and the tape sync processor (No. 317).

The output of the switcher, a single channel, passes through the FM equalizer module (No. 132). It provides an operational overall equalization control for precise setting of playback equalization.

At this point, a separate output signal is provided for CRO monitoring of the FM playback signal.

Demodulator Group (Fig. 15)

The FM signal from the FM equalizer module (No. 132) is fed to the input of the limiter module (No. 203). In the limiter the signal is converted to push-pull and passes through several push-pull limiter stages to achieve an overall limiting characteristic of at least 55 db. From the limiter the signal goes to the demodulator module (No. 204) which contains the demodulator and output filter circuits.

Two switches at the input of the limiter module provide for MOD-DEMOD operation in all modes except play, if desired, and the FM reference feature. For FM reference operation, the signal is passed over to the FM reference module before limiting, and two reference frequencies are keyed in from crystal oscillators. These references are introduced on alternate vertical blanking intervals and represent precise sync-tip and peak-white frequencies. These frequencies are automatically selected by the switch on the FM standards module which provides choice of the desired standard.

Processing Group (Fig. 16)

The tape signal as recovered from the demodulator is marred by the presence of switching transients and noise in the blanking intervals. It is possible, moreover, that the sync-to-video ratio may be incorrect and the set-up insufficient. To correct these and other faults, and thereby prepare the signal for on-the-air use, the demodulator output is sent to the *Processing Group,* where composite blanking and horizontal sync are regenerated and inserted in the signal.

The demodulator output passes first into the video control module (No. 131). Here, gain control is provided, allowing the operator to adjust the output of the machine to the proper value. The signal is then back-porch clamped (using regenerated sync from another module of the group) and regenerated blanking is inserted. The signal then passes to the video output module (No. 233), which provides two sending-end-terminated line drivers to distribute this video within the machine. There are

FIG. 15. Demodulator group block diagram. The FM signal is converted back to video.

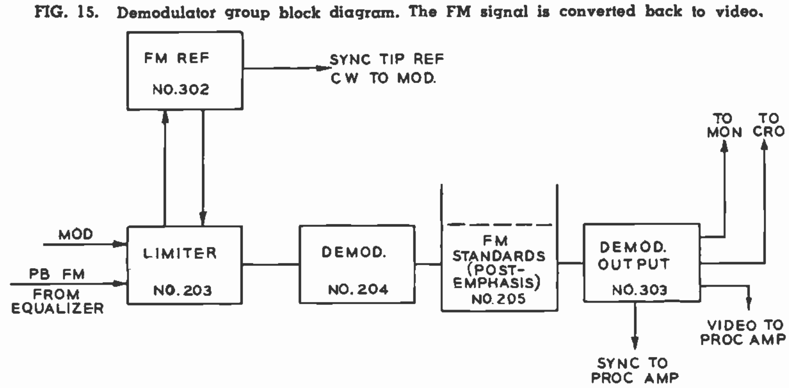
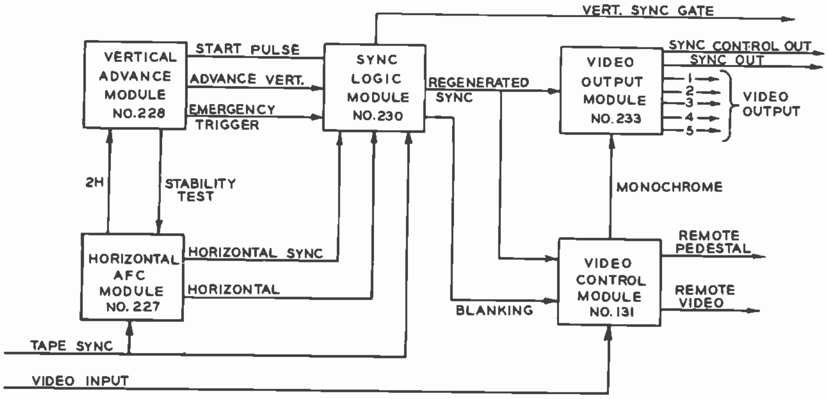


FIG. 16. Processing group block diagram. Synchronizing and blanking components are re-generated and re-inserted in the demodulated video.



three sending-end-terminated line drivers for outputs from the machine. One of these three outputs may, at the operator's discretion, become a non-composite output.

Tape sync, which is separated from the tape signal in the demodulator output module (No. 303), is sent to the horizontal AFC module (No. 227), another module of the *Processing Group*. Here the sync is used to control the frequency and phase of a multivibrator. This, in combination with other circuits in the module, generates a new horizontal sync; and also provides a pulse used (in another module) to regenerate horizontal blanking. This same phase-controlled multivibrator sends pulses to the vertical advance module (No. 228), where special circuitry counts out the number of pulses in a field to determine very accurately the position for regenerated vertical blanking.

The various outputs of the horizontal AFC module (No. 227) and the vertical advance module (No. 228) are fed to the sync logic module (No. 230). It has several functions. First, it generates horizontal and vertical blanking, then combines them into composite blanking. Second, it receives tape sync and regenerated horizontal sync and combines them into composite regenerated sync (using only the vertical interval from tape sync). Third, it generates a start pulse, which phases the counting of the vertical advance circuitry.

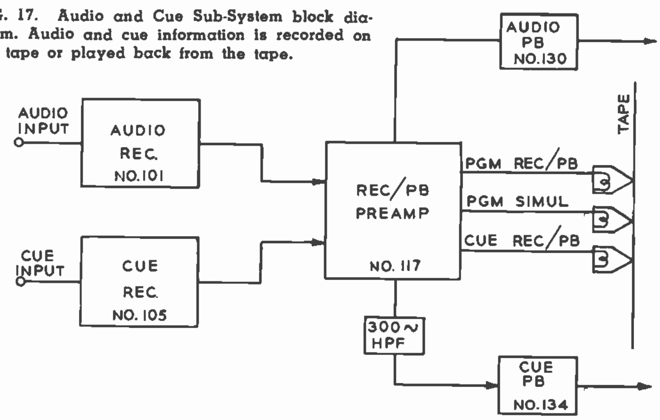
The regenerated blanking is fed to the video control module (No. 131), where it is inserted in the tape signal. The regenerated sync is fed to the video output module (No. 233), where it is added to the non-composite video signal to form a composite video output.

Thus, the *Processing Group's* output is a signal with proper set-up, regenerated sync, and noise-free blanking interval.

2. AUDIO AND CUE SUB-SYSTEM

Figure 17 shows the block diagram of the sub-system used in the TR-22 for recording audio and cue information on the tape, and playing back this information. Only three *different* modules appear in this sub-system: (1) The audio cue record modules (Nos. 101 and 105), which are identical modules used interchangeably in either the audio-record or cue-record path; (2) The audio cue playback modules (Nos. 130 and 134), which are identical modules used interchangeably in the playback paths; and (3) The erase module (No. 327), which supplies 87.5 kc erase and bias current to the audio and cue heads.

FIG. 17. Audio and Cue Sub-System block diagram. Audio and cue information is recorded on the tape or played back from the tape.



The fourth major block in this diagram, the audio cue preamp (No. 117), is not a plug-in module, but is permanently wired in—less than an inch from the audio/cue head-post cluster. This proximity results in a gain of several db in signal-to-noise ratio.

In operation, the audio signal is passed through the audio record module (No. 101) to the audio cue preamp (No. 117). Here it is amplified and sent to the program record/playback audio head, which records the audio information onto the tape. Slightly downstream a *simulplay* audio head plays back the just-recorded audio track, and sends the signal through a preamplifier stage to the audio playback module (No. 130). This delivers it to the monitor-speaker amplifier (not shown). Similarly, the cue information is passed through the cue record module (No. 105) and recorded on tape by the cue record/playback head.

In the playback mode, the audio track is played back by the program record/playback head, instead of the *simulplay* head, in order to obtain lip sync. The cue record/playback head similarly plays back the cue information through the cue playback module (No. 134). It includes a 300-cycle high-pass filter to eliminate the interference from the 240 cycle control track, located next to the cue track on the tape. (The audio playback module contains a similar filter; however, coding in the module sockets removes the filter from the circuit when an audio/cue playback module is placed in the audio socket.)

The erase module (No. 327) supplies synchronized 87.5 kc erase and bias currents to the audio and cue circuits. It also supplies erase current to the master erase head. The currents supplied are regulated against a known dc reference to insure proper bias levels and sufficient erasure. Since the regulating circuits can control the bias and erase currents down to zero amplitude output, the regulating circuits are also tied to the control-system logic to turn the bias and erase currents on and off as needed.

The TR-22 audio system, by the use of newly-designed heads, excellent preamp transistors, and close proximity between heads and preamp, produces a signal-to-noise ratio of 55 db (minimum).

FIG. 18. Audio shelf slides out and tips down to expose audio amplifier, speakers and VU meter.

FIG. 19. Picture monitor also incorporates convenient slide-out and tip-down accessibility.

COMPLETE ACCESSIBILITY

The TR-22 offers unparalleled accessibility in a compact console design. Every area in the recorder can be exposed. This kind of accessibility, notable in all RCA designs, provides easy set-up, check-out and maintenance. Examples of this outstanding accessibility are shown on these pages.

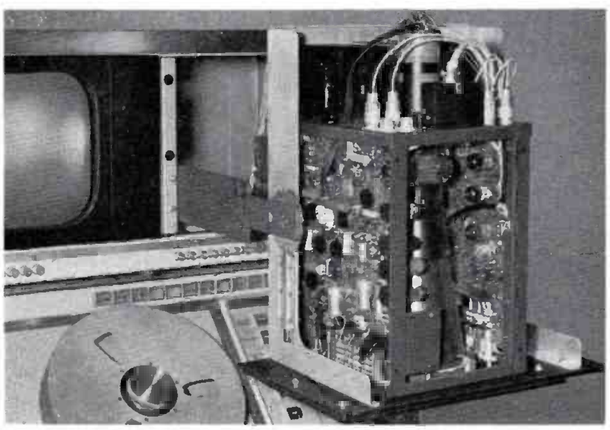


FIG. 20. The TO-2 oscilloscope in its extended position. All circuits are accessible to expedite servicing and routine maintenance.

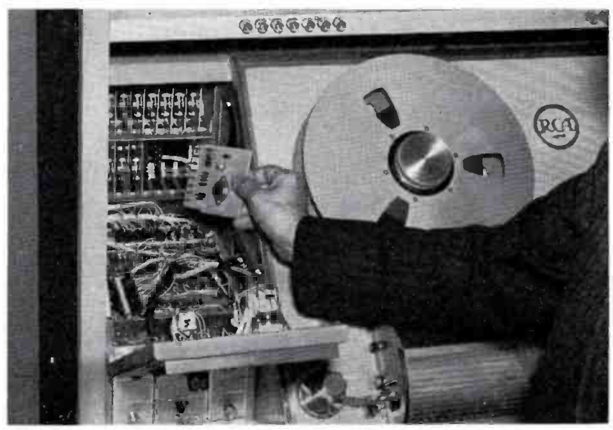


FIG. 21. Transistor-diode switch modules are easily removed for rapid replacement and bench maintenance. These plug-in boards are all identical.

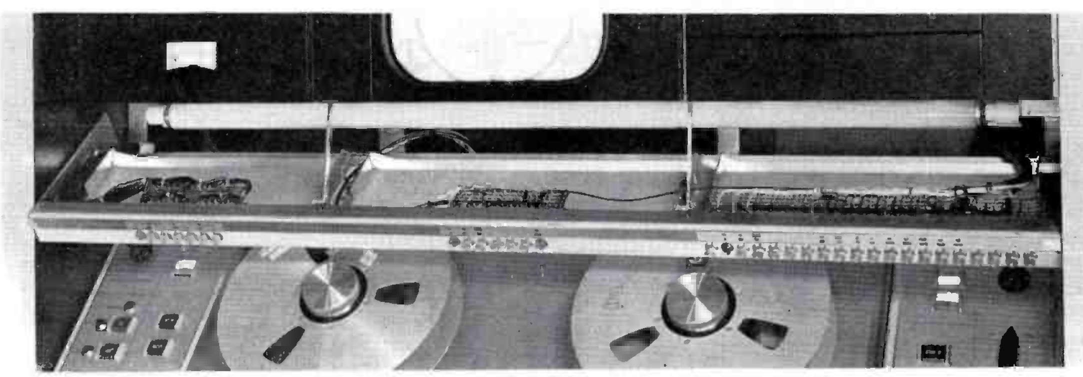


FIG. 22. Monitor selection pushbuttons are mounted on a tilt-down shelf to provide easy access to wiring. Key check points are prewired in the recorder, however, spare positions are provided.

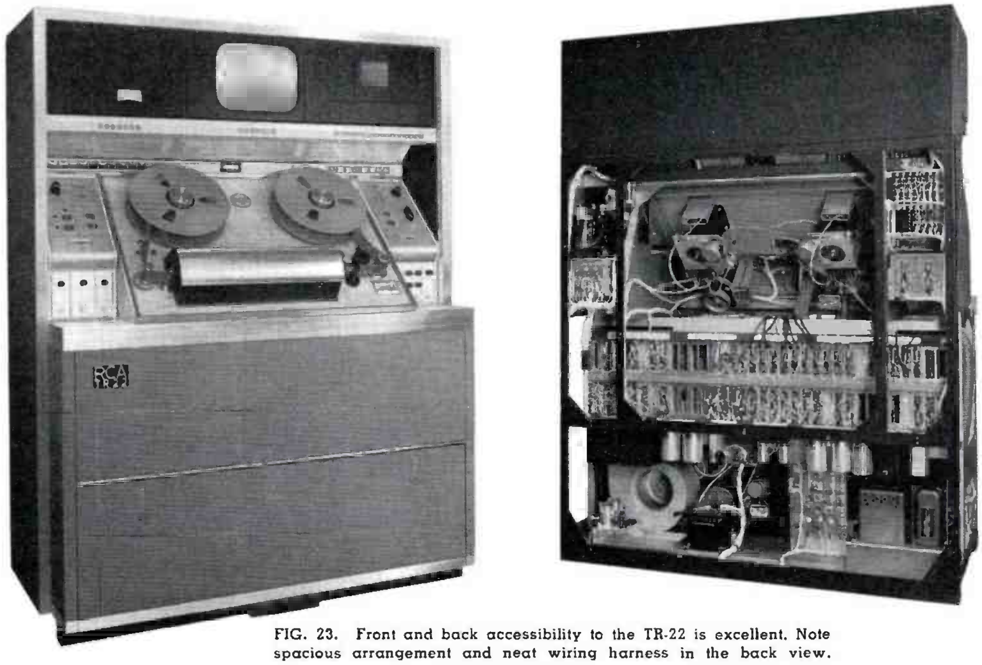


FIG. 23. Front and back accessibility to the TR-22 is excellent. Note spacious arrangement and neat wiring harness in the back view.

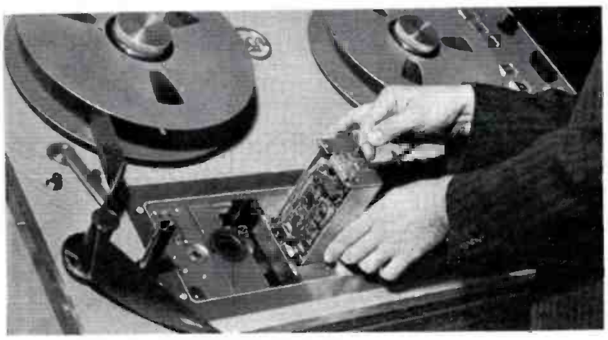


FIG. 24. Video pre-amplifier module is located beneath headwheel panel assembly. The module slides out for servicing as indicated here.

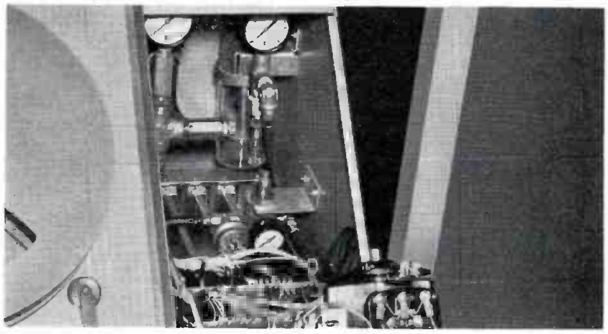


FIG. 25. Air pressure gauge for guide assembly, vacuum gauge for the headwheel and air bearing pressure gauge are accessible by tilting back the play control panel.

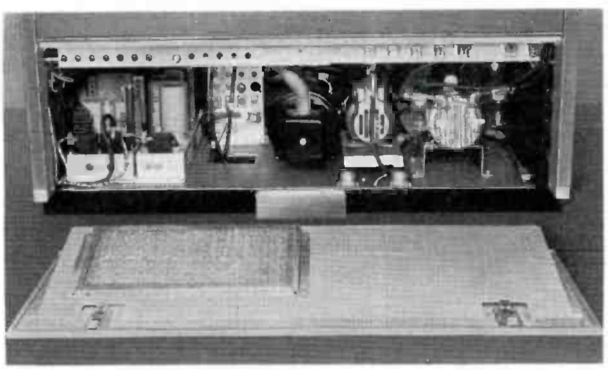


FIG. 26. Snap-off bottom cover gives access to power supplies, the headwheel blower, the vacuum and pressure pumps, air bearing pumps and main cooling blower.

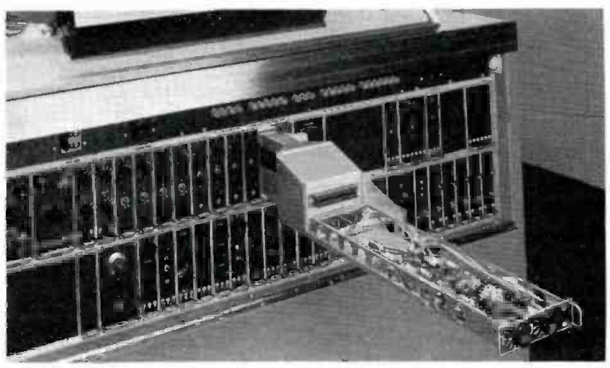


FIG. 27. Module extenders permit check-out of all circuit modules while recorder is in operation. Both sides of the circuit board are accessible for repair and inspection.

3. SERVO SUB-SYSTEM

As a deluxe machine, the TR-22 includes in its servo group all the features normally obtainable only as extras or accessories on other machines. In the *Capstan Servo*, for example, the TR-22 provides switchlock as a standard feature, allowing the operator the advantage of virtually roll-free switches from tape to other sources, or vice-versa. The *Headwheel Servo* is supplied with Pixlock, which allows the operator to super-impose live and tape sources, and also to use wipes, dissolves, and other special effects. The remaining servo of the group, the *Guide Servo*, provides the same accurate guide-positioning for skewing free pictures already familiar to owners of the TRT-1 series of machines.

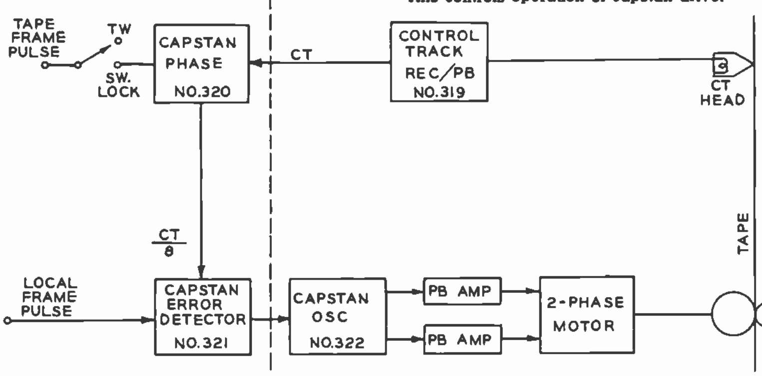


FIG. 28. Capstan Servo block diagram
This controls operation of capstan drive.

Capstan Servo

The *Capstan Servo*, which is illustrated in the block-diagram, Fig. 28, is best understood by considering first its operation when it is not switchlocking. To obtain this mode, the switch shown at the top of the diagram (marked "switchlock") is left open. In this case the servo operates as a standard, non-switchlocking servo.

The control-track head, seen at the right of the diagram, picks up the pre-recorded 240-cycle control track on the edge of the tape and sends it to the control track record playback module (No. 319). Here it is amplified, filtered to produce a clean 240-cycle sine wave, clipped, and shaped into a pulse. This pulse is sent to the next module, the capstan phase module (No. 320). Here the pulse feeds a chain of binary counters which divide the pulse frequency by 8 to produce a 30-cycle output pulse.

The 30-cycle pulse, which bears information about the phase of the control track (and hence, the position of the tape) is passed to the capstan error detector module (No. 321). Here it is compared in a phase detector against another 30-cycle pulse—the local frame pulse, which is made from local sync in another part of the machine. If the phase detector sees a difference in the phases of these two 30-cycle pulses, it produces a d-c voltage which is proportional to the magnitude of the phase error.

The d-c error voltage is sent to the capstan oscillator module (No. 322), where it is used to control the frequency of the oscillator which supplies the drive frequency for the capstan motor. The capstan motor is thereby caused to accelerate or decelerate the tape to correct the phase error between the two 30-cycle pulses, hence synchronizing the tape speed to local sync.

The capstan oscillator is not capable of supplying enough power to operate the capstan motor directly, therefore, the controlled-frequency signal is passed through two power amplifiers, one for each of the two phases required by the motor. These power amplifiers (which, like the rest of the machine, are completely transistorized) are forced-air-cooled units each capable of 60 watts peak output. There is a total of five power amplifiers in the machine. Two are used to drive the capstan motor; three identical ones are used to drive the headwheel motor. These five power amplifier modules are completely interchangeable.

Switchlock

The foregoing discussion describes the non-switchlocked mode of the *Capstan Servo*. To obtain switchlock, the switch at the top of the diagram is moved to the SWITCHLOCK position. (This may be done before the machine is started or while the machine is playing.) This switch connects a 30-cycle frame pulse, made from tape sync, to the capstan phase module.

The 30-cycle pulse is used to reset the binary counters to a counting phase producing an output pulse phased near tape frame pulse. When this pulse is compared against local frame pulse in the capstan error detector (No. 321), a d-c error voltage is produced, forcing the capstan motor to accelerate or decelerate the tape until the two pulses in the capstan error detector are again phased together.

Since one of the pulses at the capstan error detector is the local frame pulse, and the other is controlled in phase (through counter reset) by the tape frame pulse, the preceding action results in the phasing together of the local frame pulse and the tape frame pulse. This constitutes *Switchlock*.

In the record mode, two of the capstan modules—capstan phase and capstan error detector—are not used. Instead of being operated as a servo, the capstan derives its drive frequencies directly from the 240-cycle pulses supplied by the tonewheel. These pulses are sent directly to the capstan oscillator module, and fed to a divide-by-four circuit to obtain the 60-cycle drive frequency required by the capstan motor.

In order to record the control track on the edge of the tape, the 240-cycle pulses from the tonewheel are sent to the control track record play module (No. 319). Here they are shaped into a sine wave of accurate phase and recorded onto the edge of the tape. The local frame pulse is also sent to this module in the record mode to be recorded on the tape as the edit pulse.

Headwheel Servo

The *Headwheel Servo* for the TR-22 is housed in six modules (plus three power amplifier modules). These six modules (see Fig. 29) are: (1) the reference generator (No. 312), which processes local sync to produce horizontal-rate reference, field-rate reference, and frame-rate reference; (2) the tape sync processor (No. 317), which similarly processes tape sync to produce three corresponding signals; (3) the tone wheel processor (No. 313), which shapes the tone-wheel pulse, and also provides 960-cycle switcher drive; (4) the tone wheel servo (No. 314), which derives the error signal controling the headwheel motor in the tonewheel mode; (5) headwheel modulator (No. 315), which uses this error signal to amplitude-modulate the motor-drive sine waves; and (6) the linelock module (No. 316), which provides line-by-line lock-up in the Pixlock mode.

In operation, sync—derived either from local sync or separated from the incoming signal in the record mode—is applied to the reference generator. This module provides a 60-cycle (field-rate) reference, which is sent to the tone wheel servo module. At the same time, the pulse from the tone wheel mounted on the headwheel motor shaft is shaped by the tone wheel processor module and also sent to the tone wheel servo module. In this module, the two pulses are compared in a phase detector, which generates a d-c error voltage proportional to the phase error between the two pulses.

Also in this module, a frequency-measuring device called a *velocity loop* measures the pulse-to-pulse period of the tone wheel pulses and derives a d-c error voltage proportional to the frequency error of these pulses—the speed error of the motor.

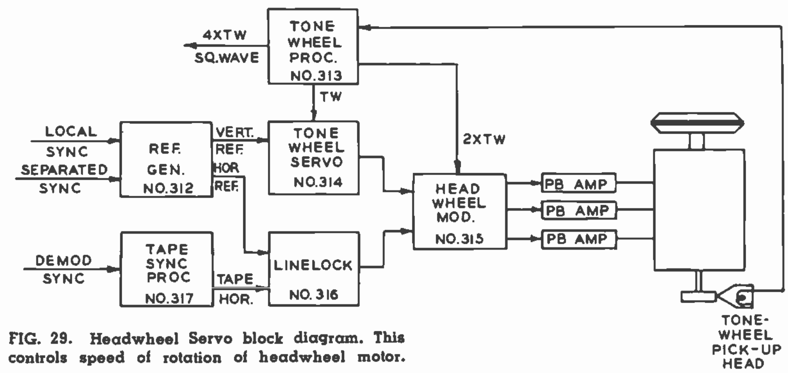


FIG. 29. Headwheel Servo block diagram. This controls speed of rotation of headwheel motor.

The two error voltages are combined and sent to the headwheel modulator module, where they are used to control the amplitude of the motor-drive sine waves to minimize speed error and phase error.

The 480-cycle motor-drive sine wave is derived in the tone wheel processor module by multiplication of the 240-cycle tone-wheel pulse. Thus, the motor-drive sine wave is locked in frequency and phase to the actual speed of the motor. Since the motor runs at 240 rps, and the drive frequency is 480 cps, the slip frequency—the difference between these two—is also 240 cps. Thus, the slip frequency cannot introduce any unlocked variations in motor torque. This type of drive makes a major contribution to stability and freedom from jitter in tone-wheel and Pixlock modes.

This synchronous 480-cycle sine wave is fed to the headwheel modulator, where it is phase-shifted *before* modulation to form three signals, 120 degrees apart. The technique of phase-shifting prior to modulation is an important feature of Pixlock-style servos. By such arrangement, the bandwidth limitations inherent in post-modulation phase shifting are avoided, and the resulting wideband modulator is capable not only of accurate control in the Pixlock mode, but also of markedly-improved control in the tonewheel mode. Since the latter mode is the one which must be used for recording, this servo is capable of making a more-nearly jitter-free recording.

Employment of pre-modulation phase shifting requires three independent modulators: one for each phase. The error signal from the tone wheel servo module is fed in parallel to these three modulators. The three outputs are fed individually to three power amplifiers, which, in turn, feed the three-phase headwheel motor.

In the Pixlock mode, a horizontal-rate reference from the reference generator and a horizontal-rate signal derived from tape sync by the tape sync processor are fed to the line-lock module. Here, a phase detector compares the phases of these two horizontal-rate signals and derives a d-c error voltage proportional to the phase error between them. When certain sensing circuits (not shown in the block diagram) ascertain that the conditions are correct, control of the modulator is switched from the tone wheel servo module to the line-lock module.

Two advantages (immediately apparent in the pictures produced) result from linelock control. First, the higher rate of sampling (15,750 samples per second as compared to 60 samples per second in the tonewheel mode) permit faster correction of any errors that may occur. Second, since the servo information is now being taken from the tape instead of the tone wheel on the motor shaft, the playback servo sees and corrects not only its own errors, but also whatever errors the recording servo may have put on the tape originally. In effect, the servo loop is closed around the recording servo and the playback servo.

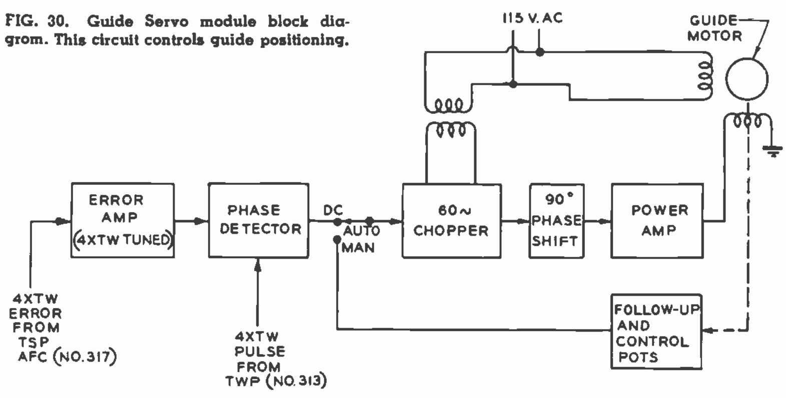
Guide Servo

In order to give a high-quality skew-free picture at all times, the TR-22 includes an accurate servo to control the position of the guide. By detecting the presence of 960-cycle phase modulation of the horizontal signal from the tape, this servo drives a motor which moves the guide position to minimize this phase modulation, thus minimizing any skewing effect. This servo section may also be bypassed to permit manual control of guide position.

The guide servo module (No. 221), which contains all the circuits and power amplifiers for this function, is shown in the block diagram, Fig. 30. The polarity of the guide error is detected in a phase detector, and the resulting d-c error voltage is fed to a 60-cycle chopper, which provides one of the phases of a two-phase motor. If there is no error, the chopper has no output and the motor is stationary. If an error appears, the phase detector determines its polarity, causing the chopper to produce either a plus or minus 90-degree 60-cycle sine wave at the output of the power amplifiers, thus driving the motor in the proper direction to minimize the error.

The guide servo can operate in any one of four modes. The first mode, called *automatic*, is the servo mode just described. The second mode, ***manual***, bypasses the servo and permits the operator to set the guide position manually by means of a control on the front panel of the guide servo module. The third mode, ***record***, is identical to ***manual***, except the guide position control is located on the record control panel of the machine. The fourth

FIG. 30. Guide Servo module block diagram. This circuit controls guide positioning.



mode, *record set,* is included to allow the operator to set the penetration when recording. To do this, the operator plays a test tape and presses a button on the front panel of the guide servo module which puts the *record* manual control in the circuit during *playback*. Holding this button, he adjusts the guide position to give a good *playback* picture, but using the *record* guide position control. He then locks down the *record* knob and releases the pushbutton. The tip penetration is then set in accordance with the standards recorded on the test tape.

4. CONTROL SUB-SYSTEM (Fig. 31)

When a tape recorder is switched from one mode to another—for example, from STOP to RECORD—a large number of individual functions must be simultaneously switched. The reliability of the control system, which does the switching, is of highest importance. In the TR-22, semiconductors do most of the switching; relays are used for a-c switching only.

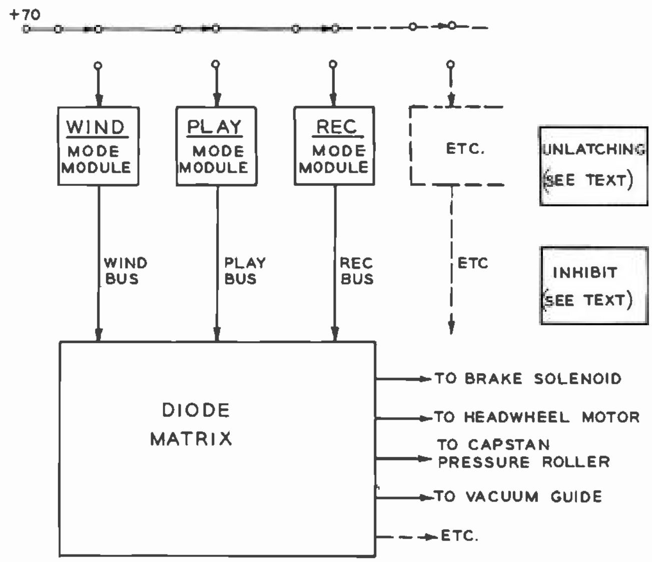


FIG. 31. Control Sub-System block diagram. This is the switching brain of the TR-22 recorder.

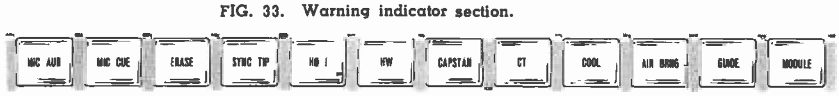
When the operator presses a button to put the machine in a certain mode—for example, the RECORD mode—a momentary contact switch in the pushbutton triggers a two-transistor bistable circuit, which latches into the "on" position, and thereby energizes a bus called the record bus. At the same instant, all other similar two-transistor bistable circuits (there is one such circuit for each mode of the machine, such as WIND, PLAY, SET-UP, etc.) receive a pulse called the "unlatch" pulse. This turns "off" any circuit which might have been "on" before the operator pushed the RECORD button. Thus, the machine can be in only *one* mode at a time.

The record bus is connected to a modified diode matrix. (All buses, such as record, wind, play, etc., go into this matrix. Crossing these buses at right angles (but not connected to them directly) are the outgoing controlled functions, such as capstan pressure roller, headwheel motor, capstan motor, reel motors, air pressure solenoid, etc.). The controlled functions to be operated by the record bus are connected to that bus by a diode. It is oriented to conduct when the record bus is energized, and cut-off when the record bus is not energized. Similarly, other diodes are connected between the other buses and their controlled functions. The result is a simple, reliable system which uses no moving parts other than the momentary contact pushbutton which initiates the action.

When the machine is in the RECORD mode, it is undesirable to be able to go directly to certain other modes, such as PLAY or STANDBY, without first going into the STOP mode. Similarly, when the machine is in the WIND mode, it is desirable to go to the STOP mode before going to any other mode. To protect the machine from an operator mistake, the energizing of the record bus establishes a voltage called "inhibit", which is fed to those bistable circuits which control the unwanted modes. This voltage will prevent the machine from going into the unwanted modes even if the operator inadvertently pushes the button requesting one of those modes. Similarly, energizing the wind bus inhibits all other modes except STOP. Every mode is thus interconnected to prevent operator error from damaging machine, tape, or program.

FIG. 32. Mode indicator section.

FIG. 33. Warning indicator section.



The two-transistor binary circuits referred to above are called "mode modules". The two transistors are held physically on a plug-in card, plugged into the machine, in a space beneath the left-hand, RECORD, control panel. See Fig. 21. Fourteen of these modules are found here, as well as the diode matrix. Only 8 of these 14 actually function as latching circuits; the balance are used as amplifiers to drive solenoids. The circuit arrangements are such, however, that any of the plug-in cards may perform either of the two functions.

The majority of the control circuitry is found beneath the left-hand control panel. Two groups of control circuits, however, are not found here. They are housed in a module located with others containing electronic circuitry of the entire machine. This module contains the electronic circuits that generate time delays required to control air-lubrication pressure to tape guides, and to control headwheel blower. Also in this module are circuits that control the "inhibit" function.

All the control functions may be remoted for operational convenience, if desired. In addition, the remote control panel includes two additional functions—FAST FORWARD and FAST REVERSE—for remote winding and rewinding of tape.

5. MODE AND WARNING SUB-SYSTEM

Earlier it was pointed out that the TR-22 gave the operator a means of checking the operation and modes of his machine by merely flicking his eyes across a row of mode and warning lights, located just above the tape transport. These lights are the operator's first line of defense against faulty recording. Every major point in the machine is checked continuously by the circuits connected to these lights, and any fault immediately lights a warning light. Similarly, the various modes of the machine are indicated to prevent a possible mis-recording from a mis-setting of some control. See Figs. 32 and 33.

Switchable Standards

In recognition of the increasing importance of international exchanges of television programs, the TR-22 is available as a production item in any one of the three following models: (1) a 525-line machine; (2) a 525/625/405-line machine, switchable; and (3) a 525/625/819-line machine, switchable. All models are identical in appearance; however (2) and (3) include special monitors and CRO's plus eight special modules and a pair of 50-cycle power supplies. Operation and performance are identical for all models.

To change from one standard to another, an operator merely moves a single selector switch to the desired position. This master switch changes all machine circuitry to the indicated standard. Changeover is practically instantaneous, being limited chiefly by servo re-lock-up time.

The reliability of the switchable machines is considerably enhanced by the use of a novel circuit-control technique, which eliminates the need for multiple relays to modify circuits when the standards selector switch is operated. In this method of circuit control, the master switch controls the potentials on four master control buses. These buses are fed to the monitor, to the CRO, and to all modules which require modification between standards. The potentials on these buses are used directly to make required circuit changes, in all semiconductor circuitry, without using relays.

Conclusion

Broadcasters who have long known that the RCA symbol on Broadcast Equipment indicates the highest quality obtainable will welcome the TR-22 as an important addition to the famous line of RCA quality equipment. Striking in its styling, outstanding in its performance, the TR-22 is a Television Tape Recorder not likely to be surpassed for many years to come.

SIMPLIFIED CONTROLS

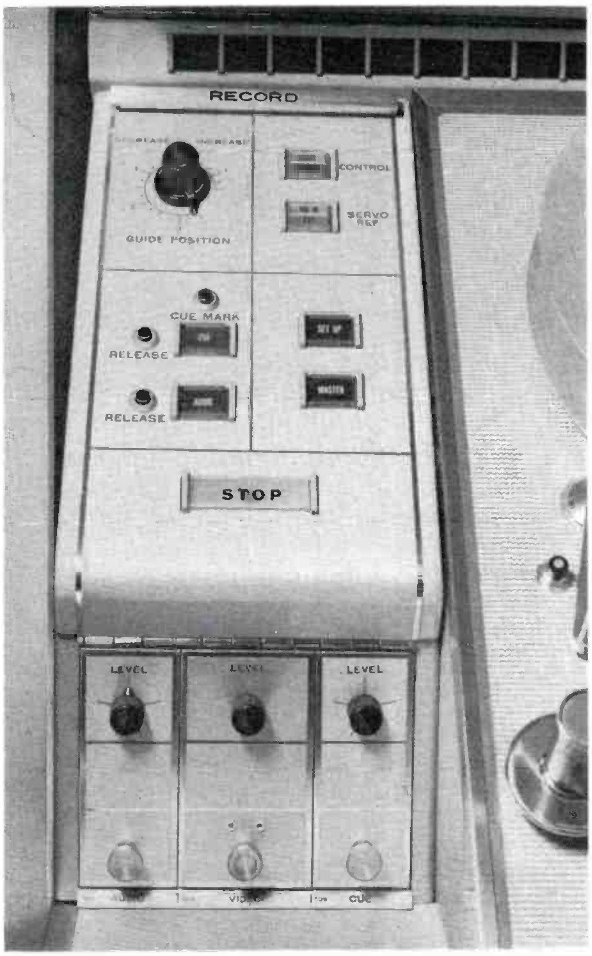


FIG. 34. All record controls are grouped to the left of the tape deck. This panel features simplified operation—controls are grouped to avoid accidental errors. Facility for marking the cue channel with a cue tone is included along with normal recording controls—guide position, servo reference, etc. Level controls for audio, video and cue information are also included.

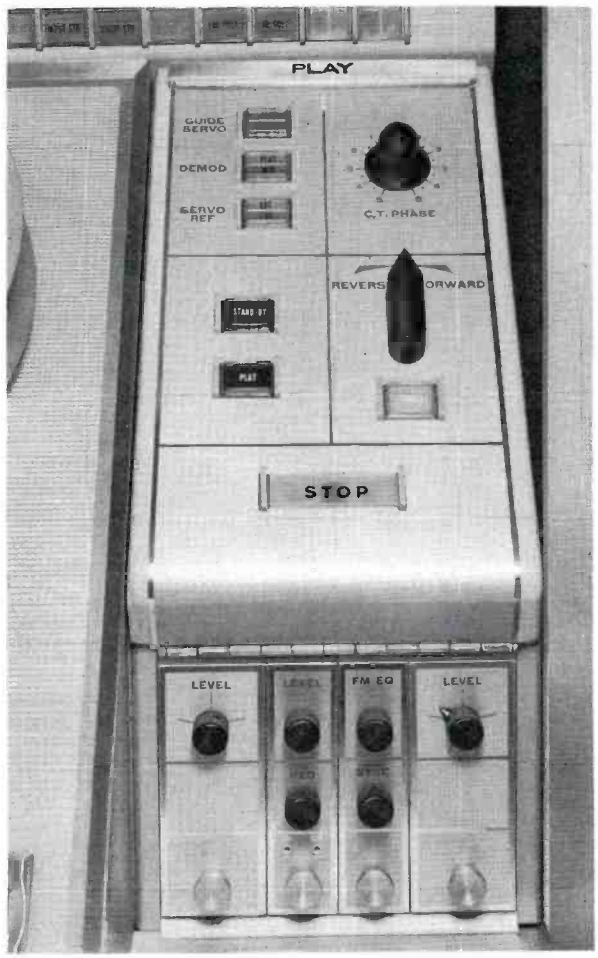


FIG. 35. All playback controls are to the right of the tape deck. Featured here is continuously variable wind/re-wind control for quick cueing—also a vernier adjustment of control track phase, selection of automatic or manual guide servo positioning and a standby position for rapid lock-up. Audio, video, cue level, rf equalizer and sync controls are also included.

BROADCAST STEREO WITH

What makes the listener turn the dial to your FM station? Superior programming and superior quality rendition. Programming at such levels virtually demands highest fidelity transmission. To achieve such standards, the unquestioned choice of knowledgeable FM stations is RCA's unmatched Direct FM Transmitter. RCA had "Direct FM" in its first FM transmitter, built in 1941—and in all the FM transmitters built since then (over 500). With their time-proven Direct FM exciter, RCA FM transmitters supply the widest frequency response, with minimum distortion. Such a system is simpler, requires fewer tubes, and needs less adjusting. Consequently, RCA FM transmitters have the finest sound, and are easily tuned and maintained. Such performance is the happy result of RCA's long background of pioneering and achievement in the world of radio.

1 Kw

5 Kw

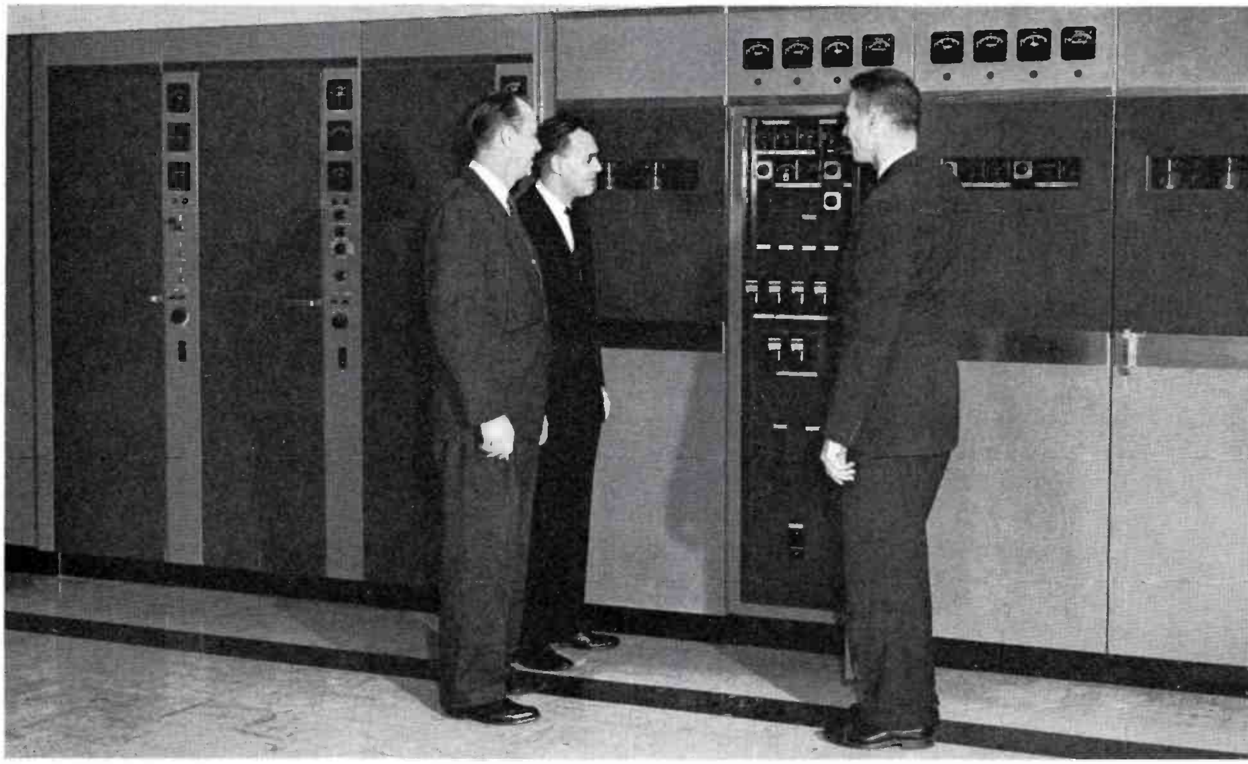


FIG. 1. Carl E. Lee (left), Arthur E. Covell (right) and the author standing before the control panel of the FM final amplifiers. Mr. Lee is vice president and general manager of Fetzer Broadcasting; Mr. Covell is chief engineer of WKZO-TV. The two 25-kw final amplifiers originally served as finals for the Channel 3 TV signal. They were diplexed to become part of the BTF-50B Transmitter.

WJEF-FM . . . STEREO AND SCA WITH HALF-MILLION-WATTS ERP

Grand Rapids Station Uses RCA 50-Kw Transmitter and 12 Bay Antenna for 25,000 Square Mile Coverage

by BRUCE M. GLYCADGIS, *Chief Engineer*

To the people of Western Michigan "FM" means WJEF-FM with true FM quality service with power. For twenty-one hours of each day, WJEF-FM radiates its stentorian voice of 500,000 watts (ERP). WJEF-FM began broadcasting with one-half-million watts (ERP) November 15, 1961. It was a great day for FM listeners within the reach of its signal because it meant that all could receive noise-free programming whether they owned small receivers, large receivers, cheap receivers or expensive receivers . . . whether they had or did not have antennas. It brought on a great resurgence in the purchase of FM receivers within the area this signal reaches, especially in areas that had never before heard FM. But, in reality, this was not the beginning but merely the ending of a great struggle to bring powerful, quality-FM broadcasting to the listening public of Western Michigan.

The Beginnings of WJEF-FM

The birth of WJEF-FM goes back nearly seventeen years ago to 1946. It was during 1946 that the Fetzer Broadcasting Company obtained its first construction permit for WJEF-FM. This CP was for the, in those days, unheard-of power of 500,000 watts (ERP).

The company was immediately confronted with many complications arising from the fact that equipment capable of producing 500,000 watts (ERP) such as the "RCA 50 kw Transmitter" and "RCA 12-Section High-Gain Antenna" were not readily obtainable. There was also the problem of obtaining a suitable antenna site with adequate ac power available for such a powerful transmitting plant.

In 1950, the Fetzer Broadcasting Company constructed WKZO-TV. It immediately became apparent that the TV tower would also be suitable for an FM antenna at reduced power. On June 25, 1951, WJEF-FM took to the air waves with an effective radiated power of 115,000 watts. WJEF-FM operated from this site for ten

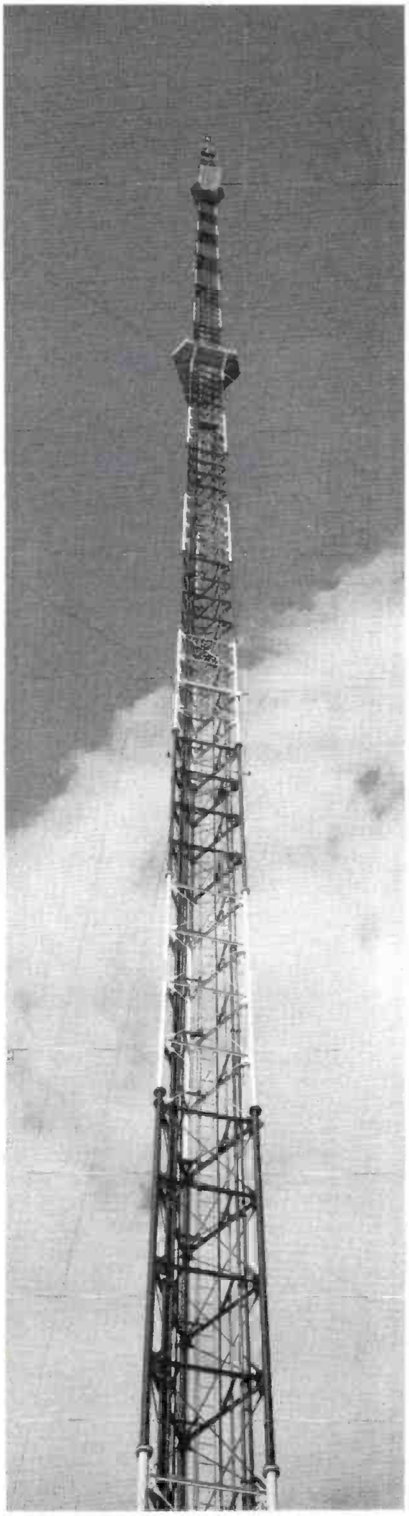


FIG. 2. Skyward view of 1100-foot tower. FM antenna located out of view at the 800-foot level. Microwave reflectors attached at several levels. Note Channel 3 super-turnstile antenna on top.

years and, in 1961, WKZO-TV moved its transmitter to the new Gun Lake site, located half-way between Grand Rapids and Kalamazoo, Michigan. When the new TV transmitting equipment was placed into operation, it made equipment on hand, such as the "RCA 25AL TV Amplifiers", available for the FM operation and to fulfill, after ten years, WJEF-FM's dream of serving the people of Western Michigan with a one-half-million-watt signal.

During this entire period of time, the income of WJEF-FM was not great enough to pay the power bill, but, the Fetzer Broadcasting Company has always had great faith in the possibilities in FM and felt that it was in the interest of all of the radio public to keep this FM facility on the air for the public's enjoyment. In order to realize some income from the operation, the Fetzer Broadcasting Company purchased a Muzak franchise for Western Michigan and began the first multiplexed operation in this part of Michigan. The increase in power to one-half-million watts (ERP) produced even greater multiplex potentials which coincided with the initial decision to purchase the Muzak franchise. All this took place during the years that FM stations all over the country were going off-the-air because they felt that FM could not exist with TV and AM.

WJEF-FM radiates its signal to an area ninety miles in radius from the transmitter site. In addition to its metropolitan-area coverage, it covers a great rural area that would not, otherwise, receive service from a lower-powered transmitter.

WKZO-TV Moves to Gun Lake

During 1960, Fetzer management decided that it was time for a modernization program. This resulted in the conclusion that WKZO-TV should locate its transmitter and antenna at a point midway between Kalamazoo and Grand Rapids so as to serve both communities equally well. Since the planned antenna tower for the new site would be 1100 feet high, it would make an excellent location for WJEF-FM's antenna.

To keep WKZO-TV's signal on the air during the move from Kalamazoo to Gun Lake, management purchased a new TV transmitter for the new site thereby releasing the two 25-kilowatt TV-power amplifiers at Kalamazoo. These were Type TT-25AL amplifiers and, since they operated on Channel 3, it was a relatively simple task to raise their operating frequency from 61 and 66 megacycles to 93.7 mc . . .

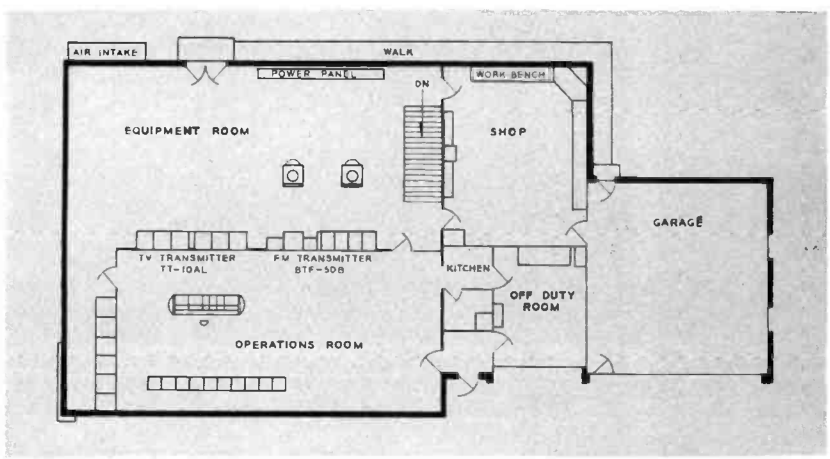
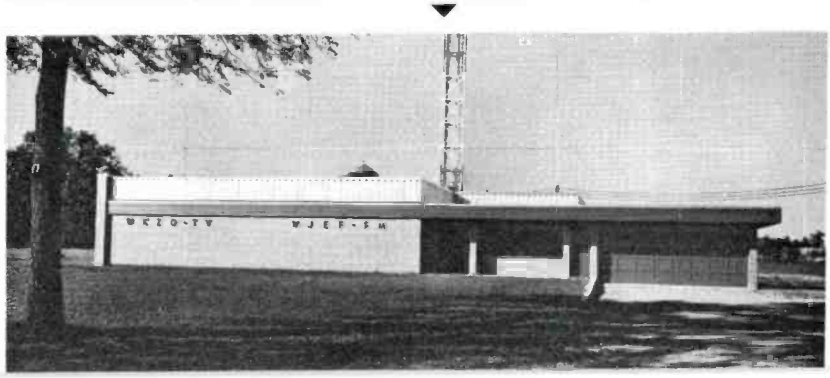


FIG. 3. Floor plan of transmitter building, first floor. These spacious quarters house the TT-10AL television transmitter and BTF-50B FM transmitter. Ample shop space, an off-duty area and garage are included.

FIG. 4. WJEF-FM/WKZO-TV Transmitter Building. Constructed of prestressed concrete faced with aluminum and brick, the building uses a special design roof to withstand the falling ice from the 1100-foot tower immediately adjacent to the north.



WJEF-FM's assigned frequency . . . to diplex the amplifiers and raise the 10-kw output of the new RCA Type BTF-10D driver transmitter to 50 kilowatts of FM power.

Amplifier Conversion

The Type TT-25AL amplifiers use the well-known cluster of seven Type 5762 triodes operating in parallel in a grounded-grid configuration. This cluster design, owing to the physics of VHF frequencies and the mechanics involved, lends itself excellently to frequency conversions.

The RCA BTF-50B transmitter design utilizes two TT-25AL amplifiers diplexed and driven by the BTF-10D. The modification of our units, as made in the field by RCA engineers resulted in the first BTF-50B transmitter. The performance of the system has been very satisfactory.

Side-Mounted Antenna System

WJEF-FM uses a 12-section, gapped-ring antenna (BFA-12A) attached to one leg of the TV tower at the 800-foot level. Center-fed, this array provides a power gain of 12.5 and raises the 50-kw transmitter output to 500 kw ERP.

With the antenna system mounted on one leg of the triangular cross-section tower, it provides substantially circular coverage over a 25,000 square-mile area. This area includes Kalamazoo and Battle Creek on the south, Grand Rapids on the north and Lansing on the east, plus dozens of smaller municipalities at all points of the compass. For 90 miles in any direction, FM receivers can receive WJEF-FM.

Gun Lake Facility

The transmitters of both sations, TV and FM, are housed in a modern, well-engineered building of prestressed concrete, clad in aluminum and buff-colored brick. The 1100-foot antenna tower stands immediately outside of the north wall to practically eliminate outdoor-horizontal runs of transmission lines to the antennas.

Locating the tower so close to the building presents a falling-ice problem during the Michigan winter. However, this is overcome through a specially-designed roof on the structure that withstands the potential damage of the falling ice.

Building Features

A novel arrangement in building design places all of the electronic gear of the transmitters on grade level with the power transformers and blower equipment arranged in a basement room. This set up makes the transmitter room extremely quiet since the hum of transformers and the sounds of moving air stay confined to the lower level. Further, this arrangement reduces, considerably, blower vibration in addition to increasing the accessibility to the equipment.

Massive Plenum Chamber

Each of the blowers operating in the basement performs without an individual air filter. Instead, all of the air in the room is filtered prior to its entry into the room.

Outdoor air, entering the side of the building, is first filtered via spun-glass filters. This air then passes through electrostatic filters to axial fans, which "pressurize" the basement room and thus make it a massive plenum chamber. Since the blowers operate in a dust-free atmosphere, there is no need to provide each blower with an air-filtering device.

The blowers, mounted on concrete piers, push the filtered air upwards through the basement ceiling and into the bases of the transmitter equipment. Ducting, at the top of the transmitter cabinets, is thermostatically controlled so that the warmed air from the equipment goes directly outdoors in summer or, indoors in winter to thus heat the transmitter room.

This loop system, using entirely-outdoor air, reduces the BTU requirement of the air-conditioning equipment in summer and, delivers fresh, warmed air in winter.

Another advantage in prefiltering the air before it enters the basement room is the elimination of a settled-dust problem in the basement as well as providing a dustless atmosphere in the transmitter room. This, of course, simplifies maintenance.

WJEF-FM Programming

When the station went to the half-megawatt ERP, management decided that the station should be an entity in itself and, for that reason, should generate its own programming.

The staff spent many months in surveying and devising the programming that is now a part of everyday operation. WJEF-FM programs its educational and informational shows throughout the day instead of the early hours of the morning. The surveys also pointed out that the listener desires large blocks of time set aside for each musical category. As a result, WJEF-FM maintains a considerable disc- and tape-recorded library which provides an excellent range of literature in each musical category.

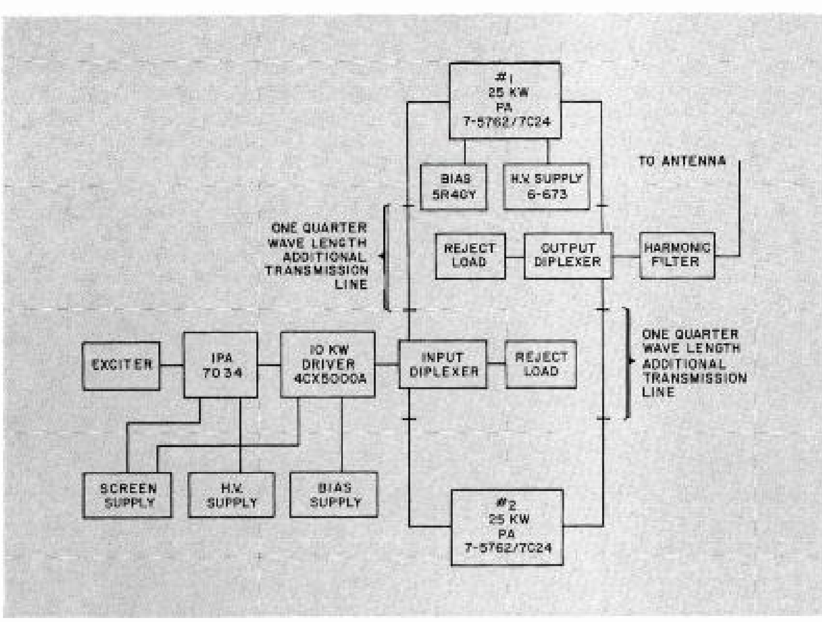
Program Sources

Discs and tapes supply the high-fidelity program material. The discs are played on BQ-51 Turntables and tapes on RT-21 and RT-7 tape machines. The RT-21 is a reel-to-reel tape transport while the RT-7 operates with endless-loop cartridges.

RT-21 Stereo Equipped

To play commercial stereo tapes, the RT-21 Tape Recorder is equipped with

FIG. 5. BTF-50B FM Transmitter Block Diagram.



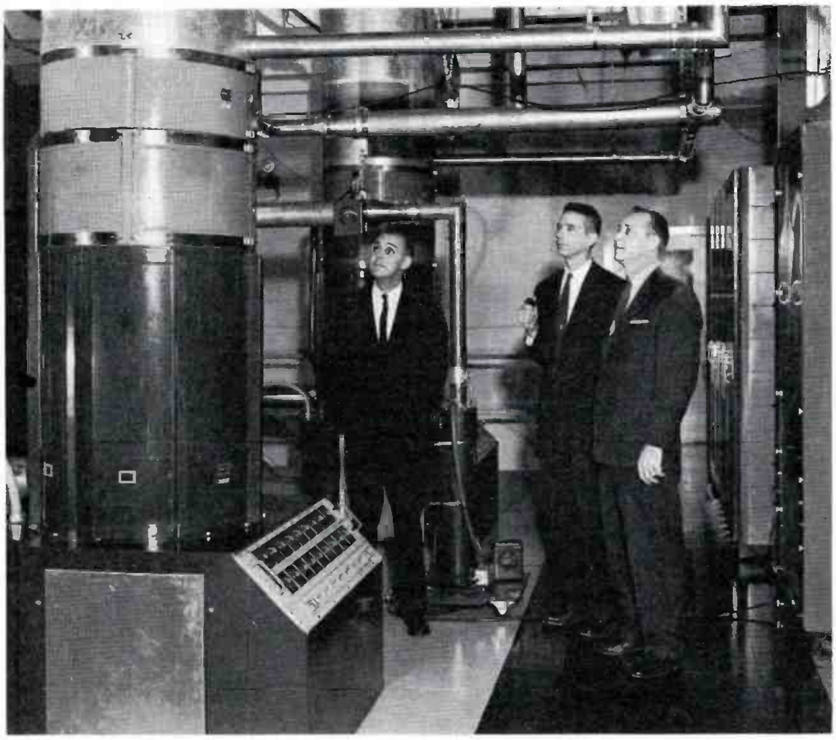


FIG. 6. View of FM power amplifiers and their associated transmission line. Floor plan provides excellent walk-around access to each cabinet.

a four-track *playback* head in addition to the separate *erase, record* and *play* heads for two-track stereo tapes. This is a special feature of the RT-21 in that it permits the machine to play virtually all quarter-inch-tape recordings: full-track, half-track, half-track-stereo and four-track stereo tapes.

BQ-51 Turntables Use Lightweight Tone Arm

In the center of a horseshoe arrangement is a BC-6B Audio Consolette while the turntables are at either elbow of the announcer. Each turntable contains its own preamp and attenuator pad. The knob for the pad is located conveniently next to the turntable controls. Each RCA Lightweight Tone Arm supports a stereo phono cartridge famous for its quality reproduction. For cueing purposes, BA-8 Cue Amplifier —with self-contained speaker—is used.

Cartridge Tape Simplifies Cueing

The self-cueing feature of the RCA RT-7 Cartridge-Tape Machine serves ideally for spot announcements. This, of course, permits greater use of the turntables for program material. The cartridge-tape facility, being monophonic only, serves only in non-stereo announcements: the stereo commercials being played on the RT-21 or either of the two turntables.

Muzak Programming on Long-Play Tape

The SCA subchannel programming comes from two long-play tape machines located in the main control center adjacent to Studio 1. These two machines operate almost completely unattended in that the tapes come from Muzak pre-programmed for such operation. The signal from these machines travels via multiplexed microwave to the transmitter site. Here it modulates a 67-kc sub-carrier of a Type BTX-1A Multiplex Generator which, in turn, modulates the BTE-10B Exciter in the FM transmitter.

FM Stereo Programming

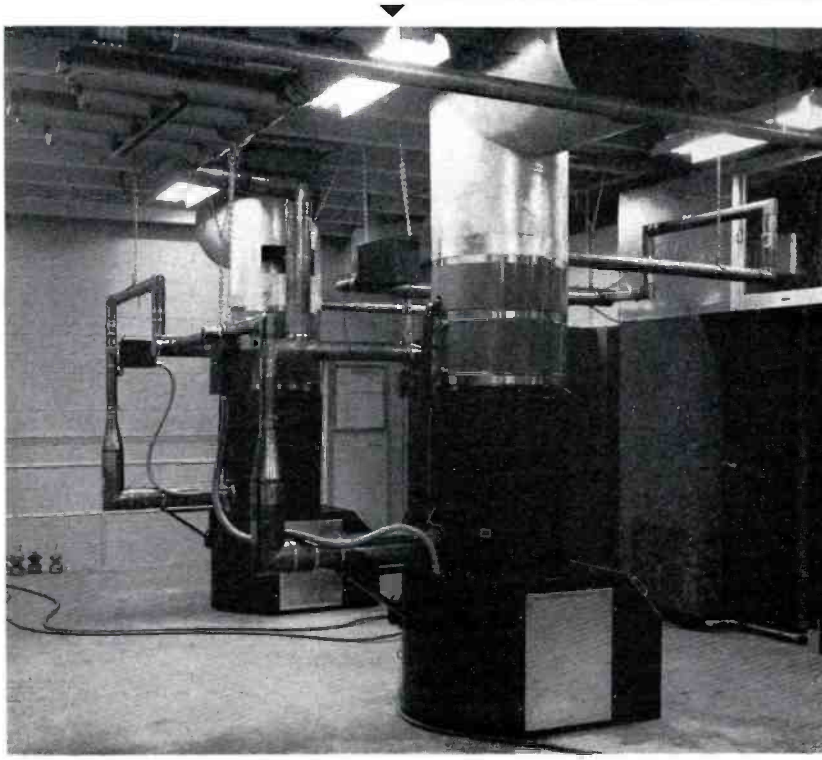
A portion of each day's programming is transmitted in multiplex stereo (FM Stereo) using an RCA BTS-1A Stereo Subcarrier Generator mounted at the top portion of the center cabinet in the BTF-10D FM transmitter.

Since introducing stereo programming, WJEF-FM has built up a separate stereo-record library (see Fig. 9).

Audience Response

The primary signal-coverage area serves more than a million families. More than 50 per cent of these families have indicated, via mail, that WJEF-FM was the first FM station they had ever heard. In many cases, the primary reason for buying an FM re-

FIG. 7. View of FM transmission line and diplexing equipment. Note that air filters in base of amplifier cabinets have been replaced with sheet metal since cooling air enters cabinet through floor from blower unit in basement. Rear of BFT-10D transmitter appears at far right.



ceiver was word-of-mouth praise for WJEF-FM programming by a neighbor or a friend. It's important to note that most of these new listeners are located in rural areas and, quite possibly, would have no FM service were it not for the half megawatt signal of WJEF-FM.

Fulfils A Dream

Fetzer Broadcasting management believes that high power and high fidelity go hand in hand. The two converted RCA TV amplifiers provide 50 kilowatts of transmitter power for WJEF-FM. The combination of this transmitter power and the new BFA-12A Antenna produces 500 kilowatts (ERP) of power. The availability of this equipment made it possible to fulfil a dream of serving the people of western Michigan with a one-half-million-watt signal.

FIG. 8. All-RCA-equipped stereo-program center. BC-6B Audio Consolette at center, BK-5 announce mike on pantograph, BQ-51 turntables at announcer's elbows, RT-21 reel-to-reel tape deck and RT-7 cartridge facility mounted in rack at right, 12-inch studio speakers mounted on wall.

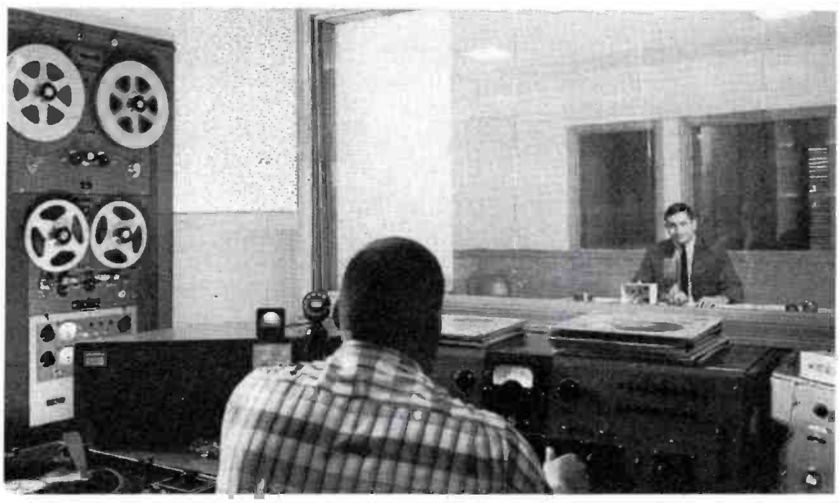


FIG. 9. Main control room. Rack at far left supports two Muzak-program tape machines for SCA operation, RT-7 tape-cartridge machines at left foreground with one of two 15-inch turntables adjacent. Talent using BK-11 mike.

FIG. 10. The fast-growing stereo-record library built up since WJEF-FM went "stereo". Miss Janet DeCraene, WJEF-FM's Traffic Director, (left) and Mrs. Dorothy Payne, WJEF-FM Receptionist Secretary, are shown returning records to the library. WJEF-FM found, through surveys, that the listener in the area prefers large time periods of a given musical category. Thus, programming is oriented to this preference.

PRACTICAL FM STEREO

by A. H. BOTT

Broadcast Transmitter Engineering

FIG. 1. The Type BTS-1A installed in an RCA Type BTF-50B Transmitter. Front-panel test points simplify check-out and other maintenance. (Photo courtesy of WJEF-FM, Grand Rapids, Mich.)

Beginning June 1, 1961, the Federal Communications Commission permitted FM-radio stations to transmit program material to the public in stereo using newly adopted standards. Stereo enhances the reproduction of FM sound and also increases the presence effect. RCA introduced the prototype BTS-1 stereo generator in April 1961, and later released the simplified stereo generator known as the Type BTS-1A. This article deals with the design philosophy of the BTS-1A generator, includes a description of the RCA stereo-transmitting equipment and operational theory (see Fig. 2).

The Stereo System

Any stereophonic system utilizes two pick-up channels. One channel, designated *L*, is derived from a microphone placed on the left side of the live-program source (as seen by an audience), the other designated *R*, originates from a microphone placed on the right-hand side. The microphone signals derived from these two channels are processed differently depending on the end use. If this is a recording for playback, the two signals are simply amplified and recorded in separate *L* and *R* channels and no special techniques are involved. However, if this stereo program is to be broadcast, the standards specified by the FCC must be employed.

The FCC-approved system involves the use of time-division multiplex for transmission of the *L* and *R* information, in which the switching is accomplished at a rate of 38,000 times per second. The composite wave of such a system contains all signal components of the *L* and *R* channels, in appropriate amplitude and phase, plus additional components contributed by the 38-kc keying signal.

Composite Signal

If a mathematical analysis of the composite waveform is made, it will be found to break down into three main components:

1. The sum of *L* and *R* audio frequencies.
2. A 38-kc sine wave of proper phase and amplitude *minus* the modulating frequency, and
3. A 38-kc sine wave of proper phase and amplitude *plus* the modulating frequency.

There are, in addition, other frequency components consisting of odd multiples of the 38-kc keying signal as well as its associated sidebands.

Methods of Signal Generation

One method of generating this standard composite signal is to actually switch at a 38-kc rate between the *L* and *R* channels. In this system, complete matrixing (the adding of two signals in a passive resistive or inductive network) is not required, but fractional matrixing *is* required to the extent of introducing an extra 2 db (approximately) of $L + R$ information, because the FCC Rules require removal of odd multiples of 38 kc (114 kc, 190 kc, etc.). When this is done, (by means of a low-pass filter) the envelope of the resulting waveform is distorted to the extent that the additional $L + R$ is required for correction.

A second method (which, incidentally, is the preferred method and is employed by RCA) uses *complete* matrixing to break down the *L* and *R* signals into $L + R$ and $L - R$ so that the $L - R$ signal can be given special processing. In the matrix, the *L* and *R* signals are simply added to obtain the $L + R$ information. To obtain $L - R$, the matrix reverses the polarity of the *R* channel before addition to the *L* channel. The $L - R$ information is then specially processed to become a double-sideband, suppressed-carrier (DSB) signal, amplitude modulated around the suppressed-carrier frequency of 38 kc. This signal is then recombined with $L + R$

FIG. 2. The RCA Type BTS-1A Stereo Subcarrier Generator. Bathtub chassis design results in uncrowded layout. Pre-emphasis networks and filter capacitor are plug-in units as well as diode quad, 38-kc crystal and relay.

signal to obtain the desired composite stereo intelligence.

To aid the receiver in the demodulation process, a 19-kc pilot carrier is added. The result is the final composite signal, occupying a frequency spectrum between 50 and 53,000 cps. It is in a form suitable for frequency modulating the main r-f carrier and which complies, in all respects, with the FCC Standards.

Simultaneous SCA Subcarrier

If transmission of an SCA subcarrier, (for multiplexing) centered on 67 kc, is desired, it can be added to the composite signal. This subcarrier requires spectrum space between 59.5 and 74.5 kc. Whatever the combination of subcarrier signals added together to modulate the main carrier, the peak deviation must not exceed the standard ±75 kc.

An additional requirement applies to the SCA signal whenever simultaneous SCA and stereophonic transmission is desired. Any spurious components from the SCA subcarrier signal must not exceed a level which is 60 db below 100 per cent modulation of the r-f carrier, in the frequency spectrum between 50 and 53,000 cps. To meet this requirement, additional selective filtering of the SCA signal is required.

RCA Design Protects SCA

The RCA BTS-1A Stereo Generator is designed to be added to an established line of FM exciters (RCA Type BTE-10B, for example) and transmitters. This exciter equipment was originally designed to handle main-carrier programming plus multiplex programming (several subcarriers) with excellent performance characteristics. It is of prime importance that the addition of a stereo subcarrier not degrade this performance, and, for the most part, the FCC has foreseen this problem and has set down appropriate specifications.

However, in RCA's tests, certain additional requirements have been found necessary to fully maintain a proper level of quality. One such requirement relates to the permissible amount of spurious signal present in the SCA channel (67 kc ±8 kc) as a result of the presence of the stereo subcarrier (38 kc ±15 kc). Good engineering practice dictates that equipment design should limit the effects of such spurious signals to be 60 db or more below the normal programming level in the SCA channel.

Early field tests by NSRC (National Stereophonic Radio Committee) and later confirmed in laboratory systems tests at RCA, indicated that crosstalk was indeed a vital factor in composite performance of a stereo-plus-SCA system, and that not only the transmitting equipment, but also the receiving equipment must be carefully designed and constructed if it is to avoid adding serious deficiencies to the signal-to-noise ratios. The systems work in the RCA laboratories brought out several helpful suggestions on receiver design, which are now being incorporated in most SCA receiving equipments.

The transmitter, however, should be the strongest link in the system. In view of the possibility of excessive crosstalk from the stereo subcarrier into the SCA subcarrier spectrum, a particular effort was made to reduce the spurious components above 53 kc, even though not specified by FCC Rules. It seems desirable, for instance, that any spurious component above 57 kc should be attenuated to a level 50 db or more below the level of the 67-kc SCA subcarrier frequency in order to provide a 60 db signal-to-noise ratio in the SCA channel.

Filter for 70 db Attenuation

Means for removal of the unwanted components above 53 kc are more easily applied and are more effective in some systems than in others. In the ordinary switching system, the filter for removal of the spurious components is a 53-kc low-pass network. This type of network lacks the ability to remove components above 53 kc to the degree possible in the method used in the RCA BTS-1A Stereo Generator. The BTS-1A uses a symmetrical bandpass filter to confine the $L - R$ (DSB) components within the 38-kc ±15 kc region. Thus, response is maintained at ±1.5 db through the stereo generator and the FM Exciter. This filter has considerably narrower overall bandwidth than a 53-kc low-pass filter, and thus achieves at least 70 db attenuation in the SCA frequency spectrum.

The bandpass filter causes an absolute time delay through the $L - R$ (DSB) channel, the magnitude of which is determined mainly by the steepness of the sides of the response characteristic. Therefore, a time-delay network is inserted in the $L + R$ signal path to delay the $L + R$ an identical amount and thus compensate for the relative delay between the channels so that the two signals may be properly recombined to form the composite stereo signal. If exact compensation were not achieved, L vs. R separation at the receiver would be somewhat degraded. A very satisfactory solution was found, using the symmetrical bandpass filter and time-delay networks. with practical manufacturing tolerances, they maintain an L vs. R separation of better than 30 db and, at the same time, provide excellent spurious-signal rejection.

Monophonic AM Simulcast

The ability to matrix provides additional advantages in the system selected for the BTS-1A. An AM transmitter can be fed simultaneously from the $L + R$ output provided in the BTS-1A.

On-Air Reliability

Fail-safe operation results in that any failure in the BTS-1A does not take $L + R$ program modulation from the main carrier of the FM transmitter, since no critical active components are used in the $L + R$ portion of the unit. In the worst possible case, only the stereo effect is lost. A further advantage is that the matrixing system permits a design using a minimum of active components (only two electron tubes), thus providing very high reliability.

Equipment Description

Figure 3 shows a simplified block diagram of the stereo generator and exciter portions of the FM transmitter. It can be seen that the new BTS-1A is intended for use with the RCA BTE-10B FM Exciter. For stereo operation, a simple input-adapter kit replaces the audio-input transformer in the exciter. This adapter allows the wideband composite signal to be fed directly into the exciter input by extending the low frequency response to about 5 cps, to eliminate the need for variable phase-adjusting networks to meet the ±3 degree

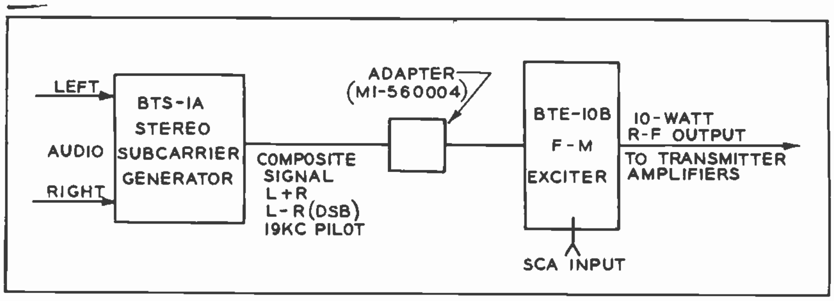


FIG. 3. Simplified block diagram of the stereo generator and exciter portions of the FM transmitter. Note that the SCA subcarrier connects directly to the exciter. The adapter unit replaces the audio-input transformer in the exciter.

maximum phase-shift requirement at 50 cps. The adapter increases the high-frequency response to 75 kc. (If, in addition to stereo, it is desired to transmit an SCA subcarrier, connections are made to the BTE-10B subcarrier input in the usual manner.)

Figure 4 is a block diagram of the BTS-1A Stereo Subcarrier Generator. This generator uses standard 75-microsecond networks to apply pre-emphasis to both the L and R channels independently. The pre-emphasis networks are designed to work from a 600-ohm source into a 600-ohm load impedance. Input transformers are provided for purposes of isolation and impedance-matching.

The $L + R$ information is subsequently fed to a time-delay network (see Fig. 6). This network is a low-pass device which is terminated in R18, a 600-ohm resistor. Across this resistor an $L + R$ signal appears delayed approximately 50 microseconds by the time-delay network. An output is provided for the $L + R$ signal at terminal *J3*. Figure 7 shows the mode of connection for the parallel feeding of an AM transmitter.

The $L - R$ signal is connected to a diode quad, which consists of four germanium diodes (see Fig. 6). This diode quad, connected as a ring modulator, is basically a double-pole, double-throw switch. Depending on the polarity of the biasing voltage, (in this case, 38-kc) the switch is thrown from one position to the other as indicated in Fig. 8. This reverses the $L - R$ signal-voltage polarity at the rate of the switching frequency. The switching frequency is derived from the crystal oscillator. The resultant of the $L - R$ signal being switched at a 38-kc rate is illustrated in Fig. 9. This waveform contains the desired $L - R$ (DSB) signal, in addition to amplitude-modulated components with carrier frequencies of 114 kc, 190 kc, etc. Practical $L - R$ (DSB) also contains small amounts of even order harmonics at 76 kc, 152 kc, etc.

A balance control, R20 (see Fig. 6), is provided in the modulator circuit. This control permits adjustment of the carrier-rejection by compensating for slight differences in the diodes of the quad and the transformer (T6) following the quad. Due to the close proximity and the matching of the diodes in the quad, the ring modulator is highly independent of ambient temperature variations. The variation in the amount of carrier rejection is in the order of only a few db over a temperature range from —20 to +45 C.

The $L - R$ (DSB) signal is fed into an impedance-matching transformer and a bandpass filter. The bandpass filter has a bandwidth of 36 kc (3 db points) with a center frequency of 38 kc. This filter eliminates all harmonic components (below

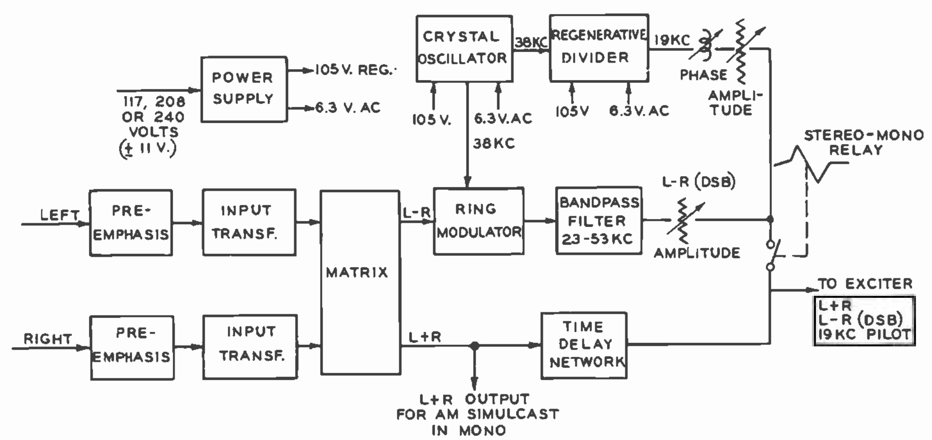
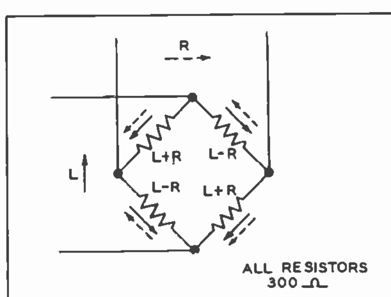


FIG. 4. Simplified block diagram: Type BTS-1A Stereo Subcarrier Generator. Note that the unit employs only two active circuits (indicated by supply voltage inputs). Since all other circuitry is passive, the utmost in reliability is achieved.

The functioning of the matrix can be visualized in Fig. 5. This is an ordinary bridge circuit with a 300-ohm resistor in each leg. If the left and right channels are applied across the two diagonals of the bridge as shown, the $L + R$ signal appears in two legs and the $L - R$ signal appears in the other two legs. In the actual BTS-1A circuit, the 300 ohm resistors are replaced by half windings of transformers T3 and T4 respectively (see Fig. 6). These half windings are connected in series to provide a 600 ohm source impedance of the $L + R$ and $L - R$ signals. Resistors R21, R22 and R23 (see Fig. 6) are provided so that each diagonal offers an impedance of 333 ohms, and also to provide a method for balancing the matrix.

FIG. 5. Simple bridge circuit aids in visualizing the function of the matrix circuit in the BTS-1A. Actually, the BTS-1A uses a transformer matrix for increased fidelity and reliability (see text). The matrix mixes left- and right-hand signals for subsequent processing within the stereo subcarrier generator.



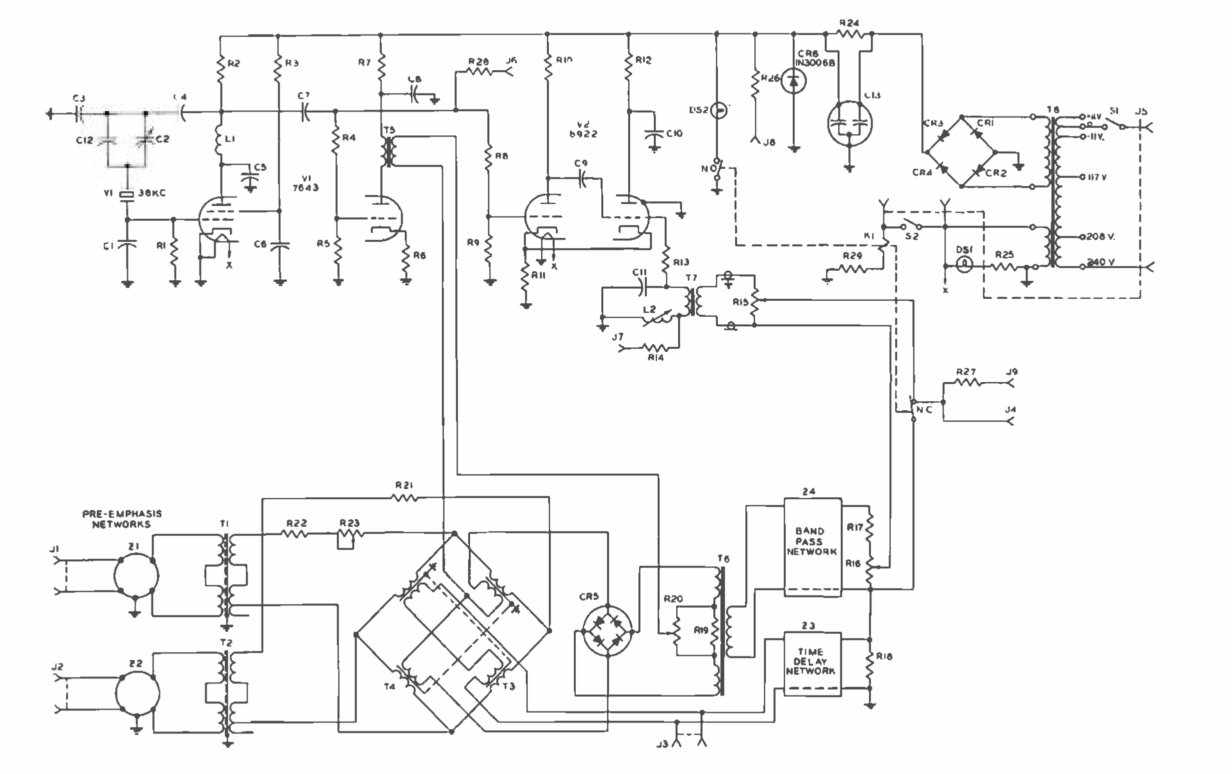
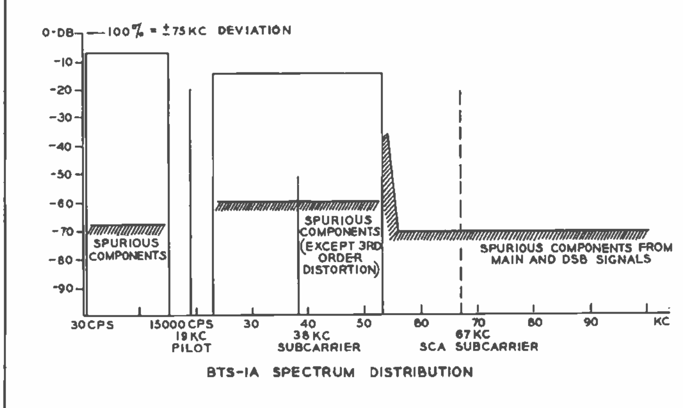


FIG. 6. Simplified schematic. Type BTS-1A. Straightforward, logical circuit assures the maximum in reliability and long life. Largely passive, this circuit employs a transformer matrix to mix left- and right-hand signals prior to signal processing.

23 and above 53 kc) and is particularly effective for removing components in the band of frequencies utilized by SCA subcarriers (57 kc and higher).

Any spurious components in a frequency range from 57 kc and higher are attenuated to a level of 70 db below 100 per cent modulation of the main carrier. This is 50 db below an SCA subcarrier with a modulation percentage of 10 per cent (see Fig. 10). The bandpass network (see Fig. 6) is terminated with resistors R16 and R17 which total 3600 ohms. At this point, an

FIG. 10. Intensity relationships of the spurious components generated in the BTS-1A. In every case, spurious components are well below the levels suggested by good engineering practice.



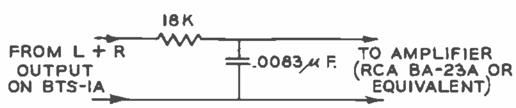


FIG. 7. De-emphasizing network for use at the L + R output of the BTS-1A for simulcasting an AM transmitter with a monophonic signal.

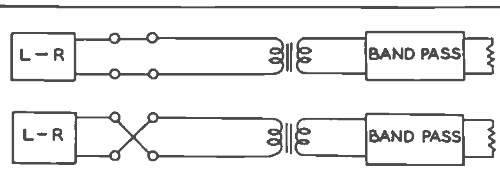


FIG. 8. Switching analogy of the ring modulator (diode quad). When the 38-kc sine wave is in one polarity, the upper situation exists: when the 38-kc polarity reverses, the lower situation exists.

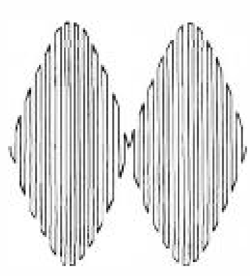


FIG. 9. Drawing of the waveform at the output of the diode quad. This represents the L – R (DSB) signal. (The modulating waveform, in this case, is a sub-multiple of 38-kc.)

L — R (DSB) signal is present. This signal is added to the L + R signal appearing across R18. In order to match the amplitude of both signals properly, the L — R (DSB) signal is adjustable through R16.

The composite signal has a 19-kc pilot signal added to the L +R and L — R (DSB) signals. This 19-kc pilot appears across a resistor, R15, which is connected in series with the L + R and L — R (DSB) R18 and R16. The three signals L + R, L — R (DSB) and the 19-kc pilot are added together thus forming the composite signal. The composite signal is available, for test purposes, on the front panel, at *J9*.

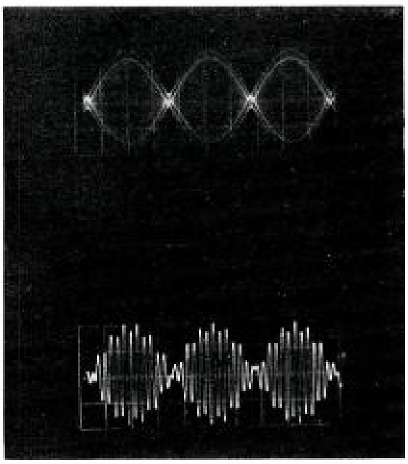


FIG. 11. Waveform appearing at BTS-1A output indicating proper phasing of the 19-kc pilot. (See text.) The upper waveform represents a modulating frequency which is not a sub-multiple of 38-kc, while the lower waveform shows a modulating frequency that is an exact sub-multiple of 38-kc.

A system using a composite signal to directly modulate the transmitter rather than individual L + R and L — R (DSB) portions has several advantages. First, it is easy to adjust modulation percentage and pilot phasing. Waveforms for this purpose can be observed on an oscilloscope without FM detection. Figure 11 shows a waveform obtained with proper phasing of the 19-kc pilot. To obtain this waveform, equal signals, out-of-phase, are fed into the left and right inputs of the generator. The top waveform in Fig. 11 represents a modulating frequency which is not a sub-multiple of the carrier frequency, while the bottom waveform of Fig. 11 shows a modulating frequency being an exact sub-multiple of the carrier frequency. The upper waveform in Fig. 12 shows incorrect phasing with a pilot carrier approximately 45 degrees out-of-phase, and the lower waveform of Fig. 12 shows correct

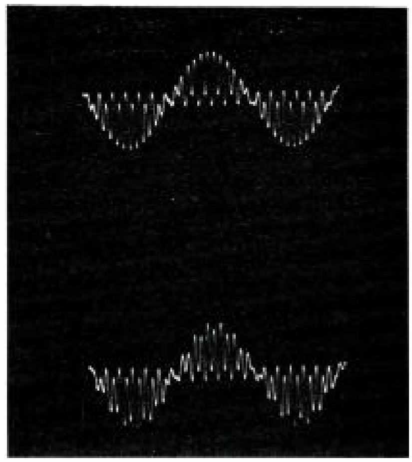


FIG. 12. Waveform showing incorrect phasing of pilot carrier. The carrier is approximately 45 degrees out-of-phase. The lower waveform shows correct phasing with either left or right signal only.

phasing with either a left or right signal only.

Monophonic Operation

To operate monophonically, part of the series connection of R18, R16, and R15 is short circuited through relay *K1* (see Fig. 6). This relay can be actuated locally or remotely: locally by switch *S2*, and remotely by short-circuiting contacts 15 and 16 of *J5*. For stereo operation, relay *K1* is energized and the short circuit across R15 and R16, will open. Another relay contact closes and applies power to pilot light *DS2* indicating that the subcarrier generator is in the stereo mode.

The 38-kc crystal oscillator can be varied 2 cps by capacitor C2; however, the oscillator normally requires no adjustment. This 38-kc signal can be checked at test point *J6*.

The 38-kc signal is amplified in the triode section of *V1* and then applied to the ring modulator. The 38-kc switching frequency does not contain any components at 19 or 57 kc. Both these components, if present, would be very difficult to remove from the composite signal, since they are very close to the edges of the bandpass-filter response characteristic.

The required 19-kc pilot signal is obtained by feeding the 38-kc oscillator signal to a regenerative divider *V2* (see Fig. 6). The divider is very stable, maintaining lock-in over synchronizing-voltage variations of 40 db, and plate voltage variations in excess of 50 per cent. The output of the divider can be checked at test point *J7*. The amplitude of the 19-kc pilot frequency can be varied using R15, while the phase of the pilot can be adjusted by means of *L2*. With amplitude adjustment (R15) fully CCW, the amplitude of the pilot frequency, appearing in the composite signal, is attenuated at least 60 db. This facilitates the precise adjustment of the rejected 38-kc carrier signal.

It is imperative that correct pilot phase be maintained, since all demodulating systems display a certain amount of sensitivity to phase errors. Should the pilot phase error be ± 90 degrees, a left-to-right channel reversal will occur. The amplitude of the pilot can be adjusted to give modulation percentages between 0 and 15 per cent of the main carrier.

Silicon Rectifier Power Supply

The power supply of the BTS-1A utilizes silicon rectifiers to provide 105 volts dc for tubes *V1* and *V2*.

A break-down diode *(CR6)* is provided to maintain the plate voltage at 105 volts ±5 per cent. This voltage can be checked at test point *J8*. The power transformer *(T8)* also provides 6.3 volts (ac) to operate relay *K1* and the heaters of *V1* and *V2*. The subcarrier generator can be operated on any line voltage between 106 and 128 volts ac and 197 to 251 volts ac at 50 or 60 cycles through the tapped-primary power transformer *(T8)*.

A bandpass filter is provided for installation in the BTX-1A Subcarrier Generator in the event the BTX-1A is used simultantously with the BTS-1A for simultaneous stereo and SCA transmissions. The purpose of this filter is to remove any components (at the BTX-1A output) below 53 kc, to a level of 60 db or lower, relative to 100 per cent main-carrier modulation. This prevents interference from the SCA channel into the stereo subchannel.

Two connections are necessary to attach the filter to the BTX-1A. The filter is a bandpass type with a 67-kc center frequency and a total bandwidth of 17 kc. The use of the bandpass filter is necessary due to the introduction of the stereo subchannel. This causes a slight increase in harmonic distortion and a certain amount of synchronous AM of the SCA channel. These are unavoidable effects within the framework of the standards, and are more pronounced at the higher modulating frequencies. At 400 cycles, harmonic distortion at the SCA subcarrier generator output is in the order of 2 per cent; at 5 kc, approximately 5 per cent.

The stereo generating equipment described above, operating in the prescribed manner, is capable of putting an excellent stereo or stereo/SCA signal on the air when operated in conjunction with any of the current line of RCA FM transmitters. The design objective, that the transmitter should not be the item that limits quality in the overall stereo system, has been achieved. This leaves a good margin for operational latitude and progress in design of stereo receivers.

Measurement Criteria for Proper Stereo Operation

An FM-transmitting facility which broadcasts only monaural programming can be measured and adjusted through only a few sets of relatively simple operations made with a modulation monitor and a distortion-meter set-up. However, with stereo or stereo-and-SCA programming, the complexity of the composite signal requires more precision in measurement techniques and operational adjustments.

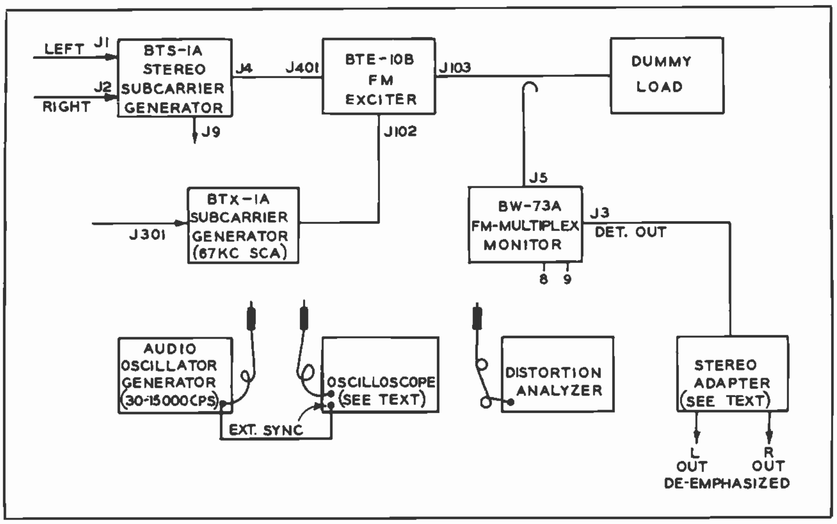


FIG. 13. Block diagram of the equipment setup used to make systems and equipment-performance tests. (See text.)

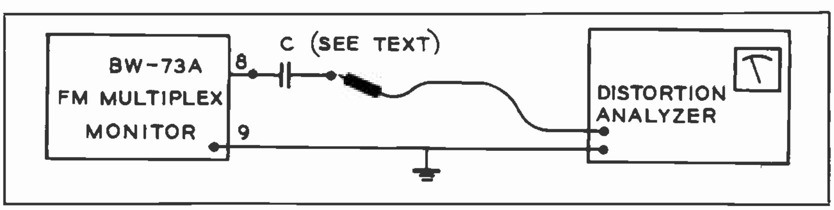


FIG. 14. Schematic of low-pass filter used in the measurement of signal-to-noise ratios.

The detailed methods of measurement presented here should assist the broadcaster to operate in full accordance with the approved standards, even in the face of receiver field troubles, and with a full understanding of equipment function.

The arrangement of equipment required to make the measurements is shown in Fig. 11. The equipment itself consists of:

- Audio Generator (with distortion less than 0.1 per cent).
- RCA Type BW-73A FM Multiplex Monitor or other suitable monitor
- Commercial Stereo Adapter (H. H. Scott 335 or the Fisher MPX-100)
- Distortion Analyzer
- Oscilloscope with vertical amplifier having a response from d-c to 300 kc.
- Dummy load for exciter output.

It is assumed that all equipment has been properly aligned according to the instructions supplied by the manufacturer. To determine the audio frequency response of the transmitter part of the stereo system, switch the *STEREO ON-OFF* switch in the BTS-1A stereo subcarrier generator to *OFF*. Terminate *J2* with 600 ohms. Feed a signal to *J1* and measure response with the regular station monitor in the same way as would be done in a standard proof-of-performance check. Select an input-audio amplitude to produce approximately 1 volt peak-to-peak at test point *J9*.

The $L + R$ frequency response is obtained in this manner. The $L - R$ frequency response is not measured directly since the L vs. R channel separation measurement will provide this information indirectly. $L + R$ channel distortion can be measured using the same methods employed at a regular proof of performance measurement. (To measure $L - R$ [DSB] distortion, a wave analyzer is required.)

Signal-to-Noise

When measuring the S/N ratio, only components in a range from 50 and 15,000 cps should be read. The necessity to extend the low-frequency response of the exciter to about 5 cps has resulted in random variations below 50 cps of significant magnitude due to the AFC action within the exciter. The components below 50 cps may cause erroneous S/N readings unless they are removed from the spectrum measured. Noise components above 15 kc are quite effectively removed by the de-emphasis network and do not materially affect the S/N reading.

When making S/N measurements, other components such as the 19-kc pilot, $L - R$ (DSB) components, the suppressed 38-kc carrier or an SCA subcarrier must be removed by separate means or by placing the *STEREO* switch of the BTS-1A in the *OFF* (MONO) position. To remove the SCA subcarrier, switch *S302* of the BTX-1A subcarrier generator to *OFF*.

To remove components below 50 cps, one should proceed as follows: With a 50 cps tone fed into the BTS-1A (*J1* or *J2*, *STEREO* switch in *OFF*) and its level adjusted to give between 30 and 100 per cent of modulation, set the distortion analyzer to read 0 db using the *distortion and noise output* of the FM monitor. Then, insert a capacitor at the input of the distortion analyzer (see Fig. 14). Select a value for this capacitor that will reduce the db reading by 3 db. In this manner, a high-pass filter with a 6 db/octave slope and a 50-cps cut-off is effectively inserted to reject the low-frequency components.

Stereophonic Balance

The measurements described up to this point do not differ materially from measurements taken at a regular proof-of-performance check. To assure proper stereophonic balance one should proceed as follows:

1. Apply 400-cps signals of equal amplitude and opposite phase at a level of +10 dbm to *J1* and *J2* of the BTS-1A Stereo Subcarrier Generator. Adjust *L2* to obtain waveform shown in Fig. 9. (Set *PILOT AMPLITUDE* fully CW, *STEREO* switch to *ON*, observe waveform at test point *J9*. Use 400-cps signal to externally synchronize oscilloscope.)

   Note 1: Whenever measurements are made to determine voltage or waveform of a composite stereo signal extreme care should be used to prevent capacitive loading of the circuit. This loading may unduly attenuate higher frequency components of the com-

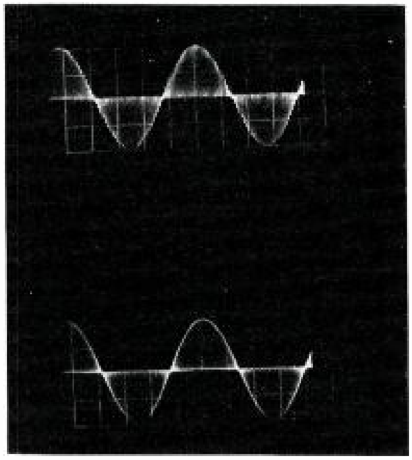


FIG. 15. Upper waveform displays a modulating frequency that is an exact sub-multiple of 38-kc; the lower waveform represents a random difference between the two frequencies.

posite signal leading to maladjustment with subsequent loss of separation. For this reason a low capacity probe should always be used with an oscilloscope.

Note 2: Many discriminator-type FM demodulators have built-in RC networks which provide a 6 db/oct. roll-off above 20-kc. These tuners are not usable for a stereo system unless the discriminator is redesigned.

2. With oscilloscope connected to *J9* set $L - R$ (DSB) *AMPLITUDE* to resemble Fig. 15, giving a straight base line. Feed 400 cps at +10 dbm to *J1* only.
3. Disconnect *J4* from BTE-10B exciter and connect directly to the receiver stereo adapter. Turn *PILOT AMPLITUDE* to about ¾ of fully CW.
4. Connect distortion analyzer to left (*A*) output of the receiver stereo adapter and adjust gain in the adapter and distortion analyzer for 0 db reading.
5. Connect distortion analyzer to right (*B*) channel and adjust adapter "Balance" control for minimum output. A typical reading would be —35 db.
6. Connect *J4* to *J401* in the BTE-10B Exciter and the stereo adapter to a suitable monitor or a tuner designed for stereo operation. Without changing the "Balance" setting of the receiver adapter, *advance* $L - R$ (DSB) AMPLITUDE for minimum reading from the *R* channel output of the adapter. (See Note 2 of Step 1.) Only a slight readjustment of $L - R$ (DSB) AMPLITUDE should be required.

The RCA Type BW-73A Multiplex Monitor will correctly measure total modulation percentage by a composite signal. However, many FM monitors presently in use will not properly indicate this modulation percentage, in that the meter indication will be lower than the actual percentage. The reduction ratio depends on the phase relationship of *L* and *R* input signals.

A way to overcome this monitor limitation is to connect an oscilloscope to test point *J9*. Place the *STEREO ON-OFF* switch to the *OFF* position and apply 400 cps at +16 db to *L* or *R* input connectors of the BTS-1A. Adjust the audio input until 100 per cent modulation is read on the modulation monitor. Observe the vertical deflection on the oscilloscope. A peak-to-peak value of 1 volt is to be expected. When the 400 cps tone is replaced by mono- or stereo-program material, the oscilloscope deflection can be used to monitor modulation percentage by visual observation.

Simultaneous Stereo and SCA

Figure 10 shows the spectrum distribution through a BTS-1A Stereo Generator, BTE-10B Exciter, and a wide-band monitor. The indicated limit on spurious response applies to any possible combination of *L* and *R* signals giving 90 per cent total modulation. Spurious components above 57 kc are sufficiently small so that a S/N ratio of 60 db in a 67 kc SCA demodulator may easily be attained.

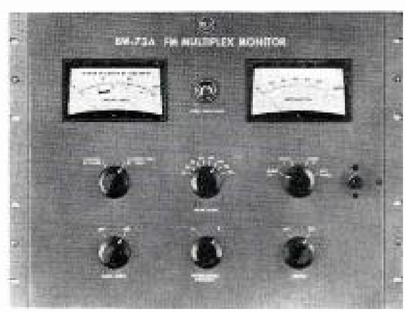


FIG. 16. The Type BW-73A Multiplex Monitor. A new instrument, designed for accurate monitoring of FM transmitters handling stereo and/or SCA programming.

Tests were conducted to determine the crosstalk (main to SCA channel) capability of a laboratory system using a modified commercial receiver. Modulation percentages were selected as follows: 10 per cent for the SCA subcarrier, 9 per cent 19-kc pilot, 81 per cent $L + R$ plus $L - R$ (DSB) components.

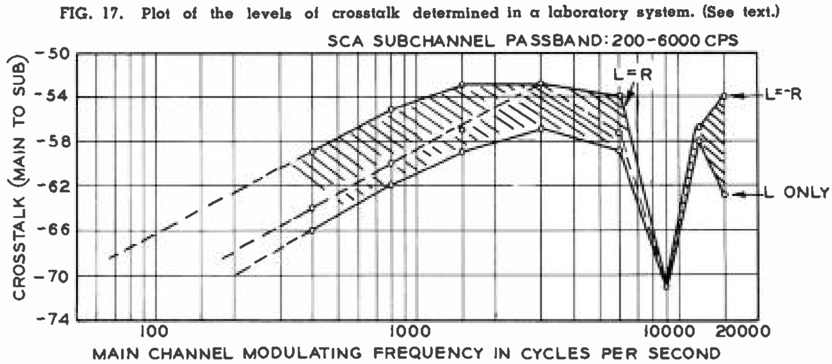
L and *R*-channel phasing was varied from 0-360 degrees and relative amplitudes between 0 and 1, thus encompassing any possible steady-state condition. Figure 17 shows the gamut of the readings taken. The lowest readings were obtained (1) with *L* or *R*-only signals below 9 kc, and (2) above 9 kc with equal in-phase signals to *L* and *R* inputs. S/N on the SCA channel was —73 db relative to +7.5 kc deviation, exclusive of 60 cps hum.

Crosstalk

It should be noted that the crosstalk, with modulating frequencies of 9 kc and lower, is at principally the same frequency as the modulating waveform or its second harmonic. However, with modulating frequencies above 9 kc, the crosstalk consists of low-frequency-beat components which are only slightly attenuated by the de-emphasis network and produce unintelligible crosstalk . . . often referred to as "monkey chatter."

Since many multiplex receivers now used in SCA service were not designed to meet the severe requirements of simultaneous SCA and stereo transmissions, addition of stereo programming to existing SCA operations may result in cross-talk problems. However, receivers having the necessary bandpass and band rejection characteristics are now available. RCA transmitters have performance characteristics which insure that their contribution to crosstalk will be negligible.

FIG. 17. Plot of the levels of crosstalk determined in a laboratory system. (See text.)



NEW RCA MODULATION AND FM-MULTIPLEX MONITOR

Type BW-73A Instrument Provides Convenient Means to Monitor and Measure the Various Aspects of Multiplexed-Transmitter Performance

by HOWARD J. SHAY
Broadcast Transmitter Engineering

The sales potential and public acceptance of FM multiplexing have had a stimulating effect on the broadcast industry. Already some 400 stations are operating with Subsidiary Communications Authorizations. Multiplex stereo-casting is now a reality. FM-Stereo promises to be the most significant advance in broadcasting since the introduction of multiplex itself.

The Type BW-73A FM Multiplex Monitor, as shown in Fig. 1, is a device that provides quantitative information necessary to help the multiplex broadcaster emit high-quality transmission. The BW-73A is FCC Type-Approved as an FM-Broadcast Modulation Monitor, and, when used in conjunction with a suitable, approved, frequency monitor it constitutes a complete FM-station monitoring facility.

Two Operational Modes

Generally speaking, the BW-73A operates in two modes. The first, as a full-time monitor for three aspects of multiplex operation: total main-carrier modulation; subcarrier deviation of the main carrier, and subcarrier modulation in percent. In the second mode, it serves as an accurate, high-quality, measuring device for all main- and sub-carrier characteristics.

Employed as a monitor, the left-hand meter (see Fig. 1) reads main-carrier deviation by either of the two sub-carriers. The right-hand meter indicates total main-channel modulation (main, plus stereo, plus SCA) or, subcarrier #1 modulation or, subcarrier #2 modulation or, the modulation on a directly-injected subcarrier. A front-panel switch permits convenient selection. A flasher (between the meters) indicates modulation peaks in any of these services. The threshold of this flasher is adjustable to permit maximum flexibility in operation. This flasher is a peak indicator and responds to short modulation bursts of 5 milliseconds (0.005 sec.) and shorter. This is considerably faster than the response of the modulation meter which uses standard FCC ballistics. The flasher feature allows the operator to set modulation level so that short peaks of modulation, ordinarily undetectable on the meter, do not cause over-modulation and its attendant distortion, crosstalk, etc.

FIG. 1. Type BW-73A FM Multiplex Monitor, a convenient instrument for monitoring and measuring multiplexed-transmitter performance.

Output terminals for aural monitoring are located at the rear of the instrument. Additionally, the subcarrier waveform is conveniently made available, at low impedance, for general station checks such as frequency measurements, etc. A stereo subcarrier signal, which consists of the 38-kc, double-sideband-suppressed-carrier, L—R component and the 19-kc subcarrier frequency, is also available at a rear-mounted output jack. An optional stereo adapter is required to derive the left- and right-stereo signals.

When used as a test instrument, the BW-73A works with the station's distortion-and-noise meter. Measurements may be made of main- or sub-carrier distortion; signal-to-noise; frequency response and the all-important crosstalk factor (the appearance of modulation on the measured channel as a result of its presence on another channel).

BW-73A Description

The unit is designed for instrument-case or standard-rack mounting. It occupies only 14 inches of rack space. The mechanical layout is a result of a survey of station engineers' preferences as to ease of operation, servicing and calibration. The tubes are removable from the rear with no exposed "hot points" (see Fig. 2). The front panel is side-hinged to permit access to the chassis underside without shutdown, thus retaining the usefulness of the meters and controls (see Fig. 3).

Control Facilities

All essential controls of the BW-73A are on the front operating panel. These include modulation and deviation meters—with their associated selector switches—and a flasher lamp. Control functions include an audio-muting defeat switch, a modulation-polarity switch, and a power switch.

With reference to the block diagram shown in Fig. 4, the rf-input signal is injected on a 50-ohm line and the level (100 millivolts nominal) adjusted according to the meter indication. This input level allows the monitor to aid in overall transmitter measurements and yet rejects spurious or unwanted signals. The oscillator is crystal-controlled and operates at 10.7 mc above the rf-input frequency. The mixer stage is followed by two stages of broadband IF's and a discriminator. The succeeding amplifier output is switch-selected for the choice of the appropriate monitoring mode. The subcarrier filters are plug-in units to allow fast and convenient addition of subsidiary services or frequency changes, should the need arise. The subcarrier chain employs two double-anode zener diodes in cascade thus assuring stability of the limiting level. At this point,

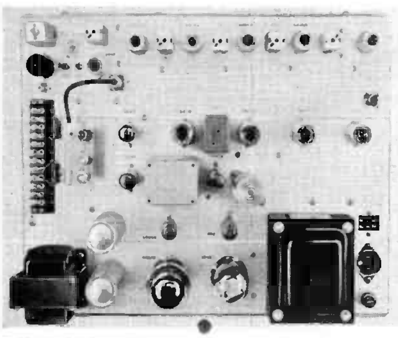


FIG. 2. Rear view of BW-73A. Note uncrowded tube and component layout with r-f and i-f stages across top, power supply at bottom with audio and subcarrier sections in center.

the FM wave is applied to the pulse-counter detector where it is demodulated. The residual subcarrier is absorbed, in the low-pass filter, and the remaining audio signal drives two separate amplifier stages. The first of these amplifiers de-emphasizes the modulation, and this output may be used for distortion measurements and/or aural monitoring. The second amplifier stage drives the peak-modulation-indicator stage and the VTVM-type modulation meter. The VTVM stage is compensated against meter zero-drift. The self-contained power supply employs electronic regulation.

Performance Characteristics

The signal-to-noise ratio is 65 db from the reference level at the distortion-meter-output terminals when measuring main-channel or subchannel characteristics.

Distortion is less than 0.5 percent between 30-15,000 cps on main-channel modulation, and the frequency response is within 1 db using 75-microsecond de-emphasis. When checking the sub-channel for distortion and frequency response, the band-pass filter is replaced with the adapter provided. In this service, the distortion is less than 1 percent from 30-6,000 cps, and the frequency response is within 1 db using 75 microsecond de-emphasis.

The main-to-subchannel crosstalk is down 60 db in the frequency range from 30 to 15,000 cps at 85 percent modulation from the ±7.5 kc subchannel reference.

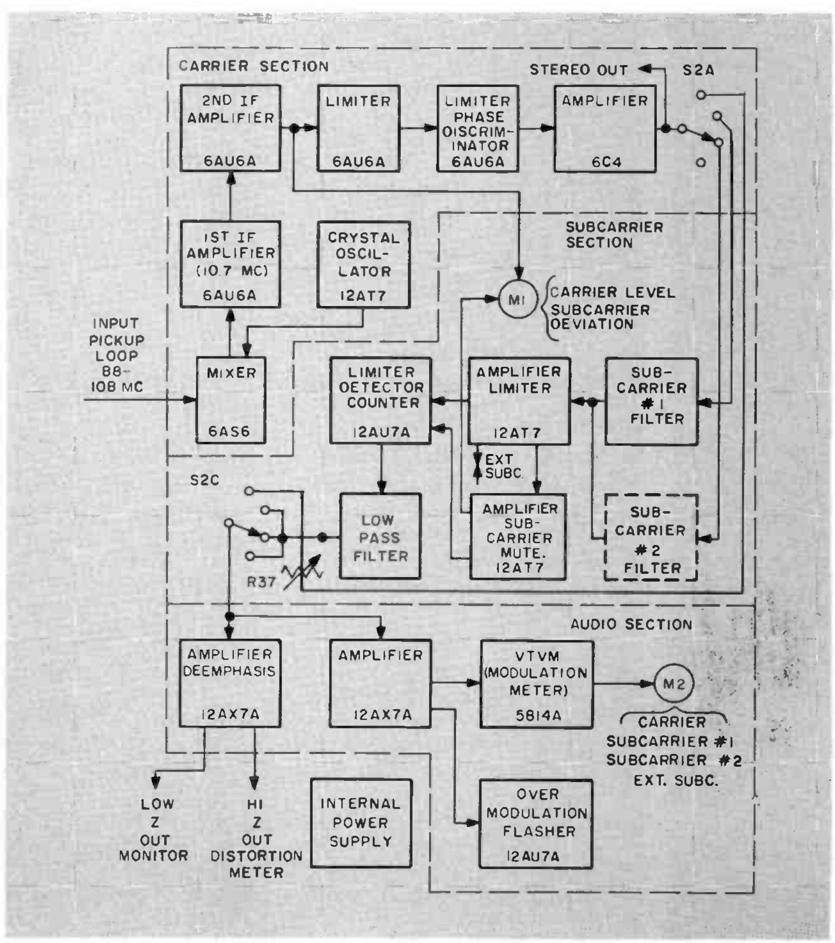
Summary

The BW-73A serves the FM broadcaster in several different, yet related, ways. In one mode, it serves as a full-time modulation monitor for all three aspects of multiplexed-transmitter operation. In the second mode, it is an accurate, high-quality measuring instrument for all main- and sub-carrier characteristics.

The mechanical design permits rack mounting—requiring only 14 inches of rack space—or mounting in an accessory cabinet for use as a table-top instrument.

FIG. 3. Swing-aside front panel provides access to the chassis underside. This feature allows examination of circuitry while instrument remains in rack.

FIG. 4. BW-73A Block Diagram showing the signal circuits of the instrument. The internal power supply employs electronic regulation of B+ voltages to prevent line-voltage changes from affecting performance.



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Distinctive silhouette of "TK-60", television studio camera that's years ahead in performance.

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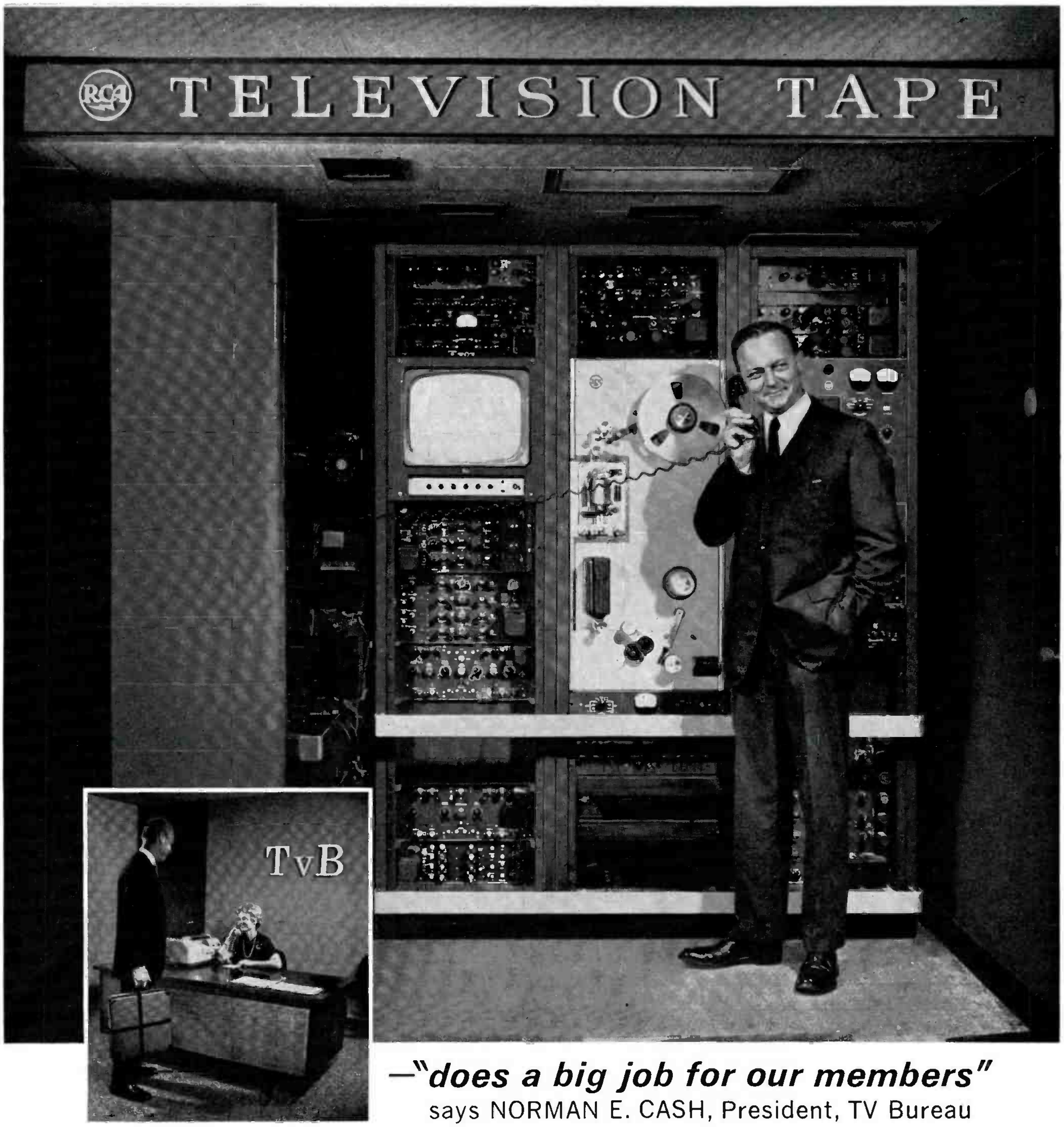
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