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ENGINEERING DEPARTMENT
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PROCEEDINGS OF THE 19TH ANNUAL NAB ENGINEERING CONFERENCE

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*Paper not furnished by speaker

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LUNCHEON ADDRESS

By
William E. Roberts
President & Chief Executive Officer
Ampex Corporation
at the
NAB Broadcast Engineering Conference
Shoreham Hotel
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Monday, March 22, 1965

Thank you very much, Frank.*

I am most appreciative of having been invited to be with you and to address you today.

Frank, one of my hobbies you didn't mention was that of being a major dog lover and I am not making any inference or reference whatsoever to some of your ABC programming.

This is totally independent. I am truly a dog lover and my wife and I a few days ago, or a few weeks ago went out and bought us a new beagle puppy. As I was leaving my home yesterday and as usual dashing off, as all of us do, late to catch the plane, I got four blocks away from my home and what did I see but this pup sitting out in the road and I slammed on the brakes and picked up the pup, dashed him into the car, turned into the first driveway, turned around, took him home, shoved him into the kitchen door and back to the car and just barely made the plane.

And it dawned on me, as we were just going down the runway that a friend and neighbor of ours four blocks away had also bought a beagle puppy. I don't know what my wife thought when she saw two of them in the kitchen. I'll know tonight when I get home.

Frank gave me quite a bit of leeway in choosing a subject matter for today and the choice, as you know, was not dogs but International Trade and Competition.

Man has communicated with man through nearly all of the 7 or 8,000 years of recorded time principally by means of the spoken word and to a considerably lesser extent the occasional written word.

To man living during the first 70-odd recorded centuries, the world and its size and scope were totally incomprehensible. At one time, this world was thought to be flat, at another it was round, and now it's said to be some sort of an ellipsoid shape.

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*Frank L. Marx, President, ABC Engineers - Luncheon Moderator

The traveling troubadour during the early centuries in England and Europe carried and disseminated the news of the events from town to town. The roving storytellers of the Far East moved from section to section of the country pollinating each area with the latest news and events of the villages through which they traveled.

The dynamic and brilliant innovation brought about by the communication and transportation industries during the past century and a half, and particularly during the past 50 years, have caused the world to shrink by several orders of magnitude.

The Mayflower consumed some 62 days and nights traveling the Atlantic just over three centuries ago. The early wagon trains required as many as 200 days from Independence, Missouri to California. Trains reduced travel time to four days from New York to San Francisco. The automobile has changed the face of the world creating our present interurbia.

Jet airplanes that came into their own just seven years ago have now cut travel time from San Francisco to London to 13 hours, or New York to Paris to 7 hours, and within a very few years this time will be cut further to about 2 hours. As a matter of fact, if you want to do a wee bit of arithmetic, somewhat negatively performed, however, you can leave Tokyo at 8 o'clock at night and arrive at 6 o'clock the same day, saving two hours. I think this is why some of our Japanese friends continue to look so young.

The telegraph was invented in 1832 and it speeded up our communications substantially. This was followed by the telephone in 1876. Radio blasted the communications late in 1921 and our intercontinental cables have tied the developed nations together even more intimately.

Coast-to-Coast television rocked the world with its introduction in 1951, followed by the intercontinental satellite communications systems now under development. Anyone who thinks that this is the end is just plumb crazy. It's barely the beginning.

The dynamics of modern communication and transportation have drastically changed the whole face of this globe. Nearly every phase of human existence has been modified in some manner or other in all corners of the globe as a result of these forces.

I shall touch on only one area of change, that of world trade and competition.

The industrial revolution begun in England in the late 1800s made a rapid transition to the United States at the turn of the century, and no other nation on earth has caught up with us since.

Our private enterprise system, plus the fact that North America was not used as a battlefield during the last two World Wars and, of course, our abundance of natural resources have made us the richest and the most advanced industrial nation on earth.

The U. S. market, up until World War II, used to be considered essentially a private preserve of U.S. manufacturers. Until the close of World War II, U.S. industry included few truly international traders, a larger number had export departments and sold through distributors in a few markets abroad, but the U.S. market was so big, it was so good and expanding at such a rate that very satisfactory results could be generated by concentrating here at home.

In addition, international markets were not understood and far more difficult to exploit. Language barriers and relatively slow communications and transportation were contributors as well.

The shrunken state to which the world awoke as soon as the Marshall Plan had taken effect in Europe and the United Kingdom has proven to be revolutionary in nature. Barring the Communist countries we are truly living in one world today and a relatively small one at that, comprised of a number of important trading areas.

Every industrial nation is playing in everyone else's back yard. Any U.S. industrialist who still assumes that the American market is his and his alone is not long for this world. The United States market is the largest and still the best in the world, but it is being exploited on a constantly increasing basis by manufacturers from every industrialized nation.

The tempo will continue to increase in the decade ahead. Tariffs and other trade barriers are being battered down. The home markets of many foreign manufacturers are providing an adequate volume to allow for economical mass tooling and production methods. Watches, bicycles, cars, cameras, steel goods, soft goods, radios, television sets, hundreds of other volume items are flowing across our borders into the American market at unprecedented rates.

We are encountering more and more serious competition for third world markets from our increasingly industrialized competitors overseas. It must be recognized by all that the United States market is no longer the private hunting ground reserved for U.S. firms.

I do not mean to in any way imply that this is a sad state of affairs. As a matter of fact, I believe just the reverse. The American customer is far better off and I would suggest that our economy and our industrialists who are intelligent enough to understand and lay plans to deal with this situation will be better off as well.

What this state of affairs suggests to me is a set of factors of which an increasing number of manufacturers are already aware, and which all of us must recognize in the near future. First, it says to me that we in industry must each think and act and live and breathe internationally and in fact become international industrialists and, further, make certain that all of our managerial and technical personnel do likewise.

We must change one of the most parochial views held by American businessmen. People in lower management and top or middle technical positions in U.S. industry can buy a ticket today for travel from New York to San Francisco or reverse with no one in the organization batting an eye. But if they were to consider purchasing a ticket from New York to London, we all practically require a board of directors approval. For some reason we all have a mental block when we think in terms of going past the Atlantic or the Pacific barriers. The day is already here when overnight visits to Japan, England and Europe are commonplace, and they must become even more so.

All of us must learn to look for and work to develop each and every worthwhile market that exists on this globe wherever it may be located.

I might add that this particular talk was written in a QANTAS Airplane, flying from San Francisco to London, it was typed by an English secretary and edited by an Australian girl in the office and read by me coming back in an Air France. It's about as international as you can get. The trip did take three days.

Second, we industrialists should develop specific plans and programs to hold and build third world market areas through an intelligent use of our home and foreign manufacturing bases.

Third, U.S. firms must continue to spend adequately for research and development to maintain our technological lead through product and process innovation, and in the spending of these R and D funds and in the development of our product and marketing plans we must take into account our international market requirements at the outset of such development.

Fourth, the free world today is face to face with the most competitive period in economic history. Our international business environment is permeated with an increasing degree of economic interdependence and healthy competition between the United States and its allies in Western Europe and Japan. To maintain our U.S. competitive posture at home and abroad, new levels of understanding and cooperation must be attained among business, labor and government.

All of us must, and I am sure will,work to this end as it is vitally in the public and our national interest to do so.

Our principal competitors overseas are nearly all experiencing tight labor markets and are mechanizing at a most rapid rate with a consequent drop in unit cost. In addition, the wage rate gap is not closing to any appreciable degree. Any unrealistic wage increases in the U.S. economy will very definitely lead to lost business and to increased unemployment here at home.

While there is still much to be desired in the way of full mutual understanding of these facts of life, it is heartening to me to see that business leaders are not alone in recognizing this problem.

Fifth, we all should do our very utmost whenever and wherever possible when talking with representatives of different segments of our society here at home to educate and inform them on the competitive economic facts of life, or our new multi-national existence.

Our competition is not the man down the street, but he is the producer of the lowest cost product of comparable quality wherever located in this world.

The President, a few weeks ago, requested of industry that we voluntarily set in motion necessary actions to improve our individual company balance of trade position by some 15 per cent or more over the prior year. At Ampex, we will comply with this request. We will do so by continuing to build our international trade rather than by cutting back on our overseas investments. Our estimates indicate that over the last five and the next five years, Ampex will have generated a favorable balance for the United States of approximately $40 million.

Open trade routes through the ages have been the primary binder of friendship between nations. Steps should be taken, and I mean now, to set up some intelligent ground rules for East-West trade. The governments of our allies have determined that it is not harmful, as a matter of fact desirable, that a quite liberal assortment of products be traded with the East. The red tape involved for U.S. firms attempting to gain approval for shipment of comparable items is grossly excessive and a serious deterrent to trade.

While the immediate volume would not be massive, we must be allowed to get our foot in the door to establish a proper U.S. trade position in these markets. Future trade volumes will very definitely be appreciable. Trade is a form of communication. I strongly believe that we must begin once again to communicate with the Mainland Chinese. Ways must be found at the earliest practical date to reopen our trade routes in this important area of the world. Two-way trade can aid substantially in thawing the cold war and preventing a hot one.

I have a great respect for the intellect of the oriental mind. A sizeable number of our top scientific and engineering personnel at Ampex are of Japanese or Chinese extraction. The Japanese were noted for the extensive copying of Western products immediately following the last war. Many of us still assume that this is the limit of their capability. Nothing could be further from the truth. Having caught up and rebuilt their economy they are now contributing more than their share of new creative and innovative products.

The United States has no corner on brains and we must expect the technological gaps to be substantially narrowed over the next decade. For America, the challenge in the next 10 to 15 years will be to remain a strong and vigorous contender in the world economic race. Only by succeeding can we in the long term contribute to real progress in the standard of living of all of our friends in the free world. Successful trade rests on the much more solid foundation of mutuality.

In closing, I would suggest that industry is prepared to take on the task of interplanetary trade. We are just waiting for you, the brains of the communication industry, to blaze the trail. If you can get them talking, we'll build and fill in the trade pipelines.

Thank you very much.

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LUNCHEON ADDRESS

By
James C. Hagerty
Vice President in Charge of Corporate Relations
American Broadcasting--Paramount Theatres, Inc.
at the
NAB Broadcast Engineering Conference
Shoreham Hotel
Washington, D. C.
Tuesday, March 23, 1965

I was very pleased and honored when Frank Marx of my company relayed to me your invitation to come here today to break bread with you and to have the opportunity of meeting so many who are engaged in the engineering processes of our industry.

My acceptance was partly due to the fact that I had a personal desire to thank all of the communication engineers for the tremendous job they are and have been doing.

You know, long before I had any idea that I would ever be connected with this industry and when I had another job down here in Washington, I quickly formed a lasting regard and respect for the engineers. In those days I learned to respect them and to take their advice. They were of inestimable value to the gentlemen I worked for and to myself down here in Washington.

Not that I fully understand your complex engineering and radio problems, far from it. You know, as a matter of fact, the first day I went to work for my company I spent the afternoon in the news department watching all hands, the news personnel and those in the engineering department trying to put together our evening report. It scared me to death.

I just couldn't see how anything was going to get on the air. But it was all confusion and complete disorder as far as I was concerned, but somehow or other by air time everything seemed to mesh together perfectly and the program went on without a hitch.

You know, right then and there I realized that Ed Murrow has everlastingly right when in appointing Howard K. Smith in 1946 as Chief European Correspondent for CBS he told him, "You don't have to worry about or even understand how they put you on the air, and don't try to find out."

"That's engineering's job and they do it damn well."

I couldn't agree more. You're all first-rate professionals and that's the highest claim I can give anyone. You know your jobs and you carry them through, as far as I am concerned, in the face of a most difficult set of circumstances almost every time a program goes on the air.

You know, like a football team, the news correspondents and the entertainment stars are the ball-carriers and they get all the glory. Engineers are the blockers who do the rough, tough work, the unsung linemen and that's a pun intended.

So, again, congratulations to all of you and thanks a million.

Now, when I told Frank Marx a few days ago that I wanted to start off my remarks by paying a few words of tribute to the engineers he said that would be fine. But then I asked him what else he thought I should talk about, what you would be interested in, and I will give him credit, he really tried. "You wouldn't want to compare the Eisenhower-Kennedy-Johnson press conferences from an engineering and philosophical point of view would you?" he suggested. And I said, "No, I wouldn't...that's up to the individual President."

"Well," he said, "maybe you could give us a rundown on the situation in Viet Nam. You know, maybe you could talk to Ike and get his views and then propose some definite solutions. I am sure the engineers would like that."

And I said, "No...I think that's the President's business."

Finally, he said, "What about civil rights?"

"We have just gotten word that the President will talk to the Congress Monday night, maybe you could start with Little Rock, bring in the University of Alabama, touch on Selma and then discuss the whole new voting bill, okay?"

I said, "No, that's for the President and the Congress."

That's when he gave up. With a shrug of almost complete frustration, he ended the discussion and walked out of my office, snapping over his shoulder as he left, "Oh hell, talk about something."

Well, I would like to. I would like to talk about something that may be a little off-beat for you here at this meeting. Now, I would not have the gall in front of this group to talk about radio and television. You know much more about the industry than I do and ever will. But since we are convening down here in Washington and since I did once work down here it might be that I could present my selected subject from a little different angle than you might have heard it before.

What I would like to discuss is some of the operations of one of the most important positions of awesome responsibility in the world today, the Office of the President of the United States.

While I make no attempt to talk about that high office in other than impersonal terms, I think I do have a personal observation of it through eight long, hard years, and while I have no similar knowledge of the last four years, I do not believe that the office has changed so much, except maybe for the different problems that confront the man that occupies it.

You know Merriman Smith who is the Dean of the White House Correspondents in his book on the Office of President said that the President is a man of many things, and that is exactly what our President is in this modern day and age.

Just stop for a moment and try to reflect briefly with me on the duties of the President, on what the American people want their President to be. He is the Chief Executive of the biggest corporation in the world...the Executive Branch of the Federal Government with its far-flung operations spread throughout this nation and the world. He is Commander in Chief of our military establishment and, by virtue of that constitutional assignment, the most powerful man in the world. He and he alone in our nation has the terrible, soul-shaking responsibility for and control of the eventual use, God forbid, of the awful arson of nuclear power.

Day in and day out, night in and night out, week after week, month after month, year after year, the bomb is sitting on his left shoulder all of the time. He is the diplomatic leader of the free world, the defender of freedom when it is endangered by aggression from any quarter, any place in the world.

He must work with friends and allies, he must preserve our friendly relations with neutral nations, he must counteract the movements of our enemy or enemies, and at all times do what he thinks is in the best interest of the United States of America.

He is the leader by his example of the conscience, the moral and spiritual tone of the peoples of our nation. He is the accepted leader of one of the two major political parties and, quite naturally, he tries to do everything he can to build up his party and to get increased popular support for its policies and philosophy. Yet he must also, in the national interest, forego partisan behavior and speak and work for all the people, regardless of party.

Finally, he is often forced by tradition to be a sometimes reluctant leader of the hospitality brigade, sought by executive secretaries of all sorts of organizations, by social hostesses for appearances at endless and sometimes inconsequential luncheons, dinners, meetings and receptions.

I think that's quite a load of different duties to place on one human being, and, incidentally, all too often we seem to forget that the President is, after all, only a human being, who does the best he can in the way he can for the good of the nation, yet we have been overloading the presidency with multiple duties for a long time and it's getting worse instead of better.

Remember, as President Kennedy once said President Eisenhower told him, only the impossible, almost unsolvable problems come before a President. He doesn't get any easy ones. If they are easy, they are decided somewhere else down the government line. Only the real hard ones reach his desk and he has to make the ultimate decision.

But, as President Truman said, "If you can't stand the heat, don't go into the kitchen."

And, believe me, ladies and gentlemen, a president lives continually in the hottest kitchen of them all.

Under our system of government, the President has many different duties, as I have tried to outline, maybe too many for one man to possibly handle. I have always believed that he should be relieved of some of the less important ones, particularly some of the protocol or hospitality assignments that have been saddled on his office, for, you see, our nation is one of the few countries in the world that continues to pile all sort of responsibilities on one individual.

In the parliamentary nations, like the United Kingdom, for example, the protocol duties are assumed by Her Majesty, the Queen, while the business of actually running the government is left to the Prime Minister.

In the Soviet Union, the President of the Presidium is the Protocol Chief of Staff, but I don't think anyone doubts who is running the country.

But we all so often continue to force our President into these time-consuming duties, to leave him too little time to just sit and think, to ponder and to study the vital decisions of our time.

Now really some of the more unnecessary duties are really holdovers from the less complicated days of our nation's history when both national and foreign affairs problems were far less pressing on the President than they are today.

Today, for example, and certainly since World War II, more than 70 per cent of a president's working days and nights are involved with international affairs, not domestic ones, and these are tense, delicate and complicated situations that require the personal and continual study and action by the President.

Now, before 1940, the ratio was almost reversed, with domestic problems taking precedent.

I think we are all beginning to realize that as a people we have saddled our President with some antiquated duties and certainly, believe me, presidents have long since realized it.

It is also becoming increasingly evident that we recognize this because we are expanding the duties of the Office of Vice President. You know, he is no longer the unknown and lonely throttlebottom of, Of Thee I Sing, whose sole duty was to preside over the Senate providing someone would recognize him and get him admitted to that body.

In the evolution....the Office of the Vice President, as the President's first main assistant, has grown in importance in our country. Actually, I think it was started by Dwight Eisenhower with his Vice President Dick Nixon, it was continued by Mr. Kennedy and his Vice President, Mr. Johnson, and it certainly has been continued with Mr. Johnson and his Vice President Hubert Humphrey.

But it was not too long ago, and it is hard to realize it, Mr. Truman writes this in his memoirs himself, from the day he was nominated as Democratic Vice President with Mr. Roosevelt until the day Mr. Roosevelt died, Mr. Truman, as Vice Presidential Candidate and then as Vice President, actually saw the President of the United States only eight times.

When he lowered his hand after taking his oath of office after the death of Mr. Roosevelt, the Secretary of Defense, Jim Forrestal, had to step up to him and say, "Mr. President, there is something I have to tell you." That something he had to tell him was the atom bomb, and Mr. Truman as Vice President had no knowledge in those days of the secrets of our nation.

Now this just cannot possibly happen any more. The Vice President is a member of the President's inner circle, he's a member of the Cabinet, the National Security Council, he heads the Space Committee, he usually heads the Labor Contract Compliance Committees of the Federal Government and those on Discrimination and many other matters and he represents the President when the President does not wish to represent himself.

But despite this expansion of the duties for the Vice President, despite an easing off of some of the more unnecessary, out-of-date obligations placed upon the President, there is still only one man, when the chips are down, who can make the final policy decisions affecting our nation, and that is the President.

Now he can have all the advisors he wishes, he can have all the government experts he desires, he can have anyone from his Cabinet or anyone else he seeks, but in the last analysis he and he alone must make those final decisions, though maybe not entirely alone. Every president that I know anything about has had a deep and simple religious faith and I will be always personally convinced that the exercise of that faith has helped them over some mighty tough spots.

The office is a very lonely one, perhaps the loneliest in the world. The power and the responsibility which reside in that office affects the men who occupy it and it affects some or most of those who come in personal contact with him.

I will always remember an incident which occurred in the office the first full day after President Eisenhower had been inaugurated. General Omar Bradley, then Chairman of the Joint Chiefs of Staff, a West Point classmate of the President, a wartime associate and a close personal friend came in to see him on business. Between them it had always been Ike and Brad from cadet days up 'til that day, but that day, as General Bradley entered the office to meet his friend now the President, he came smartly to attention and said, "Good morning, Mr. President."

And after the meeting, President Eisenhower rather sadly told his personal secretary, Mrs. Whitman, "I suddenly realize how things have changed. Do you know that Brad called me 'Mr. President,' throughout our meeting."

But that's the way it has to be. The President always stands apart from his fellow citizens and even his closest friends. Though the President might wish it otherwise, once he enters that house over on Pennsylvania Avenue, no one can ever quite forget that he is the President of these United States.

But while it's the loneliest job in the world it is also, with the strange contradictions that office always holds, the most public job in the world. The President and his family live in a goldfish bowl and are expected to have little, if any, privacy. He is also expected to have the wisdom of Solomon and the patience of Job. Newsmen by the hundreds cover his every activity and try to outguess or anticipate his mental processes as he tries to think out important decisions.

If, for example, he holds too many press conferences or appears frequently on radio and television, he is publicly criticized in some quarters of over-communicating, whatever that means.

Or destroying the intimacy of his meeting with news representatives by permitting radio and television to cover, or of using too big a room. If, again, only as an example, he doesn't hold as many press conferences as some people think he should, and there are times particularly during a tense international situation when I don't see how he can, but if he doesn't hold too many press conferences, he is again publicly criticized, often by the same people, of under-communicating, or operating in secrecy, of destroying the opportunity for hundreds of newsmen to question him, or of not using a big enough room.

If he reveals the normal human habit of getting mad sometimes at criticism, some of it unmerited, some of it political, some of it justified, such conduct is again open to public question.

I can recall a time when word got around Washington that people could tell the mood President Eisenhower was in by the way he dressed. If he wore a brown suit, the legend developed, watch out.

Well, what was completely overlooked in this supposed weathervane of presidential temperament was that President Eisenhower had a liking for brown suits and had quite a few in his wardrobe. What was further forgotten was that his valet always laid out his dress in the morning, and if the brown legend had any basis of acceptability, it probably reflected more how the valet felt on any given day.

But there is no doubt that presidents do live in a goldfish bowl and usually they get used to it, although sometimes they try to rebel and steal away occasionally, to get out of Washington from time to time. Mr. Hoover liked to fish, Mr. Roosevelt liked boating and Warm Springs, Mr. Truman liked to take the presidential yacht down to the Potomac or to Key West, Mr. Eisenhower liked to golf in Augusta, Palm Springs, or Denver, Mr. Kennedy liked the seashore at Hyannisport and Palm Beach, and Mr. Johnson loves that Texas ranch. And more power to them in their escape from Washington. You'll go nuts if you stay in this town too long at one stretch.

Now every president can and should on occasion get out of Washington, but it's only for a breather, he never leaves his job behind, his office is really wherever he is, whether he is at the White House or whether he is in Johnson City. There is no such thing as a vacation for a president or at least a vacation as you and I like to think of from time to time.

I thought, winding up these remarks, you might be interested as engineers in the communication system which permits a president to keep in touch with the job at all times. Within the confines of certain security provisions it operates this way.

When he is at the White House the lines of communication are, of course, all built in. There are the regular lines of the White House telephone switch-board which link the President to all of his top administrative personnel throughout the government.

There are also certain other direct line installations which put him in instantaneous touch with certain other people in the Department of State or in the military, and, of course, there is that telephone line direct to Moscow.

Complementing the switchboard at the White House there is the United States Army Signal Corps Detachment assigned to the President's office with all the necessary code equipment and other communications machinery.

When a president leaves the White House to drive, say, to this hotel, his automobile has a telephone and radio connection in it direct to his office and when he arrives here at the hotel there are direct communications already installed back to the White House, even though he is maybe going to be here for only a few moments.

When he travels outside of Washington, the communications are even more elaborate. His airplane is equipped with a radio-telephone, single side band radio, telex machine for ordinary messages and a code machine for more sensi-tive reports.

I can remember on one of the advance trips we took of testing out the single side band machinery we had as we were taking off from Kabul, Afghanistan relayed through our military channels and talking to the White House just as easily as if I were making a telephone call from New York to Washington.

But when a president arrives by air at his destination, ground line telephone connections have been installed in advance at the airport just in case he wants to use the telephone or somebody wants to get him and again the automobile he uses on the ground has radio and telephone connections.

Wherever he is staying overnight or for a few weeks similar communications have been arranged well in advance and if he leaves the immediate vicinity of his communications, walkie-talkies are carried by Secret Service personnel or Signal Corps personnel that link him to his communications.

If he goes overseas, as all of our modern-day presidents do, the far-reaching worldwide communication facilities of our government are at his immediate disposal and connect him to his home base, the White House, just as easy as if he were merely out of town for an overnight stay in New York or Johnson City.

Incidentally, the radio and television networks on an approval basis have added another form of communication direct to the people from the White House. The networks have installed hot equipment in the White House theater and keep it manned so that they can be ready at any time to pick up important in-person presidential announcements.

So you can see there is never any time that he is out of touch with his job, that he is on call day and night.

I have no doubt also that most of you have gathered by now that I have the highest personal respect and regard for the office of the President and the individual who occupies it. Well I certainly do, and I think that anyone who has had the opportunity and privilege to work for any president, to be in daily contact with him, will always feel the same way, and I know no better way to end these rather rambling remarks about the office than to quote an inscription that is embossed in gold letters on the mantle of the fireplace in the State Dining Room in the White House.

It reads: "May the best of blessings fall on this house and all that shall hereafter inhabit it. May none but honest and wise men ever rule under this roof."

The date, November 2nd, 1800...the author, John Adams. I have always had faith in the wisdom and the judgment of the American people. I will always believe that John Adams' blessings will always hold true.

Thank you.

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LUNCHEON ADDRESS

By
General Bernard A. Schriever
USAF, Commander, Air Force Systems Command
at the
NAB Broadcast Engineering Conference
Shoreham Hotel
Washington, D.C.
Wednesday, March 24, 1965

Thank you, Mr. Chairman. Ladies and gentlemen:

I really am sincere when I say I welcome this opportunity to address your Association and I appreciate being allotted this prime time at your National Convention.

I know also of your continuing campaign against long commercials so I shall make my comments brief. However, I would like to make a few off-the-cuff comments. Yesterday I was at Cape Kennedy and, along with a lot of others, along with the Vice President and as we were sitting in Mission Control watching the count-down, he became fascinated with one of the consoles and there were many of them there and on one of these consoles there was the heartbeat of the astronauts showing, both Grissom and Young.

As the count-down proceeded, why, he would mention from time to time, Golly, they haven't changed one bit. They're just as slow as they ever were and this went on for about 30 minutes and I guess he commented on this three or four times. I could see that his excitement was going up by considerable leaps and bounds and I know that his heart beat wasn't keeping pace with that of the astronauts.

Finally, when the count got to about T-minus-5, why, the heartbeats started to speed up a little, so he looked at that with great interest and remarked, Well, they're human after all.

I could see that he said that with a great deal of relief.

We all know that yesterday's flight was a very successful one and this has been brought about by the ingenuity of the American people, by the industry, the scientific fraternity and the government. I can remember just 8 short years ago when the first long-range ballistic missile was launched from then Cape Canaveral. This happened to be an Air Force Thor Missile for which I was responsible.

That particular flight went exactly 10 inches in the air and then settled back down through the stand and we had a great big ball of fire, and that wasn't the last one that had that sort of fate, but that was just 8 short years ago and it should give you pause to think of the tremendous advance that has been made in this very short period.

There was another little incident that I think might be amusing. It wasn't amusing at the time, and this was on the second Thor and this was just about -- it was in March, as a matter of fact, of 1957, and this one was going perfectly and after about 40 seconds of flight suddenly it exploded and in checking to find out what happened the range safety officer had pushed the "destruct" button.

What he had seen on his range safety devices was that the missile instead of going out over the Atlantic was actually curving back and moving inland over Florida. It happened to be that his instrumentation was wrong but there were also people -- it was a perfectly clear night and people were telling him that the missile was going fine, going fine, but he pushed the "destruct" button anyway.

I won't be a Monday morning quarterback or second guess, but our missiles were expendable in those days, but so were range safety officers.

We had a nice little Island right off the Coast of Brazil called De Noronha, this is one of our tracking stations, but we very seldom ever use it. It was a penal colony about 3 or 400 years ago. That's where he ended up.

I might say just at that time we were in quite a contest with the Army and you may remember the controversey between the Thor and the Jupiter and so this particular flight didn't make any of us very happy. I understand that you have had General Bruce Medaris address this group and also General Trudeau, both of the Army, both of whom I know very well. I know what kind of spellbinders they are. They are both now retired.

Today, of course, you will get nothing but the unvarnished and the ungarbled truth.

But seriously the Air Force and Army and Navy work together very well in the technical field. Sometimes we have little squabbles in Washington at the highest policy level but I can assure you that the taxpayer is not wasting his money by duplication in technical areas. We do, in fact, work extremely well together.

I mentioned that we have been in this age of space and missiles only a short period of time. I can recall making a speech in 1957 in which I discussed space at some length and then found out to my dismay that space was quite a nasty word, and I didn't use it for a while, that is until after Sputnik. That occurred in October of 1957.

In 1959 we had had five straight Atlas failures and I was appearing before the Space Committee in the House explaining what was wrong with the Atlas missile and it just so happened that on that day we had a flight scheduled and it was successful. So I think it is more important to be lucky than good.

Now, getting back to the subject at hand, and I am going to talk about space today, first I want to acknowledge the splendid way in which the networks, the local stations and broadcasting interests of this nation have supported the activities of the U.S. Air Force in the missions of the Air Force Systems Command, my organization.

More than 1300 radio stations are currently broadcasting the Systems Command Program which is entitled "Take a Giant Step." The extent to which radio and television reporting has contributed to the public's awareness and understanding of U.S. space pursuits is very commendable. You in the broadcasting business and we in the Defense Department are each responsible to the American public. You contribute to the public's entertainment, information and education. We provide for their defense and security.

In programming for the present and for the future we both must depend on our professional judgments to determine what will best meet the needs of the American people. Making these judgments requires wisdom which has been defined as common sense in an uncommon degree.

Both the dangers and the opportunities of our age make it clear that management wisdom is one of our urgent needs. This is particularly true with regard to space.

To indicate the scope of our space effort, let me give you a brief list of our accomplishments during 1964. They included the first two launches of the Titan III Space Booster, the successful test firing of an ion engine, and several successful flights of the Asset Winged Re-entry Test Vehicle.

I might point out here that this is a very important program because certainly in the space age we don't want to always have to fish our astronauts out of the Atlantic. We want to be able to land on land and we need to have maneuverable re-entry systems. This particular program is aimed toward that attainment.

The Air Force developed boosters launched many of the nation's major space shots, including the Ranger, the Mariner, and the Orbital Geophysical Laboratory which is the largest U.S. scientific satellite.

During 1964 the Atlas Launch Vehicle attained an 18-month unbroken string of 26 successful flights for a reliability record of 100 per cent. These and other achievements of 1964 are listed in the Systems Command Annual Report which is being released today.

To bring this list up to date, I would like to add that the Gemini Launch Vehicle used in yesterday's space shot is also an Air Force booster. It is a modified version of the Titan II ICBM which was carefully man-rated for its space mission by the Air Force Systems Command, the Space Systems Division located in Los Angeles.

The man-rating program included the use of redundant components to provide back-up systems. Critical components were given special handling in super-clean white rooms, a special malfunction detection system was built into the vehicle to automatically inform the crew in the event of an in-flight malfunction.

Systems were simplified wherever possible to increase reliability and you were introduced a while ago to Colonel Deneen, who is a member of the Systems Command located at the Space Systems Division who has been the program director of this. It all sounds easy today but I can assure you that we had many problems to contend with. A missile can do things that a man-rated booster can't and we had to get rid of some of these characteristics in order to make it applicable for manned flight.

So all of this work paid off and it paid off well as yesterday's flight indicated.

It is important to know not only what we are doing in space but also why we are doing it. Obviously any large national effort can be justified only if it serves specific national objectives. The two broad aims of the U.S. Space Program have been clearly stated by the President when he said:

"Space progress is essential if this nation is to lead in technology and in the furthering of world peace."

Let's look at the first of these objectives. Technological leadership is essential to both our military and our economic strength. It also contributes substantially to national prestige. Rightly or wrongly, achievements in space are taken to be a sign of a nation's technical leadership, and I think there is a lot of truth in this.

Now that I have raised this point, let's see what our competition is doing. We learned of their latest achievement last week. It is still true that we lead in some aspects of space exploration such as the total number of space shots, number of scientific probes and practical applications of space satellites for such purposes as communications and weather observations.

On the other hand, the Soviets lead in a number of areas with both propaganda and practical implications. It is interesting to note that their timetable always seems to put them one step ahead of us. Thus we have put into space -- thus they have put into space the first satellite, the first living creature, the first man, the first woman, the first multispace ship, and now the first man to step out of the capsule into space itself.

They also hold the world's record for time in orbit, orbital distance, orbital weight lifted and highest orbital altitude. They now have a total of 507 hours of manned space flights. Yesterday's Gemini flight brings our total to 61 hours.

The question naturally arises: How will the Soviets use these capabilities? As the Vice President told the National Space Club here in Washington on Friday, we would be foolish if we did not understand the military implications of Soviet space science as well as our own, and he pointed out our national security alone would suggest reason enough to strive for absolute leadership in space exploration.

Since we in the military have responsibility for national security, we are interested in any medium of operation where the actions of others could threaten us or where our own actions may enhance our own security. This is by no means a new interest on our part. As early as 1949 the Air Force School of Aviation Medicine established its now well-known Department of Space Medicine.

Back in 1946 when General Arnold established the Rand Corporation in California, the first task that he gave to that organization was to determine the feasibility of satellite observation. The development of the ICBM gave us the means of actually entering space and by 1956 the Air Force started studies of manned space flight.

In April of 1958 we prepared a detailed development plan for a manned military space system program with the goal of a manned flight to the moon and return.

These are only a few indications of the depth of Air Force experience in preparing for manned space flight during the past 15 years.

Space can be used to enhance our national security in two respects:

First, space satellite systems are practical for certain supporting missions. I mean communications, weather, observation, navigation and warning. These space systems provide certain unique advantages and can perform many tasks more effectively than ground based systems.

Our second interest in space is to explore its military potential, particularly the military role of man in space. Intuitively we have a strong feeling that man will be essential to a number of military tasks in space, just as he has proved to be in the atmosphere, at sea and on the land.

He provides a flexibility and reliability that cannot be attained by black boxes alone. It is clear from the X-15 Program and the Mercury Program that the man on board is often essential to mission success. You will recall that both Colonel Glenn and Major Cooper were required to control their spacecraft manually when difficulties occurred in the automatic control system.

In the X-15, quite a number of flights, as much as a third of the flights of the X-15 would have failed without a pilot in the cockpit to correct malfunctions of equipment.

We want to go beyond intuition and find out through actual experiment how well man can perform in space. This is the purpose of the manned orbiting laboratory, commonly called MOL. As a laboratory in the literal sense, it is designed for the purpose of experimentation, study and evaluation of man. MOL is unique in allowing free movement within a pressurized capsule and outside of it in tests of extra-vehicular activity. In other words, we plan to have a shirtsleeve environment inside the spacecraft. Thus it complements the other elements of the National Manned Space Flight effort.

Project Mercury has given us a toehold on manned exploration of space. Gemini and Apollo may give us a foothold. But to establish a more secure place for man in space we must study carefully his adaptability and his limitations over prolonged periods. This is the objective of MOL.

These military considerations I have discussed are all aimed at achieving the second objective stated by the President, the furthering of world peace. This fact underscores the importance and urgency of our space efforts. For this reason, as well as because of the cost involved, we must manage them with the greatest wisdom and effectiveness.

A good example of our management approach to space projects is the development of the Titan III which is designed to launch the MOL into orbit. Secretary McNamara has commented on the extremely efficient manner of the Titan III Program. To date we have had three test launches of the Titan III, the third took place just last month. This launch achieved the most nearly circular orbit in the history of the U.S. Space Program.

With the Titan III we are attempting to get extra value for our investment by carrying what we call bonus payloads. These are useful payloads designed for flight on a non-interference basis with the test objectives of the booster system.

We plan to orbit two satellites for the Office of Aerospace Research, each containing 14 independent scientific experiments. Three launches of the Titan III will be in support of the Interim Defense Communications Satellite Program. This will give us our first communications satellite capability aimed specifically to support military operations.

With each booster capsule we are capable of orbiting 8 communication satellites packaged in a special dispenser, so on three successive launches of the Titan III we have a network of 24 communication satellites in near synchronous equatorial orbit.

Other launches are reserved for payloads supporting the Air Force MOL Program. The payload capacity of the Titan III ranges from 5,000 to 25,000 pounds and makes it ideally suited for the purposes which I have just stated.

Looking ahead to future space needs, we are now preparing to test an expandable honeycombed structure for possible use as a space station. The structure can be compressed into a very small package and volume is very important particularly during the launch phase, and then it can be expanded in space to a cylinder of 10 feet in diameter and 25 feet long.

The structure will be tested in a vacuum chamber later this spring by our Propulsion Laboratory in Dayton, Ohio.

This has been only a very brief discussion of some of the things that we are doing in space. As our programs become increasingly large and complex even greater wisdom and skill will be required to manage them effectively. Today we have laid the foundations both in terms of technology and of management experience and I am confident that we will be prepared to meet the challenges that lie ahead.

In the final analysis, the real key to our progress in space is the backing that we receive from the American people. This is the way it has to be in a democracy and in the months and years ahead I believe that you in the broadcasting business will help to bring about an even greater understanding of the nature and importance of the National Space Effort.

I am heartened that your stand for freedom in broadcasting is also a stand for responsibility in broadcasting. As you carry out this responsibility you will be contributing in a real way to the intelligent public support that is vital to our continued progress in space and, for that matter, in all areas of technology because it's a very complex business and all of these are vitally essential to our national security and I might say our national economy.

I have been telling you only about space and it hasn't been too long, I hope, but I don't get the opportunity very often to speak to a group of this kind that has such great influence throughout the country, so I am going to take the opportunity to show you a short film so that you will go away from here at least with the understanding that the Systems Command is not only a space-oriented organization but we are responsible for space, aircraft, electronic systems for all the things that are used by the Air Force in carrying out its mission in support of the national security.

So if you will bear with me, this film will not take over 10 minutes, and I would appreciate it. Thank you.

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PRESENTATION OF NAB ENGINEERING ACHIEVEMENT AWARD
to
EDWARD W. ALLEN
Chief Engineer, Federal Communications Commission

By
George W. Bartlett
at the
NAB Broadcast Engineering Conference
Shoreham Hotel - Washington, D. C.
Wednesday, March 24, 1965

Thank you, Mr. Chairman, Ladies, Gentlemen, Honored Guests and Friends...

It is indeed a genuine pleasure for me to be standing before you today to honor a man who is so well known, respected and admired by our industry, a man who has dedicated over 34 years of his life to the betterment of broadcasting and has contributed so heavily to the electronic storehouse of knowledge in our common field of endeavor.

Engineering has been the all-consuming career of Edward W. Allen, a native of Portsmouth, Virginia, and from birth destined to be a leader in his chosen profession. Ed became interested in the electronic field at a very early age. After much, much deliberation he decided to pursue a course in electrical engineering. With this burning desire in mind, he enrolled in the University of Virginia in 1921 and in 1925 was awarded his degree in electrical engineering.

Feeling that this portion of his formal education would not prepare him for the goals he had established, he again traversed the halls of higher learning and in 1933 graduated with honors from George Washington University with a degree in law.

After having worked for 5 years as a student engineer and research assistant for Westinghouse and as an assistant engineer for the Chesapeake and Potomac Telephone Company in Washington, D. C., he joined the government as a patent examiner.

Two years later, he transferred to the Federal Communications Commission as an assistant engineer and special investigator associated with telephone problems. He was appointed an assistant telephone engineer on the FCC's regular engineering staff in 1934 and in 1939 was promoted to engineer.

In 1946, he was named Chief of the FCC's Technical Research Division, a position which he held for over 5 years. In 1951, Mr. Allen was appointed Chief Engineer of the Federal Communications Commission, the position which he presently holds.

He is the author of numerous books and is a worldwide authority on propagation. He is a member of countless technical societies and an undisputed champion of our free system of broadcasting.

In recognition of his continuing efforts to foster the advance of free broadcasting over the past 3 decades, for his untiring and outstanding leadership in domestic and international affairs to the lasting benefit of the industry and his country, for his many contributions to our nation's knowledge and understanding, for his pioneering spirit which has so richly enhanced the forward progress of broadcast engineering, it is my pleasure on behalf of the National Association of Broadcasters, its membership and staff to bestow on Edward W. Allen the 1965 NAB Engineering Achievement Award.

Accepting for Mr. Allen, who is presently representing the United States at the CCIR Meeting in Vienna, will be Ralph Renton, Deputy Chief of the Federal Communications Commission and a lifelong friend of the recipient.

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Ralph Renton
Deputy Chief Engineer
Federal Communications Commission

Ladies and gentlemen, I have a statement here from E. William Henry, Chairman, FCC.

"I regret that I could not be with you personally today as you honor Ed Allen, the Commission's Chief Engineer for many years, with your Engineering Achievement Award. I know that Ed was most appreciative of this recognition and was deeply disappointed that meetings in Europe took precedence and he too could not attend.

"As most of you know, this is the day for the FCC panel. My fellow Commissioners and I are on the line ready to field questions batted by our friendly but unsparingly critical audience of broadcasters. I venture to say, however, that few, if any, of the questions propounded either as a gentle bunt or as a line drive will deal with the engineering aspects of broadcasting. I think you should take pride in this for I take this silence to mean that you have done an excellent job in engineering for radio and television.

"Certainly, were it not for the almost unbelievable achievements of our engineers and scientists, the broadcast system that we know and rely on today, which is so important to the well being of our nation, would not exist. No one, I am sure, underestimates the importance of the reliable, economical broadcast service in these critical times and of your important role in providing it.

"We thus owe a great deal of gratitude to your profession. I know that if Ed Allen were here he would undoubtedly say that he was accepting your award not for himself but as a representative of all engineers and particularly on behalf of those with whom he has worked so closely in the Commission.

"The work of the engineers, to be sure, is in large part a team effort, but in Ed Allen you have selected for recognition this year one who exemplifies the best of a profession which has contributed so much to broadcasting.

"All of us at the Commission concur in and are pleased by your choice."

I know a lot of you have attended international conferences and you know that they work very hard and I hear at Monte Carlo where Ed was working on the last CCIR Conference that they worked night and day over there.

For instance, just about now it's about half past one, I guess, and with the time difference over there, well this is sort of embarrassing, it seems that just about now they'd be going to the gambling casino.

But I had a telegram from Ed:

"I feel this award is a very great honor indeed. I regret I will not have the privilege of being there to receive it in person, but Commission business will keep me in Europe until the middle of April.

"Although this award has been made to me personally, I must accept it on behalf of all the engineers in the Commission and those in the industry who have worked with us, for without their help little could have been achieved."

Signed "E. W. Allen".

I have known Ed for a long time, about 25 years, I guess, and maybe for most of that time we have worked fairly close together. I remember one of the very first problems we had together when we worked in close cooperation was way back in 1944 or '45 on the clear channel docket, and we have worked on many projects since. In fact, just last February before Ed went to Europe we worked on an important docket and that was the - well, I believe that was also the clear channel docket.

Ed has received many awards over his lifetime as an engineer but I think I know him well enough to speak with authority when I say that he will covet this one above the others and you know in the two papers I read here quite a bit has been said about the industry engineers and the FCC engineers doing work that made it possible for this award to be given to Ed Allen, and this is probably true, but, you know, usually there is a woman behind the man that makes all this possible. In this case I know there is, and it is Myrtle Allen, Ed's wife, and she's sitting right over here.

We at the FCC are delighted and honored that Ed has received the top broadcast engineering award from the top broadcast organization.

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NAB ENGINEERING ADVISORY COMMITTEE REPORT

Broadcast Engineering Conference
Washington, D.C.
March 22, 1965

By

John T. Wilner
Vice President for Engineering
The Hearst Corporation, Baltimore, Maryland

Mr. Chairman, Guests and Members of NAB:

As Chairman of the present NAB Engineering Advisory Committee, I am pleased to bring you this status report on its activities during the past two years. This Committee consists of a group of dedicated individuals, working quietly behind the scenes, who have carefully scrutinized FCC proposals and industry demands and have generally acted as liaison between you and the NAB. These men are: Max Bice (General Manager, KTNT Radio and Television, Tacoma, Washington); Dick Blackburn (Technical Director, Gannett Radio and Television Group, Rochester, New York); Glenn Boundy (Vice President for Engineering, Storer Broadcasting Company, Miami Beach); Bill Duttera (Director, Allocations Engineering, NBC); George Hixenbaugh (Chief Engineer, WMT Radio and Television, Cedar Rapids, Iowa); Tom Howard (Vice President for Engineering, Jefferson Standard Broadcasting Company, Charlotte, North Carolina); Les Learned (Director of Engineering, Mutual Broadcasting System); Carl Lee (Executive Vice President, Fetzer Broadcasting Company, Kalamazoo, Michigan); Frank Marx (President, ABC Engineers, American Broadcasting Company); Jim Parker (Director, Transmission Engineering, CBS Television Network).

Some of the more important problems that we have wrestled with in the past are:

1. The AM allocation problems contained in FCC Docket 15084

   This docket has lifted the "freeze" of AM applications for new or changed facilities. These new rules which were released on July 7, 1964,

   (a) Placed all AM assignments on a go-no-go basis and all applications were required to meet rigid engineering standards.

   (b) Prohibited new daytime assignments that would result in additional interference with the exception that some assignments may be granted if they provide a first local service to 25 percent of the proposed service area.

(c) Prohibited nighttime assignments that would result in any increased interference.

(d) Prohibited nighttime assignments that did not provide a first primary service to at least 25 percent of their interference free area; and

(e) Required that FM stations did not duplicate their AM programming for at least 50 percent of their time in markets over 100,000 population.

Class 2A and Class 4 stations would be excluded from the above.

The Committee felt that the 25 percent white area was the only area of concern since it would severely limit the granting of any nighttime facilities. The NAB has petitioned the FCC for the deletion of the 25 percent rule for the white area requirements for those daytime stations that would like to improve their facilities.

2. Land Mobile Study - FCC Docket 15398

As many of you know, the demand for RF space is practically at the vanishing point for land mobile users. This docket concerns the feasibility of frequency sharing of television bands and the land mobile service. A study was made by this group and others to see whether the television bands could, indeed, provide additional space for the land mobile users. The Committee concluded that very little such space was available and took a strong stand against the sharing of television space for such purposes. A special sub-committee is continuing to study this problem.

3. Type-approved FM monitor for SCA and Stereo - FCC Docket 15404

This proposal would be to amend Part 73 of the Rules to require that FM stations engaged in stereo and/or SCA operations install a type approved frequency and modulation monitor. It was the Committee's unanimous conclusion that a monitor having the requirements in the above proposal would be unduly restrictive and expensive. The NAB has filed an appropriate comment, pointing out where less stringent requirements would be acceptable. The NAB has reported in their comments that the overmodulation problem that could exist on FM stations has a serious bearing on the solution to the approved FM monitor.

4. Television Remote Control

George Bartlett will discuss this further in a few minutes.

5. Television Sound Power Reduction

The Committee had been studying this proposal for several years. Many members made individual measurements and observations of the effect of such sound reduction in their individual station service areas. They have also studied the results of other stations' results and have concluded that such reduction in sound power was not only feasible but it would afford certain technical improvements and a reduction in transmitter operating costs. As you know, the FCC has now made it possible for all VHF and UHF stations to operate with powers as low as 1/10 of the visual carrier. The FCC has recently announced that the upper limit of sound power could be as high as 20 percent of the peak visual carrier. This new rule will go into effect for present stations in March, 1966 and for new stations in April, 1965.

6. At Mr. Bartlett's suggestion the Committee approved of his idea to start publishing an equipment exchange which would be included in the monthly mailing kits to all member stations. This is a media by which wanted and for sale equipment could be listed and circulated to other stations. I believe you will agree with me that this has proved to be helpful to our members.

7. Logging - FCC Docket 14661

This proposal contained in FCC Docket 14661 related to the subject of new logging rules. As you know, a new maintenance log was initiated which meant that stations had to make five maintenance inspections per week with appropriate entries to reflect the condition of the transmitting equipment. Two items in this docket were the subject of much comment. These were: The taking of readings without modulation and the time that these readings had to be taken. For the moment, with the RF meters that are available at today's radio stations, the RF current readings have to be taken during moments of non-modulation. It was felt that in the future meters would be available that were not subject to modulation variations. As for the time that the readings were taken, it was felt that readings every half hour within usual limits would be satisfactory.

8. Loudness Problem - FCC Docket 14904

This notice of inquiry contained in FCC Docket 14904 was one of unusual complexity. Briefly, the problem relates to the apparent loudness of certain commercials and station breaks as compared to the normal loudness of the remaining program. The problem was further complicated by the fact that the average modulation indicator is called upon to measure audio levels with varying degrees of frequency response, the strident delivery of certain announcers, the varying positive or negative characteristics of certain programs, the relationship to the preceding program, the relative efficiency of the receiving device and the room acoustics, and other psychological factors.

This problem is a long way from being solved and the Committee's feeling was that only 10 percent of the problem was engineering and that the other 90 percent was psychological. Many proposed solutions, ranging from that of decreasing commercials and station breaks by an arbitrary 6 to 10 db all the way to limiting the amount of compression in the system were considered. This problem is still under active study, but I am sorry to say that an immediate solution is not in sight.

9. The Over-modulation Problems in FM and TV

Many stations have received citations for apparent over-modulation of their FM and TV facilities. It all started when the FCC started using a mobile truck to monitor an FM or TV station, with measuring equipment different from that used by the station. Essentially, the measuring equipment used in the truck was a very carefully calibrated oscilloscope. This oscilloscope did not have the characteristics that the average VU meter has and thus would indicate modulation percentages different from the meter on the station monitor. Much activity by your Committee has already taken place. Meetings were held in Washington, at the FCC Monitor Station in Laurel, Md., and a field trip was made to WRAL in Raleigh, North Carolina, through the kind invitation of Virgil Duncan, Chief Engineer. At WRAL, The Committee and FCC engineers investigated various types of program material, percentages of modulation, with and without limiters, with limiters before and after pre-emphasis and with a low pass filter in the program channel. A total of six (6) modulation monitors were checked, five (5) for FM and one (1) for TV. The above tests indicated that there was a problem in the correlation between the method used in the FCC truck and the instrument used by the station. The Committee felt that some change in equipment and/or operating procedure was warranted. Field tests at WRAL indicated that up to a 6 db difference could exist between the oscilloscopic method and the monitor flasher and up to a 10 db with respect to the monitor meter. It is felt that the same measuring device should be used by both the broadcaster and the FCC field monitoring people. I am sure that all of us agree that flagrant violation of over-modulation can cause serious degradation in the quality of FM signals. None of us will quarrel that these offenders should be warned. On the other hand our investigation has also brought out that many stations with all good intentions could, with normal indication of its monitor, be causing peaks considerably in excess of 100 percent in their operation. The FCC personnel have been very cooperative and both sides are most anxious to come up with a measuring technique which would allow the station to both modulate correctly and at the same time not spill over into adjacent channels. The Committee has proposed an interim solution to this problem. I have been told that the FCC monitoring truck will be parked outside the hotel and all those engineers who are interested in visiting this equipment will be welcome.

10. Upgrading of Broadcast Engineering Supervisory Personnel

Technological advances in our field have been coming so quickly and in so many areas that the Committee has recommended that the NAB sponsor an up-dating course for these people in such subjects as management procedures, taxes, personnel hiring, and accounting. It is hoped that the first seminar will be held this summer and it would continue yearly as long as enough interest is shown. It is also hoped that a future up-dating course be added for broadcast engineering, antenna systems, transistor devices and computers.

11. Recording Standards

Warren Braun will discuss this activity in a few moments.

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NAB - 1965.

USING A PASSIVE MICROWAVE REPEATER TO BI-PASS PATH OBSTRUCTION.

* George S. Driscoll.

The renewal of urban areas, and, particularly, the construction of high-rise office, apartment and hospital buildings, - in the suburbs as well as in downtown areas, - justifies focusing attention upon the vulnerability of many studio-to-transmitter links, to potential path obstruction.

Obviously, path vulnerability is not limited to high-rise construction alone, - but can be any obstructive blocking of any microwave path continuity.

However, a low-level obstruction, can generally be surmounted by the simple expedient of raising, or shifting the path laterally, at either or both ends. The solution generally rests in simple recourse to available mounting structures of conventional design, not of improbable height, and not of impractical cost.

The high-rise obstruction, - and in contractor vernacular, this refers to construction height over 60 feet, - may require unusual solution, where obstructive height is impractical to surmount, - and where obstacle position defeats lateral path re-positioning, in order to bi-pass the offending obstruction.

* Engineering Manager - WOKR - Rochester, New York.

It is the purpose of this paper, to assess the factors relating to microwave obstruction, - to discuss the available alternatives for bi-passing, or surmounting an obstruction, - and to explore the practicability of a simple, non-electronic, passive repeater, - where repeater insertion loss can be tolerated.

The high-rise building, is the most insideous form of path obstruction, because it can occur virtually anywhere in most STL microwave paths, - at heights normally used, and considered safe, for long-term path transmission, - and can occur without prior legal obligation, on the part of property developers to notify the Station, of such intention.

In the Authors experience, this situation has twice arisen, in respect to blocking of two different STL paths, of two different Rochester, New York television stations, - one located on the outskirts and one located downtown.

A high-rise building of over 150 feet in height, - and lower than 150 feet if in line with an airport runway, - is required to first secure "air-space" clearance, from the F.A.A., - it is not required to secure "ether-space" clearance, from the F.C.C.

While the legal concept of "adverse possession" is well established by law, governing long-term physical trespass over private property, - laws governing "adverse possession", in respect to trespass of "ether-space", are not presently within legal perception.

Therefore, expect concern, - but not much more than sympathy, - from property developers and tax-conscious Zoning Boards and City Councils.

It is not the intention of this paper to be an authoratative treatise on the legal aspects of this situation, - but, rather, to impress upon you the perpetual necessity of everlasting alertness to the potential vulnerability of your microwave paths.

Most newly developed property will, of course, be planned beyond the very small arc of a microwave path, - so that gamblers-choice favors that the majority of local high-rise development will be placed elsewhere than within your critical path. It is that small percentage, that may fall within your critical path, with which we are primarily concerned. Of this small percentage, it need take only one, and that one can be a distressing problem.

Having established the fact our important paths are not protected, the necessity for considering alternative routing to bi-pass a potential obstruction, brings us to the primary purpose of this paper.

There are three methods of bi-passing, beam-bending or dog-legging around, or over, an obstruction:

1. An active, or electronic repeater.
2. A passive microwave reflector.
3. A non-electronic passive repeater.

Each of these three methods have merit, and demerit.

The use of an active, or electronic repeater, - comprising a receiver-transmitter combination, or preferably, a hetrodyne frequency converter, - are well known, and much used, for dog-legging long paths and inter-city hops.

While electronic repeaters are essential for dog-legging long paths, they are expensive, and much more sophisticated than necessary for most short-path STL service, - but more than that, they raise serious problems of maintenance accessability on a distant roof of someone elses locked building. Losing a network or a remote is serious in itself. Losing an STL is the difference between being in business and being out of business. In STL service, an electronic repeater should be in duplicate, in all respects, to preserve continuity.

The second method of beam-bending, is the well-known, well documented, and often used, passive reflector.

The passive reflector is an efficient device for re-radiating a single-plane path at, or very near, 90 degrees. At other angles, or where both vertical and horizontal path changes are required, - the passive reflector quickly loses it's enchantment.

The third alternative, and the one we wish to explore further, is the little known, and little understood, passive repeater.

The passive repeater is, next to the passive reflector, simplicity itself. It consists of two parabolic reflectors, or dishes , - each equipped with a conventional "hook" type waveguide antenna, with the "hook" antennas interconnected by waveguide transmission line. Nothing else is required, except a secure mounting structure to preserve positive orientation of both dishes, - one facing the studio transmitter dish, and the other facing the receiver dish, at your transmitting plant.

The passive repeater has a fixed insertion loss, regardless of the complexity of path angle change, in either vertical or horizontal plane, - or both. Where a complex change of path direction is required, - a flexible-twistable transmission line accomodates this nicely.

The passive repeater may be used to dog-leg a path around, or over an obstruction.

Securely mounted mechanically, it requires no maintenance beyond seasonal inspection.

The insertion of a passive repeater, divides a path into two separate space radiating elements, each having it's own space-path attenuation. The total attenuation is the summation of the two separate path attenuations, and not the attenuation of the total round-robin mileage.

Adding two separate path attenuations results in a shocking attenuation figure, the saving factor, is that subtracting from the total attenuation, the gain factor of the two passive repeater dishes, returns the passive repeater to acceptability for most short-path STL purposes.

As an example: the conversion of a short direct path, to a passive repeater path, where total path lengths are comparable, the passive repeater path will show 28 DB loss, over the direct path, using 4 foot dishes throughout. Replacing any one of the four 4 foot dishes, with a 6 foot dish, will decrease the loss by 3 DB. Using four 6 foot dishes throughout the system, will reduce the repeater loss to only 16 DB, and larger dishes would, of course, reduce it further. By resorting to larger dishes, passive repeater paths up to 10 or more miles can be accomodated.

In most STL services, the passive repeater loss is largely relative. Most of us are using, in short-hop STL service, transmitters and receivers (such as the RCA TVM, 1 watt, 7000 megacycle equipment), capable of adequate signal-to-noise ratio over direct path lengths several times that of most STL's.

The signal-to-noise ratio, with which we are concerned in a microwave system, is high frequency tube and component noise. Most of us, with well maintained equipment, are operating short-hop STLs' with a signal-to-noise ratio of 65 - 75 DB down, when high-frequency noise is not perceptable in picture background below -42 DB.

As a design factor, in determining permissible passive repeater path loss, a 10 DB leeway is recommended beyond the perceptable noise factor, or a maximum noise level of -52 DB.

At WOKR, Rochester, the calculated noise level for the existing 1.8 mile direct STL path, is -77DB. The measured noise level, of two RCA - TVM systems, proved within 1/2 DB of calculated value. One was -77 DB and the other -76.5 DB. If a maximum noise level of -52 DB is acceptable, it will be seen that a passive repeater path, having 25 DB loss, is entirely tolerable.

It was this reserve of system capability that prompted WOKR into the currect investigation, of the use of a passive repeater, to bi-pass an impending direct path obstruction.

WOKR's studios are downtown, in the very heart of Rochester. The studio building is seven stories high, with microwave transmitter 100 feet above street level. The present direct STL path lies 30 feet over the Loews Theatre building, across the avenue and one block south.

The Loews Theatre building is now being dismantled, and is to be replaced by a 400 foot main office building for the Xerox Corporation. The existing path would intersect the new 30 story building, at about the 7th floor.

The position of the new building, and the material raising area surrounding it, prevents direct path access from immediately adjacent buildings, near the studio, so lateral path movement is not practical. Moving the studio is too expensive, and Telco coaxial video cable, which we would prefer not to use anyway, is not available. The only solution that is practical, is to dog-leg a path around the obstruction.

Several dog-leg paths are available, and the one chosen, for a test passive repeater installation, is on the roof of the 250 foot Midtown Tower building, beyond the obstruction area, and .2 mile from the studio. The path from the repeater point to the Pinnacle Hill transmitting building is 1.7 miles. Therefore, the total length of repeater route is 1.9 miles, or .1 mile longer than the direct route, which is 1.8 miles.

The present direct path space loss is 120 DB. The passive repeater route, consists of 101 DB space loss for the .2 mile leg, and the 119 DB space loss for the 1.7 mile leg.

Therefore, the total space loss of the passive repeater route is 220 DB, or 100 DB greater than the direct route. However, the gain of the two 4 foot passive repeater dishes is effective, being 37 DB each, for a total gain of 74 DB. This makes a difference of 24 DB. However, we must add, to this, a 4 DB loss factor for the flexible-twistable wave guide, wave guide couplings, and passive repeater radomes. Adding these factors, the calculated loss is 28 DB higher than the direct path loss.

Deducting the 28 DB passive repeater route loss from the 77 DB signal-to-noise level, of the direct route, resulted in a calculated noise level of 49 DB, below signal level. Since we desire a maximum noise level of 10 DB greater than perceptable visable picture noise, the 4 foot parabolic reflector, at the Pinnacle Hill receiving point, was replaced with a 6 foot reflector, increasing system gain by another 3 DB. We now have arrived at a system design, using three 4 foot dishes, and one 6 foot dish, and a calculated system noise level of -52.

To test the passive repeater route calculations, the passive repeater material, which are all standard catalog items, was ordered from RCA, and installed temporarily on the roof of Midtown Tower, using sandbagged tripods and friction tilt heads.

One microwave transmitter was oriented through the passive repeater, and the second transmitter was retained on direct route, for direct comparative purposes.

The measured passive repeater loss proved within 1/2 DB of the calculated value. The signal-to-noise level measured -51.5 DB below signal level.

Using the passive repeater path on-air, for several weeks, it was impossible to detect instantaneous switching, from direct route to passive repeater route. By measurements, the only change is the -51.5 DB noise level which is, of course, unobservable.

There was no difficulty in aligning all path dishes from the Pinnacle Hill receiver position. A three way full-talk telephone line was installed for this purpose.

The passive repeater receiver dish is oriented 12 degrees below vertical, and the passive repeater transmitting dish is oriented 1 degree below vertical, so the signal is actually being lifted over the 250 foot Midtown Tower building.

The horizontal orientation between the two passive repeater dishes is a fairly abrupt 54 degrees.

The only trouble experienced in three months of testing, has been with tilt-head friction mounts not withstanding the intense gusty winds, at that height. However, this is strictly a test set-up, and gimbol rings are on hand for installation in a well secured steel framework, for final installation in the spring.

Acknowledgment is made of the very good counsel of J. B. Bullock, of the RCA Microwave Engineering Division, and the cooperation of Messers. Hall, Parker and Ambrose, and others of the WOKR Engineering Department, who assisted in this test installation.

ENGINEERING DEPARTMENT PUBLICATIONS

CBS TELEVISION NETWORK

RF Systems for TV Remote Pickups

ORION M. ARNOLD

PRESENTED AT 19th NAB BROADCAST ENGINEERING CONFERENCE
WASHINGTON, D. C. MARCH 22, 1965

RF SYSTEMS FOR TV REMOTE PICKUPS

The RF systems requirements for TV remote pickups depend on such factors as size and/or location of remote and advance notice or planning time available. Political conventions can be classified as the largest TV remotes. As a result, RF systems for convention coverage are needed for: wireless microphones for use by both Radio and TV reporters on the convention floor; a wireless cue system by which the program director can communicate with the reporters; a communications system for wireless cameras; and general communications system for technical and production staffs' use between the convention hall and all other locations such as remote trucks and hotel headquarters. For use away from the convention halls, CBS had a one-way paging system and a two-way RF communication system for production personnel. In addition, there were, of course, the frequency requirements for the microwave systems and the wireless cameras.

Basically, each of the three major networks had the same requirements for TV. Additionally, there are the requirements for the wireless microphone, cue and two-way systems for the other radio networks, the independent stations, the news wire services and photo services. For the 1964 conventions approximately 12 different companies had frequency assignments, so it is immediately apparent that when all of these RF systems are brought together in a small area such as a convention hall, the problem of frequency assignment/allocation becomes a real challenge.

In the Fall of 1963, an RF Committee was formed and all interested parties were contacted and asked to attend a meeting or send in a list of the frequencies, type of equipment and any other pertinent information they were planning for convention use. To start with, two general ground rules were established. One: the maximum power input for any transmitter inside the convention hall would be 5 watts. This power limitation was deemed and proved to be sufficient for the required coverage. Second, no citizens band equipment was to be used. Again this proved to be a wise decision as both delegates and the general public used citizen band equipment at the halls. Next came the task of finding enough channels for everybody. The basic requirement, of course, was that each channel would be exclusive and thus hopefully interference free. Fortunately, for major national news events such as conventions, the FCC will issue licenses on a special temporary authority basis for operation on frequencies not normally available to the broadcasting industry.

Consequently, STA's were obtained for operation on channels normally assigned to other services and in the UHF TV channels. These STA's are issued on the basis that no harmful interference will be caused to the Regular Authorized Services using these frequencies. Actually, the reverse situation also was desired. That is, that no harmful interference would be caused to the broadcasters. To search out these frequencies or channels for both San Francisco and Atlantic City, the latest available listings of the FCC were used. Actually, the search was very successful because after the eighth and final meeting of the RF Committee on May 13, 1964, ten channels in the 152 to 170 Mc range were not used or allocated.

To give you an idea of the number of channels involved, here is a breakdown of the assignments made by the RF Committee:

In the 1600 kc range, three channels were allocated.

In the 25-26 Mc range, 26 different channels were allocated.

In the 152-170 Mc range, 38 channels were allocated and a total of 10 channels were not used.

In the 450-495 Mc range, 37 channels were allocated.

This gives a total of 106 wireless microphone and communications channels. In the wireless camera and microwave frequency area:

CBS had 3 frequencies in the 500 Mc and 3 frequencies in the 70 Mc range for use with wireless cameras.

The 2 Gc microwave band had all 7 channels assigned.

The 7 Gc microwave band had all 10 channels assigned.

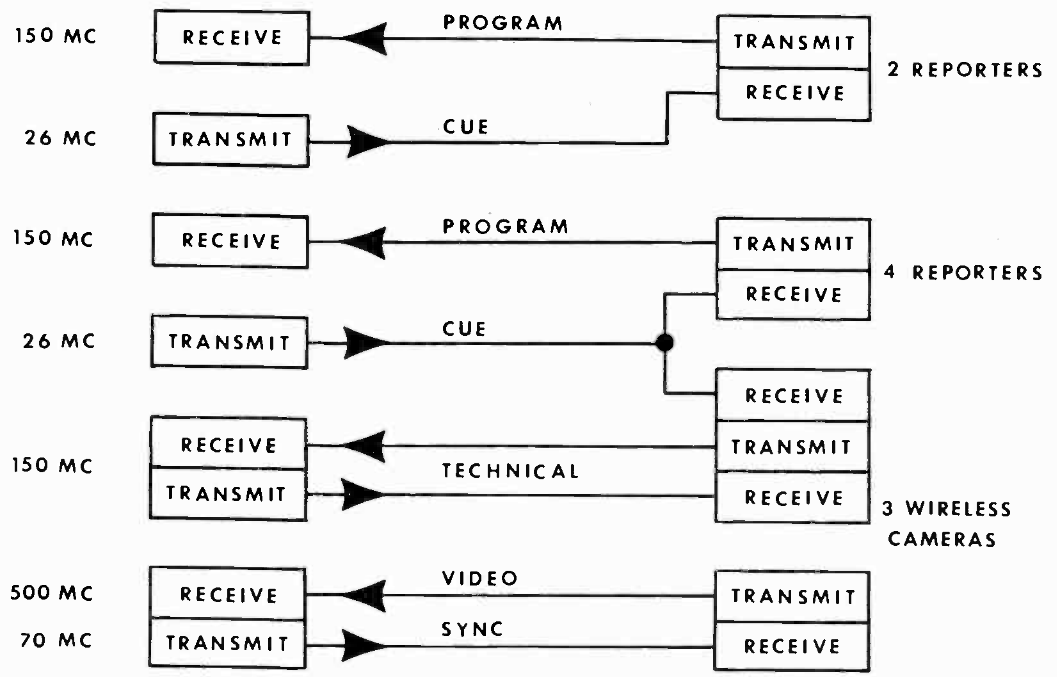
The 13 Gc microwave band had 15 channels assigned out of a possible 21 channels.

All totaled then, the RF Committee made 140 frequency allocations, of which CBS had a total of 35.

At the time the planning of the wireless microphone systems by CBS was undertaken, the primary source of wireless microphone equipment was in the 25 Mc range, and so CBS from past experience with general communications equipment in the 150 Mc range decided to investigate the possibility of using equipment in this range for wireless microphones. The main factors in this choice were availability of low power solid state, pocket-size portable equipment, size of antenna required and propagation characteristics for this frequency range. The available equipment was intended for communications use and, therefore, did not have the required audio response to be used for program audio. What was done then was to modify this equipment to obtain an acceptable audio response. For the transmitter portion this was primarily obtained by using a good quality microphone and adding pre-emphasis. At the receiver more extensive modifications were required because it was designed for narrowband voice communication response.

The wireless microphone system then was packaged and used by the reporters in the following manner: Each reporter had a headset and a specially designed vest, actually a modified fishing jacket, in which he carried a 150 Mc transmitter and external battery pack. The normal transmitter as packaged uses internal batteries, but the life of these batteries under constant use is only about 6 hours, so an external battery pack with a 24 hour life was used. For each day's operation a new set of batteries was installed. In the vest also was a 26 Mc receiver for program interupt/cue usage. Either a single or double headphone type headset was used to mount the 150 Mc antenna, the reporters microphone and, of course, provide headphone cue audio to the reporter. One additional feature which worked out very well was the addition of a second microphone in parallel with the reporters, which the reporter held while interviewing. This eliminated constant moving of a single microphone back and forth as the person being interviewed and/or the reporter spoke.

In conclusion -- we were very well pleased with the operation of all our RF communication systems and with due credit to the RF Committee and other radio, TV networks, station and wire services, essentially no interference problems developed.


150 MC
RECEIVE
PROGRAM
TRANSMIT
2 REPORTERS
RECEIVE
26 MC
TRANSMIT
CUE
150 MC
RECEIVE
PROGRAM
TRANSMIT
4 REPORTERS
RECEIVE
26 MC
TRANSMIT
CUE
RECEIVE
150 MC
RECEIVE
TRANSMIT
TECHNICAL
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RECEIVE
3 WIRELESS CAMERAS
500 MC
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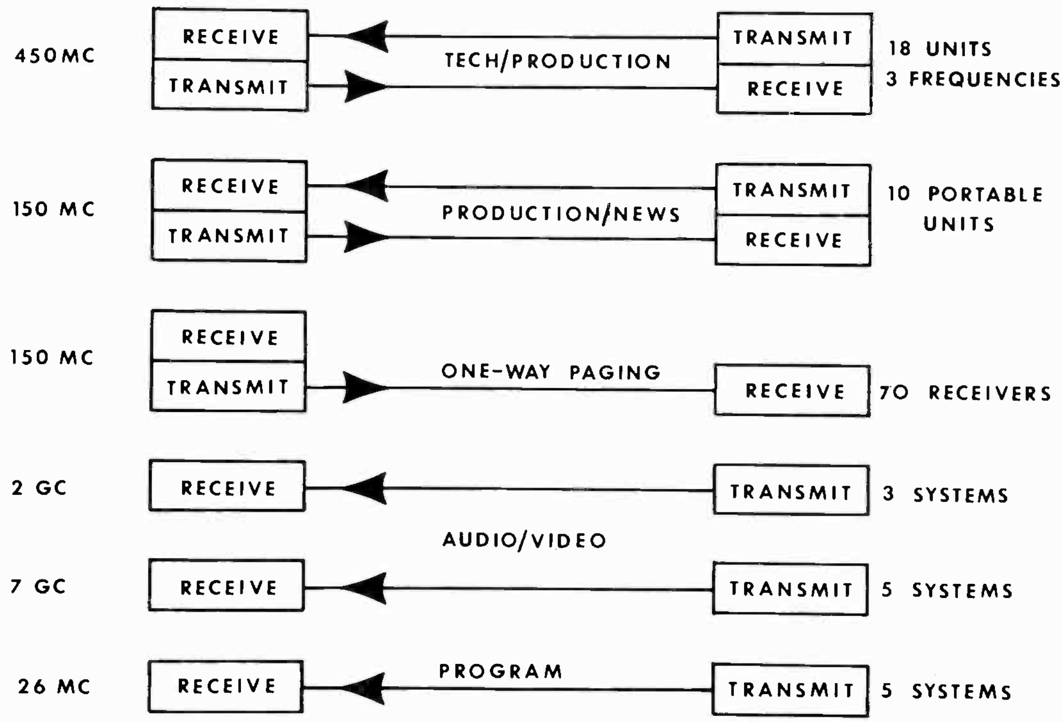
VIDEO
TRANSMIT
70 MC
TRANSMIT
SYNC
RECEIVE


450MC
RECEIVE
TRANSMIT
TECH/PRODUCTION
TRANSMIT
RECEIVE
18 UNITS
3 FREQUENCIES
150 MC
RECEIVE
TRANSMIT
PRODUCTION/NEWS
TRANSMIT
RECEIVE
10 PORTABLE UNITS
150 MC
RECEIVE
TRANSMIT
ONE-WAY PAGING
RECEIVE
70 RECEIVERS
2 GC
RECEIVE
TRANSMIT
3 SYSTEMS
AUDIO/VIDEO
7 GC
RECEIVE
TRANSMIT
5 SYSTEMS
26 MC
RECEIVE
PROGRAM
TRANSMIT
5 SYSTEMS

NEW TRANSISTORIZED AGC & GAMMA CONTROL AMPLIFIERS

Vernon J Duke
National Broadcasting Company
New York NY
March 1965

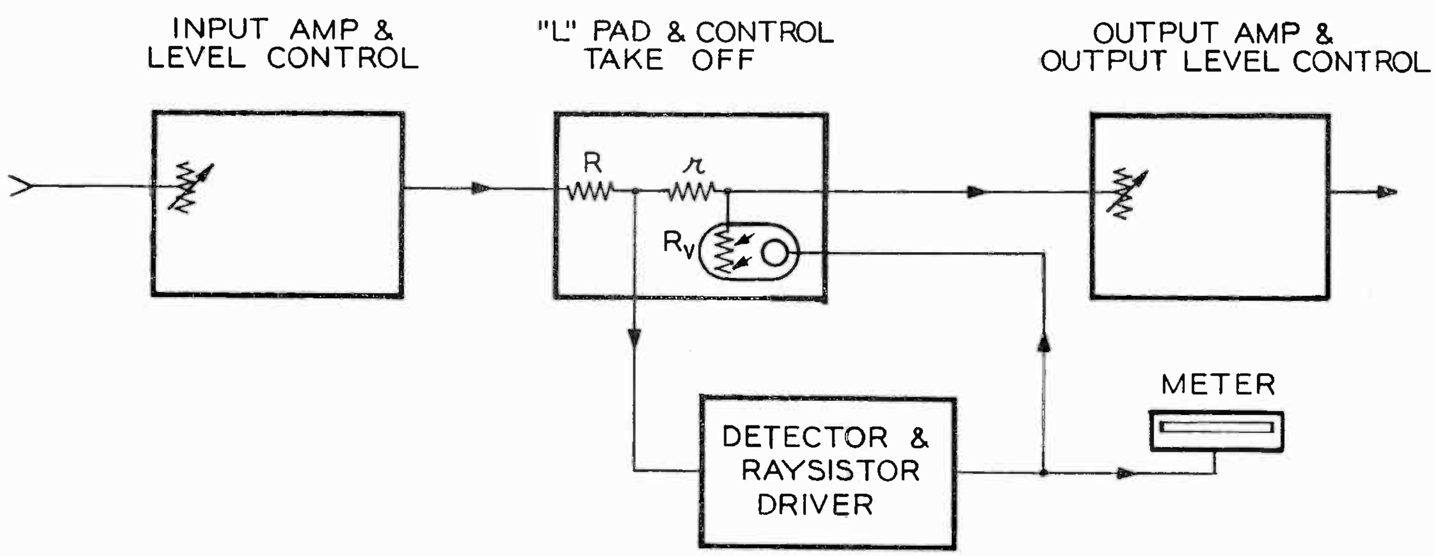
The title of this paper refers to separate amplifiers systems. In this paper they will be described in separate sections.

These two amplifiers, when preceded by an automatic black level setting system would produce a form of automatic video control. The discussion of the complete system is not within the scope of this paper.

The amplifiers are operative on non-composite signals. Black picture information should approach a zero level with no setup. This simply means the raw camera signal should have been clamped and clipped to black picture information before entering these amplifiers.

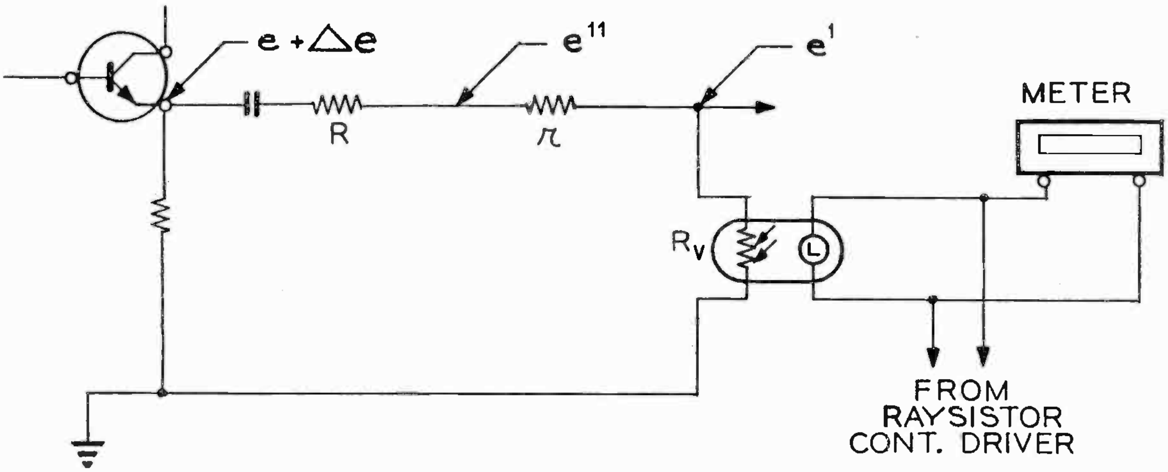
The AGC amplifier controls the peak level of a video signal within the framework of its built-in characteristics. It is not my intention to argue the probity of having a full level signal at all times. However, in film operation and slide operation, sudden changes in average density occur without warning and automatic control with its characteristics is better than manual control.

Referring to the AGC block diagram --



The input amplifier with its level control supplies a very low impedance signal to an essentially resistive "L" pad with a variable shunt element. The input to this pad has the variations inherent in the input signal while the output of the pad has practically no level variation.

Referring to the variable "L" pad as shown in the following sketch --

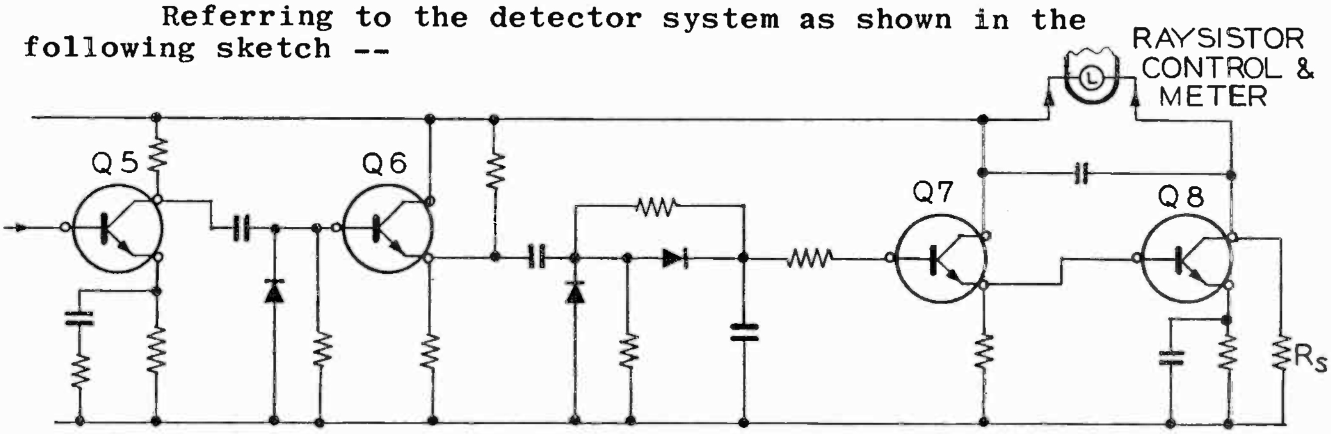


The "L" pad consists essentially of a series element R + r and a shunt element of R_v. All of the input level variations Δe are at e and we will assume no variations are at e^1. The detector takes off at point e^{11} and then has the level variations of $\Delta e \times \frac{r}{R+r}$ which in this amplifier are perhaps 4%. This method gives the detector control amplifier considerable advantage over a method which samples the output signal only and it therefore requires less gain.

The control system causes the Raysistor to vary over a range of about 40 to 1 and in so doing easily produces a control range of input signal of 6 to 1.

In this system the value of R_V has been held to a range of 4000 ohms down to 100 ohms. In general, most of the operation of R_v would be within the range of 2000 ohms to 600 ohms.

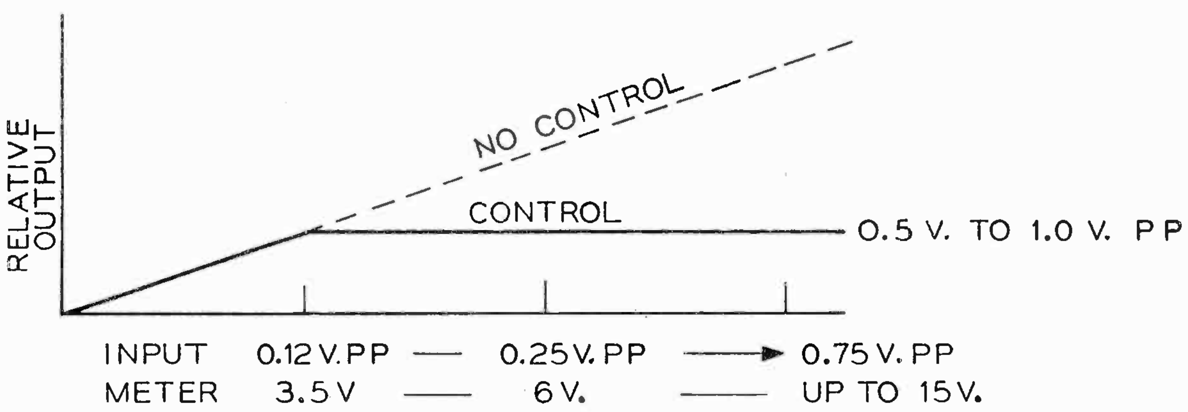
Referring to the detector system as shown in the following sketch --



The control signal from the "L" pad is fed to transistor 5 where it is inverted and slightly high-peaked. Transistor 6 with no signal is well below cut-off. The DC restorer in the base of 6 allows about 20% of full level signals to go into the operating region. The detector system between transistor 6 and transistor 7 supplies a peak to peak rectified signal to transistor 7 which is DCcoupled to transistor 8. The control filament of the Raysistor is in the collector of transistor 8. The resistor R_S places a minimum voltage of roughly 3.5 volts on the Raysistor filament. As the signal level increases, transistor 8 comes into operation and the voltage on the control of the Raysistor may go as high as 15 volts.

As can be deduced, a zero signal allows for 3.5 volts on the Raysistor at which condition the signal electrode of the raysistor R_V raises to around 4000 ohms. The raysistor remains at this value until sufficient signal arrives to operate the detector system.

Referring to the following operating sketch --



In this diagram the dashed line shows what would happen if no automatic control existed. The solid line indicates the automatic control effect. In setting up the system a test pattern or other signal of representative input level is fed to the amplifier. Starting at a minimum position the input level knob is raised until a threshold is reached at about 0.12 v p-p at the test point. The meter just starts to raise from a minimum of 3.5 volts. The level is further increased perhaps to 0.25 volts p-p with a meter reading of 6 volts. If the input control is left at this point the knee will be down 6 db. If the input control is raised to around 0.37 v p-p the knee is then down 9 db.

As in any system of this kind, it does not pay to control signals that are more than perhaps 9 db down from normal as they are probably in the noise and fade-outs become very abrupt. The amplifier will generally hold down signals which are very abnormally high.

To normalize the output to any desired voltage between 0.5 v and 1.0 v p-p it is only necessary to set the output level control.

The amplifier will, upon switching in a signal 6 db above the knee, bring that signal to normal level within 2 television fields. Any faster control would probably result in some picture distortion. Normal title printing is sufficient to control the level. Only the finest glints go over level.

The raising of the level of signals which drop very low is slower than the control of the white overshoots. As now constructed, the amplifier and its power supply occupy a 1 3/4" rack chassis.

The input signal level should be at least 0.3 v p-p non-composite at 75 ohms. The output at 75 ohms can be adjusted from 0.5 to 1.0 volt p-p. The power input at 117 v AC is less than 4 watts.

The Gamma amplifier is used to control the transfer characteristic of the video signal. Prior to entering this amplifier the black level and white level of the signal has been effectively controlled either by manual or automatic means.

This amplifier has several features and methods not normally used in this type of system.

One feature of this amplifier is a knee characteristic as shown at transistor 3 of the circuit diagram. Many amplifier systems use a white clipper which effectively chops off any signal above a fixed level. In this amplifier the transfer slope is reduced by 4 to 1 above the knee. The knee characteristic may be used with vidicon cameras to attain somewhat the same effect as one gets when operating an image orthicon above the knee. When operating this amplifier following the AGC amplifier, it is well to operate just at the knee; then glint spikes and sudden momentary overshoots will be suppressed.

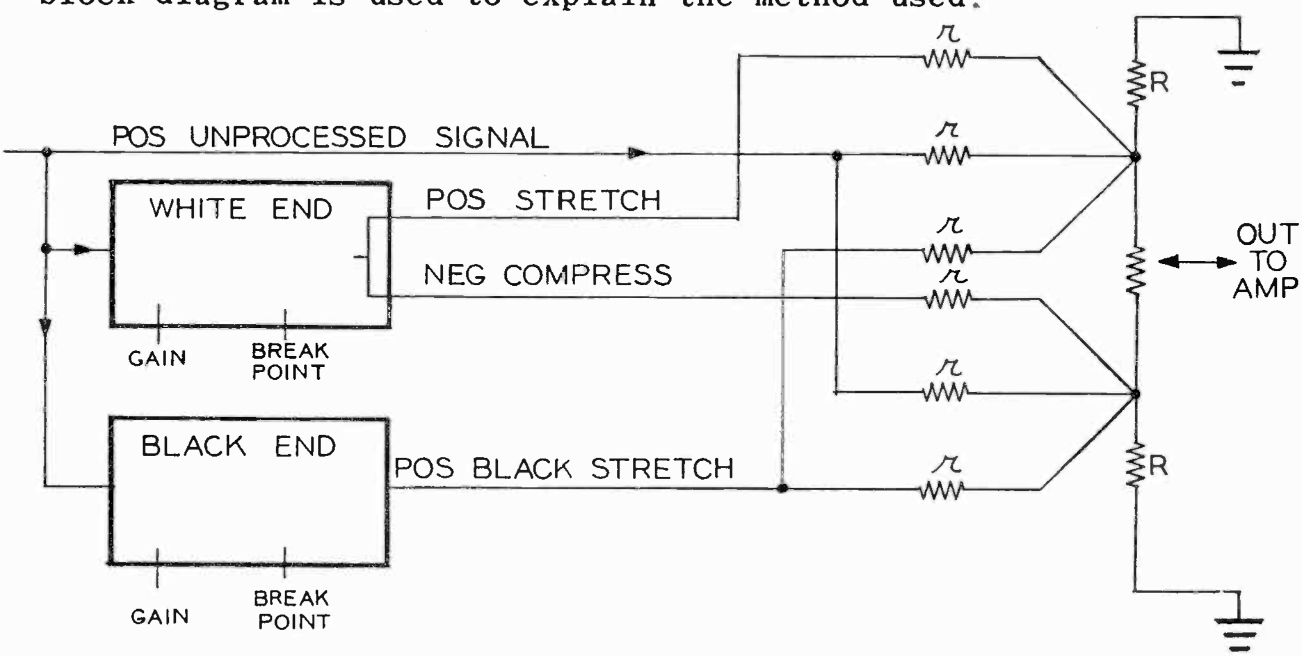
The gamma section of this amplifier has several features which can be explained in the following manner. Video signals are generated, rather generally speaking, on a full bandwidth and standard rise time characteristic which does not take into account various factors which have previously affected the general contrast range of the material. For instance, optical flare may dilute the black end contrast resulting in a compression of black material after the black level setting, or perhaps in film the gamma and contrast of the original material needs to be processed to perhaps compress the white end.

In the case of stretching the black part to normal, the signal to noise may deteriorate or in compressing the white the detail seems to lose out rapidly. The reason these things happen is that the high frequency components have been greatly affected during the stretching or compressing process. In this amplifier the high frequency components are not changed as rapidly as the general large area signals.

As the black end is stretched in an ordinary gamma amplifier and the signal checked on an oscilloscope the rate of rise in cm/micro sec becomes more steep. Inasmuch as the overall signal level has not increased, it must be presumed that the effect was an increase in the high frequency response. Now, at the same time the effective fine grain noise had increased in the black part of the signal indicating a similar high frequency gain and this limits the effectiveness of black stretching.

The reverse situation exists when the white end of the signal is compressed in gamma lowering. How much of this compression may be used is controlled by a loss of detail. As gamma is lowered the average brightness rises and detail which the ordinary gamma amplifier reduces is further obscured resulting in a washed out situation. This amplifier does not reduce the fine detail signal as the gamma is lowered. If the upper part of the signal was almost completely flattened off there would still be enough detail information for a useful picture.

To accomplish these objectives a different approach was made to the gamma control problem. The following single line block diagram is used to explain the method used.



In this amplifier an unprocessed signal goes right past the gamma control system and loads into rather low value resistors R and R through series isolating resistors designated as small r. The small r resistors are all different in value selected in such a way as to maintain nearly equal peak to peak levels on the ends of the potentiometer as the white signal is stretched or compressed.

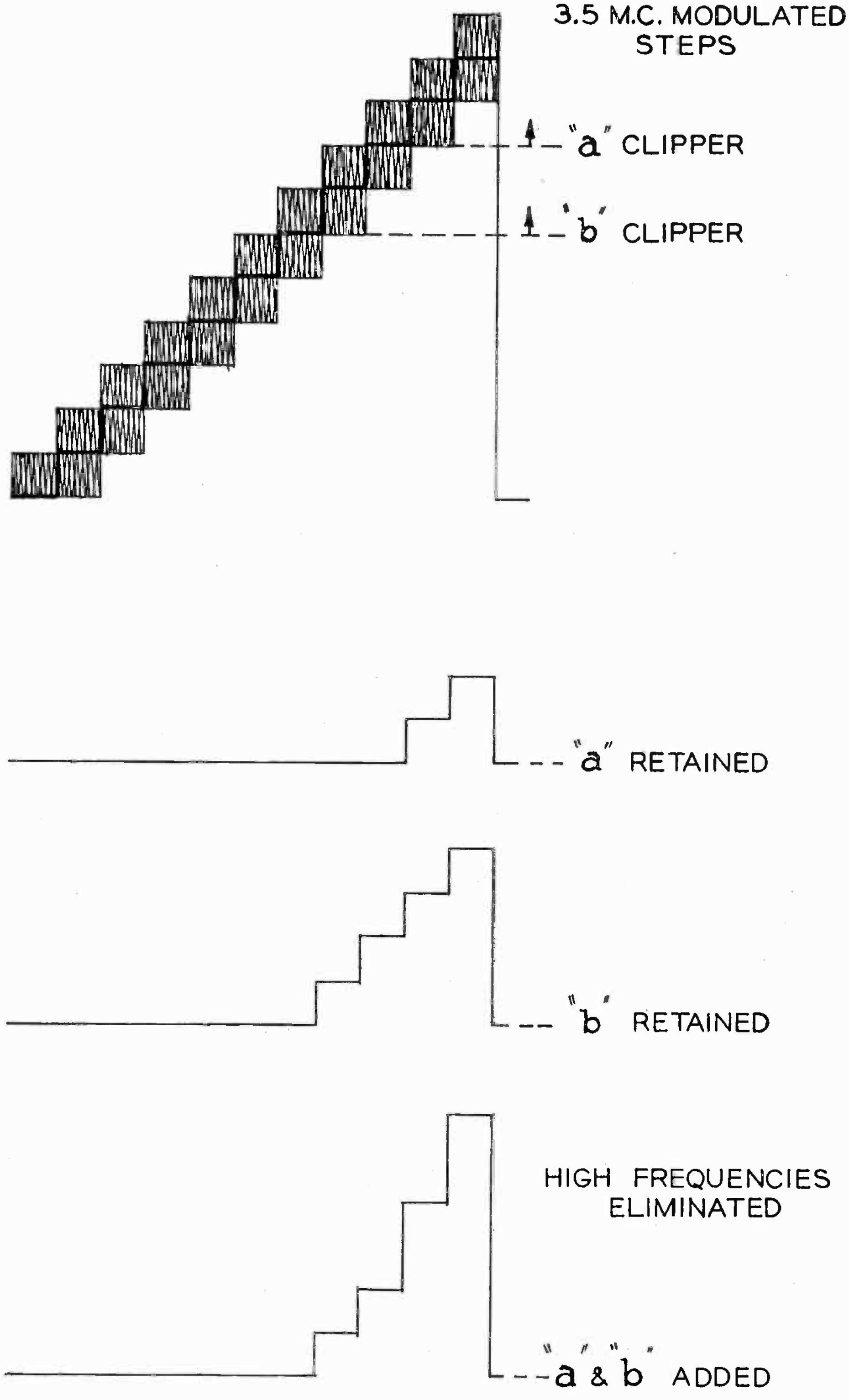
The gamma adder signals are Positive and Negative for white stretch and compress, and positive for black stretch and have been rolled off in frequency response. There may be around 10% at 3.5 mc.

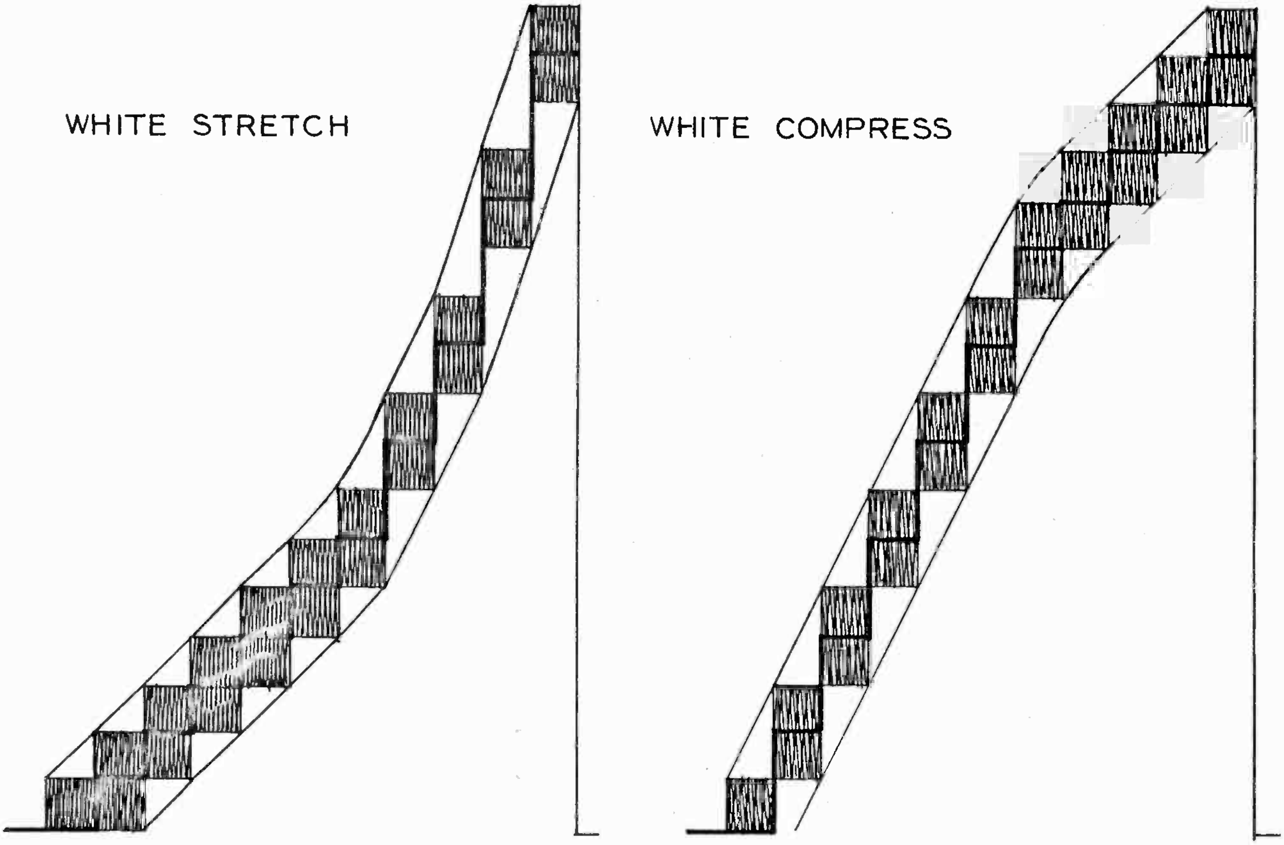
When the small r values are adjusted for say a stretch condition or compression condition of the top 40 to 50% of the signal the peak level at the ends of the potentiometer are equal and the transfer characteristic may be swept from white compression to white stretch without changing the output level or differential frequency response at high frequencies.

In the case of black stretch, the signal goes to both ends of the potentiometer and consequently also leaves one free to swing the potentiometer without peak change or high frequency change.

There are many other small circuit details in the diagram which are ignored in the block diagram.

The following indicates the general waveform operation for white stretch. A two point clipper retrieves the "a" and "b" low frequency segment of the original signal. This is reinserted as shown.





The above sketch illustrates the effect of maintaining a constant high frequency gain at all signal levels during various "gamma" operations. The apparent noise content tends to remain constant. Resolution is maintained in the compressed areas.

The general characteristic of the black-stretch is similar in that as the black is stretched there is very little increase in the high frequency content and therefore very little increase in black noise with the stretching. In the case of the black stretch the level does increase and the output level must be compensated accordingly.

The output level can be adjusted over a range of 0.5 v to 1.0 v p-o at 75 ohms.

The ampllifier as presently constructed uses a 1 3/4" rack chassis and is self-powered using less than 5 watts at 117 v AC.

The following presentation on motion picture film shows the operation of the amplifiers as various test signals are introduced.

First will be shown the test signals as used. The signals are multi-burst, plain steps, steps with 3.58 mc modulation and a window signal.

In the double trace pictures the top trace is the input signal and the bottom trace the output signal.

In the case of the AGC amplifier the input is viewed at the test point on the input gain control so as to show the effect of signals which change in level. This gain is turned up and down to demonstrate the ability of the system to control levels above threshold.

The rate of control is shown by freeze-frame printing single frame time exposures. Each segment of the trace in this case is one television field or 1/60 sec. In some cases the signal is at zero, then abruptly rises 6 db above threshold, in which case the sudden overshoot is returned to standard level in around 2/60 sec or 1/30 sec. As presently built, there is some following undershoot but no bounce. This effect is shown with various types and levels of input signal. In general, the greater the overshoot the quicker the return.

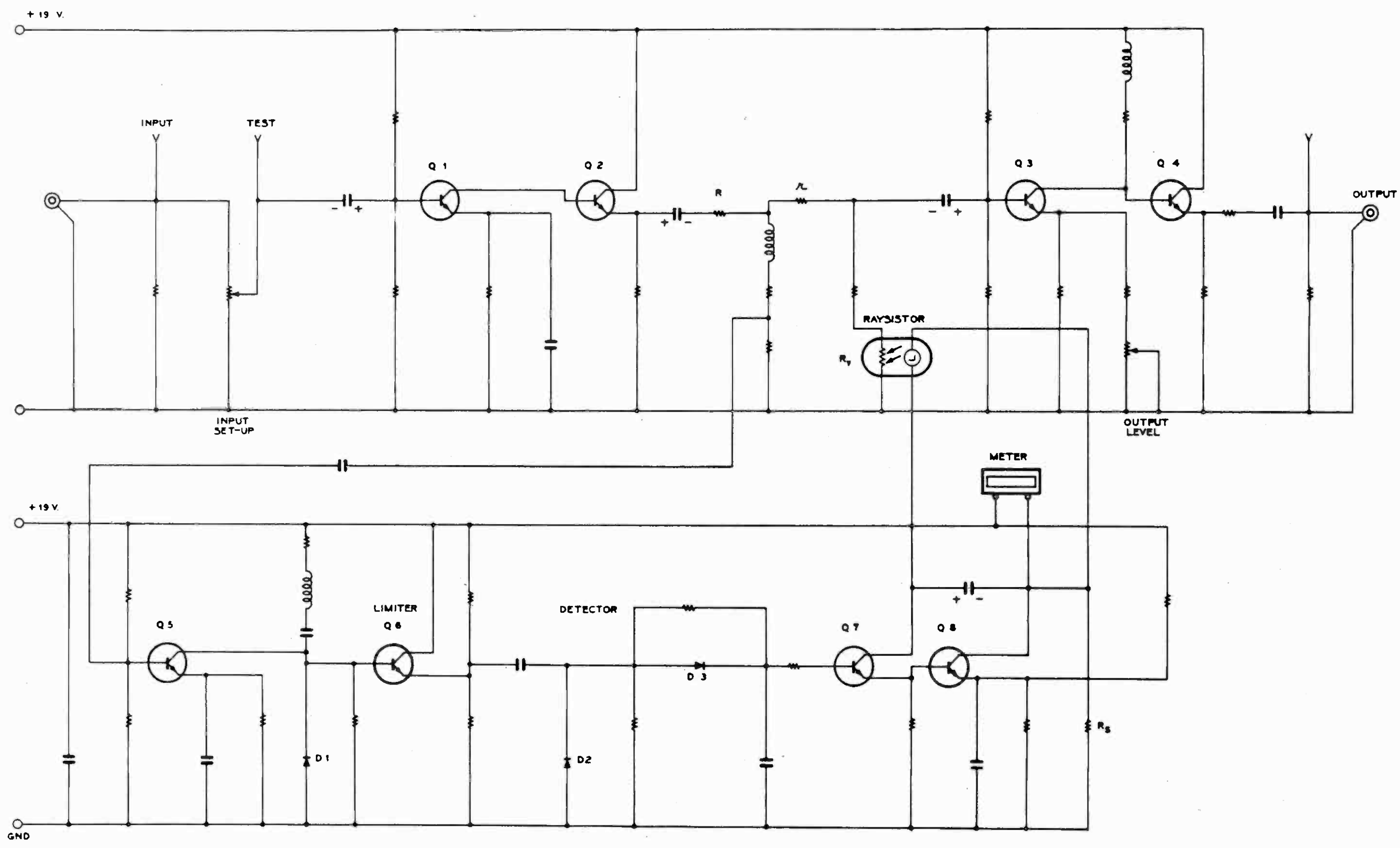
The pictures of the gamma control amplifier show first the effect of the knee on the signal. This effect is demonstrated without and with modulation on the steps. When the modulated steps go over the knee the high frequencies are greatly reduced along with the large area signals. This effect we want for overshooting signals but we would not necessarily want this type of circuit in a gamma amplifier.

The effect of maintaining the high frequencies as the upper steps are compressed by the gamma section is shown. Here the modulation is unaffected by the large area variation.

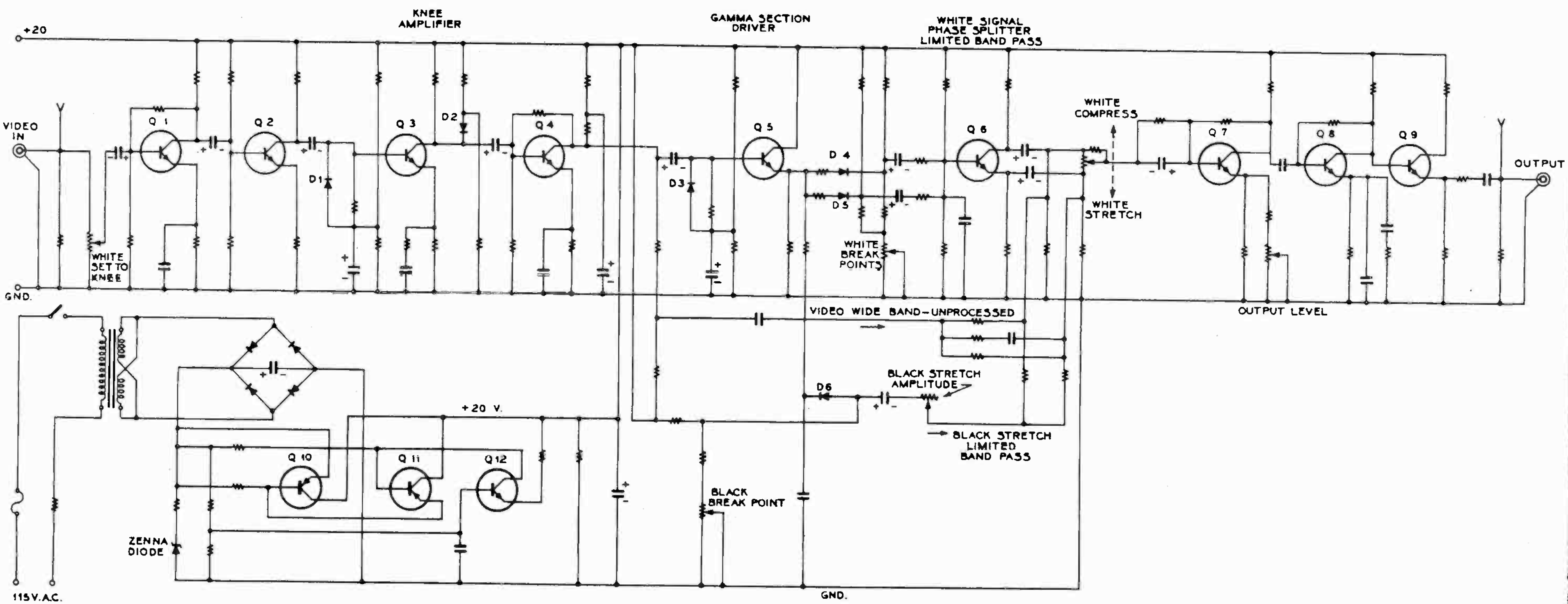
The rest of the pictures are pretty well self-explanatory.

ROLL THE FILM - WITH COMMENTS

In conclusion may I say that this material is largely experimental but does, I believe, provoke some thought in regard to the handling of video signals as perhaps artistic as well as mathematical entities. I thank you.



TRANSISTORIZED AGC AMP



TRANSISTORIZED KNEE AND GAMMA AMP

"BROADCAST AUTOMATION - PAST, PRESENT AND FUTURE"

by

Danny Coulthurst, Director of Engineering
International Good Music, Inc.

Presented at the 1965 NAB Broadcast
Engineering Conference

BROADCAST AUTOMATION - PAST, PRESENT AND FUTURE

It is a pleasure for me to represent International Good Music, Inc. before this 19th NAB Broadcast Engineering Conference. My subject matter will include some information about radio programming which perhaps you won't feel is appropriate to an engineering conference. However, International Good Music feels that when the subject of broadcast automation is discussed, there can be no real separation between engineering matters and programming matters. The development of IGM reflects this phenomenon. We are engineers, program producers and syndicators, and operating broadcasters, all wrapped in one operation. This is perhaps a little unusual in this modern day of specialization. Yet, it is our belief that this is the direction engineering in this field has taken and will continue to take in the years ahead.

The separation between the engineer and program director is becoming increasingly obsolete where modern broadcast automation is concerned. No longer can management turn to engineering for a decision as to what kind of hardware is best for the station. The hardware must meet the programming requirements, and thus programming and engineering decisions must go hand-in-hand.

Nor is this trend a recent one or unique to the broadcast industry. The roots of modern broadcast automation go back to the days of live musicians in the studio - when their presence was replaced by the staff announcer and his stack of records. It is hard for us today to believe our courterparts of 30 years ago were serious in forecasting the doom of radio when records began to be widely used in radio stations. Yet, lifted out of context, their laments of the 1930's sound remarkably similar to some of the complaints about present day trends towards further automation. Is there any one among us who wishes he could go back to the days before records?

Automation has been gaining on us in other ways, too. Automatic tower lights, transmitter remote control, leveling amplifiers, etc., are cases in point. Each of these is a form of automation.

Present day audio automation carries the advance one step further. Disc recordings are themselves replaced by taped music, often partially or wholly programmed. The live announcer is also giving way to the taped announcer. In fact, the term "live announcer" is fast becoming a misnomer even in stations considering themselves "live." Indeed, there sits the announcer at his console in front of the mike. Yet, with the widespread use of cartridges or other prerecorded means to deliver station ID's, promos, commercials, public service announcements, to say nothing of the music itself, the "live" announcer is often little more than a button pusher.

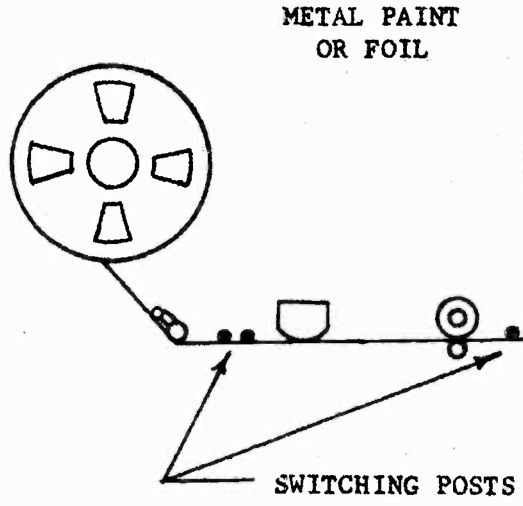
It is this fact that has led to the most significant advances in modern broadcast automation equipment - audio switching systems. Note that today's switching systems control both music and non-music sources. The advancements in modern day switching techniques usher in a true revolution in the broadcast industry.

Audio Switching Methods

Before proceeding to a discussion of present day techniques, let us examine the past for a moment and analyze the various approaches to what I have called "audio switching." There are various methods available, each with certain advantages. Simply stated, the task is to place a signal, or cue of some sort, at the end of each unit of programming. This cue is used to start the next scheduled unit of programming. The device itself should be reliable and easy to apply. Many have been tried in the past and some abandoned. The following are examples of the most common methods:

1. Metal Paint or Foil
   Probably the simplest system of switching uses either metal paint or metal foil on audio tape. As the audio tape passes over contacts, a circuit is closed and the switch is accomplished. Metal paint at one time was quite popular for this purpose on both reel-to-reel and cartridge machines. It was found, however, that foil has two advantages over the paint. It took some time before the paint dried, while the metal foil with a pressure sensitive backing was ready for use immediately. Also, the metal foil could be removed by careful peeling while the painted area had to be spliced out.

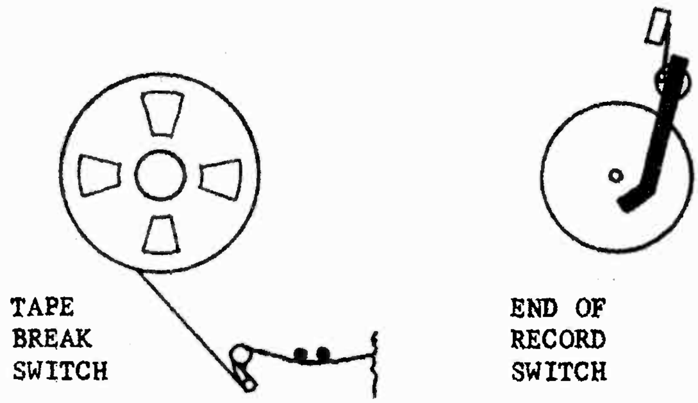
   Metal tape is still being used at IGM for reliable end-of-reel reversing or switching. It would be impractical to switch at the end of each unit of programming on a reel of tape using metal foil due to the time involved in putting on each piece of metal tape.



2. End of Tape or Record
   Most record changers start their end-of-record cycle at a particular place on the recording. This system has been used to start the next sequence in automation systems.

Reel-to-reel tape machines could use the same system. When the reel of tape has completed its run, the "tape break" switches could start the next operation. Both of these systems are quite cumbersome and are not very practical in actual daily operation.

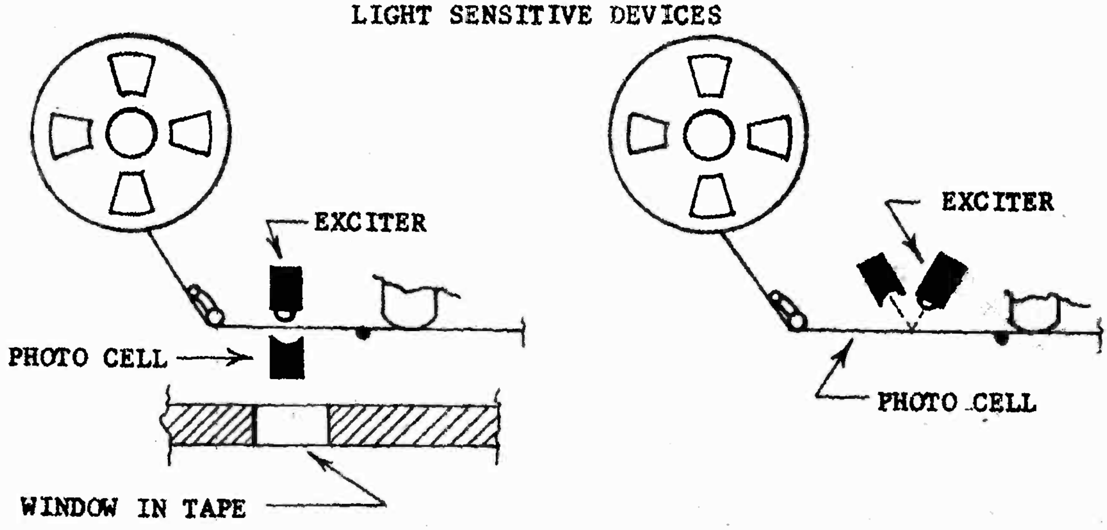
END SWITCHING



3. <u>Light Sensitive Devices</u>
Photo cells are used in various configurations. With audio tape the oxide is removed at the switching point and light is allowed to pass through the transparent backing of the audio tape to the photo cell. This system has proved quite successful except for the occasional oxide breaks that inadvertently appear in the tape giving out a false switching pulse.

Another system uses light reflected from tape or paper. Either a paint or "black light" crayon is used to fix the switching point. Light is directed at a 45 degree angle to the tape while the photo cell lens is focused at 90 degrees from the light source. As the tape moves along, more or less light is reflected into the photo cell to perfect the switch.

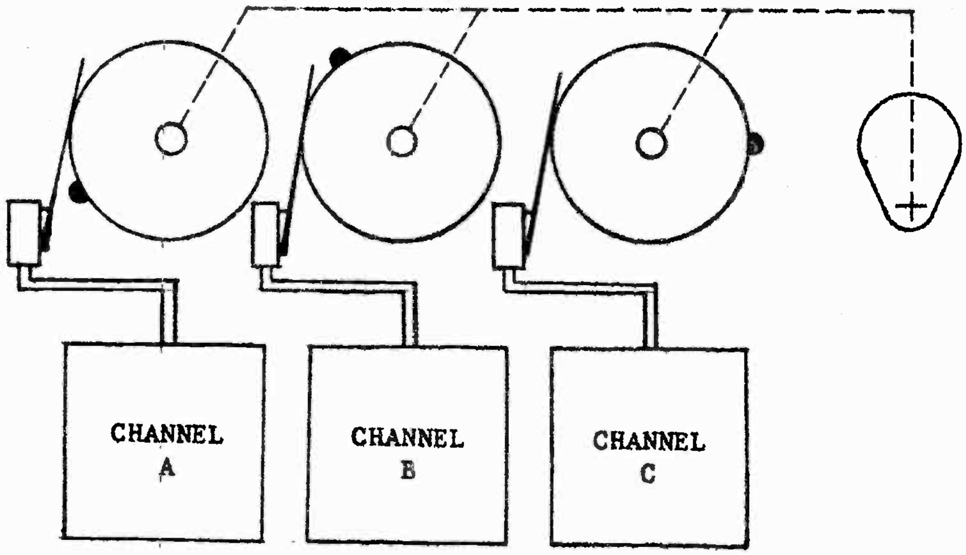
LIGHT SENSITIVE DEVICES



Incidentally, the "black light" system works equally as well for film cues.

4. Time Switching
Time switching is used in most automation systems at some point or other. This might be used to switch to a network, remote, or other operation by use of a repetitive timer or clock, or it could be used to "ready" a switching action while the switching is accomplished by other means. All complex automation systems use a timer or clock for correction so that operators are freed of the burden of timing each segment.

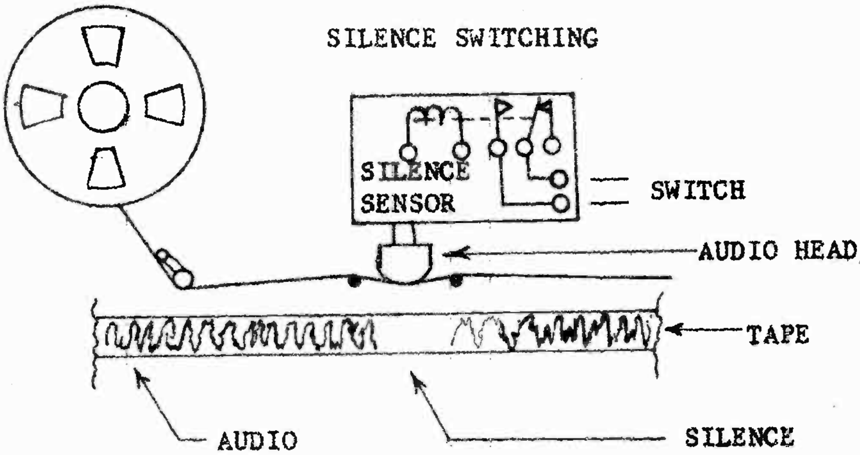
TIME SWITCHING



5. Silence Switching
In the past, silence has been used extensively for switching. It is one of the simplest systems as far as make up is concerned. The operator has but to leave a silent spot in the recording. It is about the only practical method when individual phonograph records are used in the system. It has serious disadvantages, however. Silence is a negative device rather than a positive one. If silence is inadvertently left in the middle of a unit of programming, preswitching can occur. In some instances this can be unintended and inadvertent. The classic example is the recording of a "cha-cha-cha" which never plays beyond the second "ugh." Also, silence is a relative thing. Surface noise, tape hiss, tube noise and other types of non-intelligible audio can ruin a period of what should be silence. For these reasons silence has been largely abandoned as a means of switching and is used only for fail-safe purposes in modern systems.

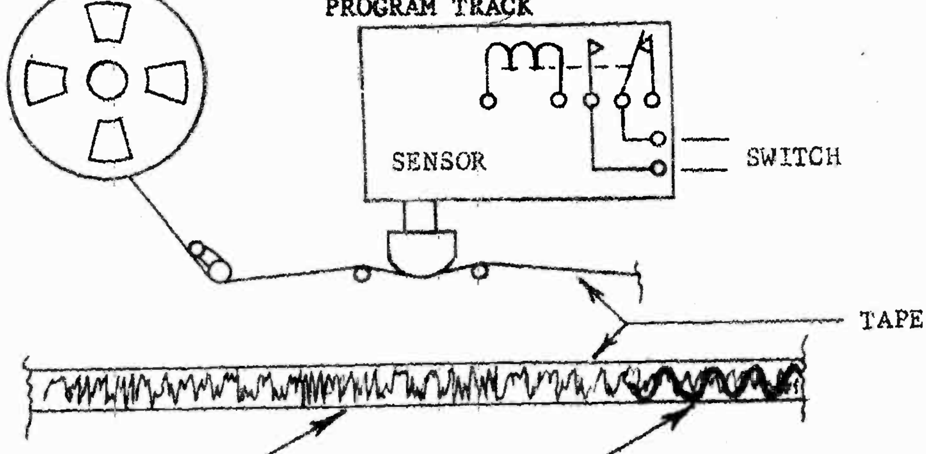
Present day silence sensors are usually solid state with variable time delay and degree of silence. If there is a given amount of silence, or lack of audio, for a specified length of time, a switch to the next source will be made and an alarm will be sounded to alert the operator to check into the reason for the failure.

SILENCE SWITCHING



6. Tone Switching
Presently the most reliable system of switching is with tones. IGM has used tone switching exclusively in its syndicated music services. We standardized on 20 cycles because it is so easy to compare to a 60 cycle line. Other systems use 25 cycles which is much harder to check to insure accurate frequency. In an effort to assist industry standardization, IGM now mixes both 20 and 25 cycle tones on syndicated tapes. Official NAB recognition of this unofficial standard would be of benefit to the industry in making systems and music services compatible. As you know, standards have already been set on cartridge equipment.

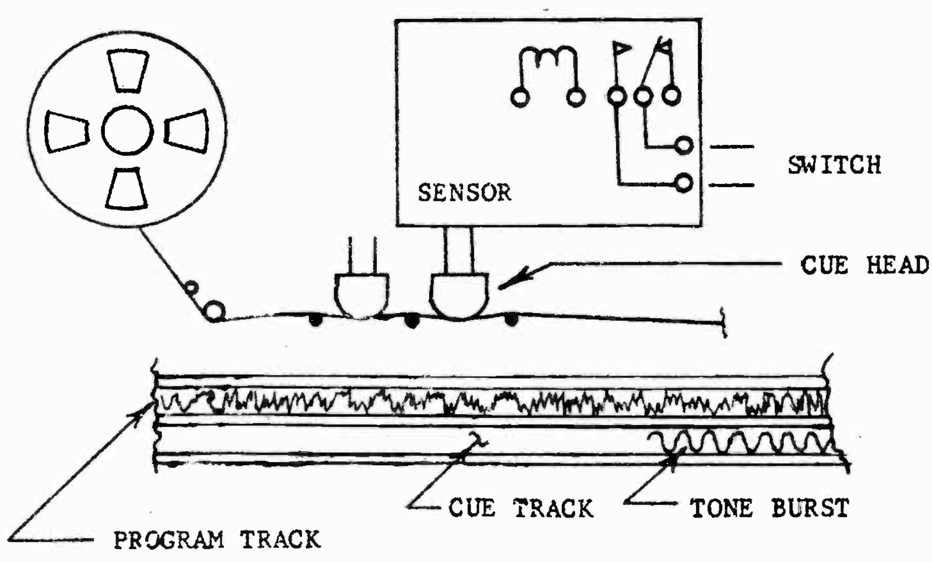
TONE SWITCHING
PROGRAM TRACK



Tone switching is more reliable than silence because it is positive. It is easier to apply and erase than metal foil and light sensitive devices. There are two basic methods of tone switching. The first is a sub-audible tone mixed with the program material. This works quite well if care is taken to insure that regular audio does not contain tones at the switching frequency which would cause false switching. These can be eliminated by the use of appropriate filters. Care must be taken, also, to insure that the ratio between the level of the switching tone and the maximum recording level is consistent.

The second method of tone switching is to use a separate or cue track for switching tones. This method is most common on cartridge equipment. This development results in increased reliability as the sensing unit need listen only to the cue track, not the program audio. The problems of level, distortion and low frequency tones prevalent in the program track system are greatly reduced. Also, a multitude of frequencies and configurations within the audio range are possible since they do not go on the air.

TONE SWITCHING - CUE TRACK



For the present, most suppliers have standardized on tone switching as the simplest and most reliable for nearly all operations. While a more exotic method may be developed in the future, none is being used presently to our knowledge.

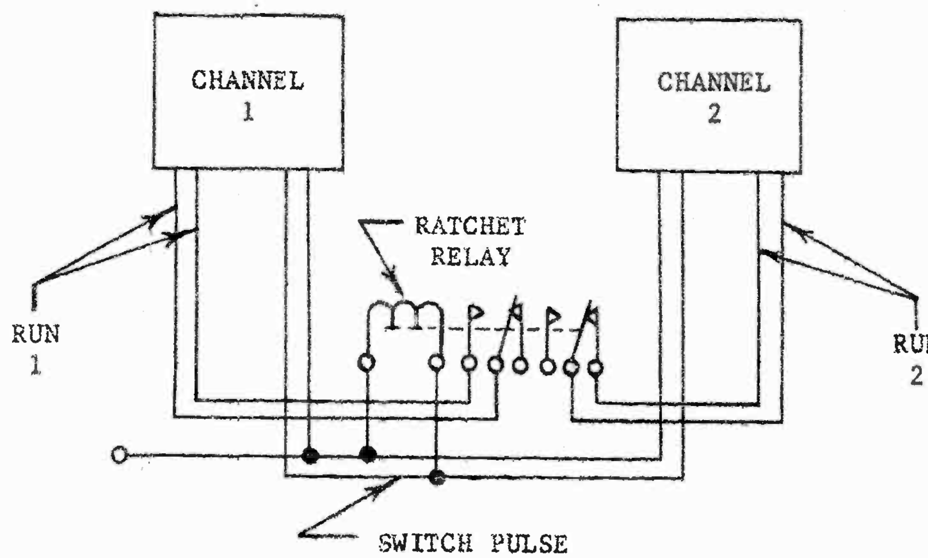
Program Control Methods

Now let us explore the various methods of program control. In other words, having recognized the end of a given unit of programming, which unit do we start next? There are two basic approaches - the sequential approach and the insertion approach. But first let's define one term. Systems commonly have two or more transports or channels. Let's standardize on the word "channel" to mean a program playback unit of any type: reel-to-reel, playback, single cartridge playback, multiple cartridge playback, remote lines, network lines, and the like. Our problem then is to determine which channel will go on the air next. We will proceed from the simple to the more complex.

Sequential Systems.

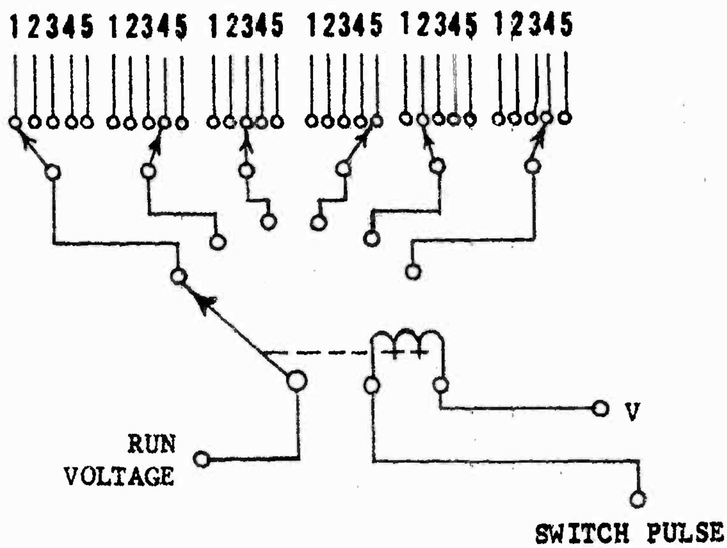
The simplest sequential system might be called a "flip-flop." Here only two channels are used and they alternate from #1 to #2 at each switching tone. Because of its simplicity, the flip-flop system is reliable and easy to operate. Its simplicity, however, limits it severely and it is used only in the simplest applications.

FLIP FLOP



To increase flexibility, additional channels are added. The simplest method of controlling multiple channels would be to set up a sequence on switches or a patch panel. Once established, the order remains fixed until manually changed. Switches are used in most sequential systems today. Typically, these systems have up to ten channels and twenty-four sequence selection switches. Any of the ten channels can be selected on each switch. Usually a simple timer is used to reset the sequence back to the beginning at fixed times. This keeps the system on time throughout the day and permits fixed time program features, such as station breaks, to be aired at approximately their proper times. Fading circuits on more sophisticated clocks are sometimes added to insure an override of the system for features which must be scheduled at an exact time.

SEQUENTIAL

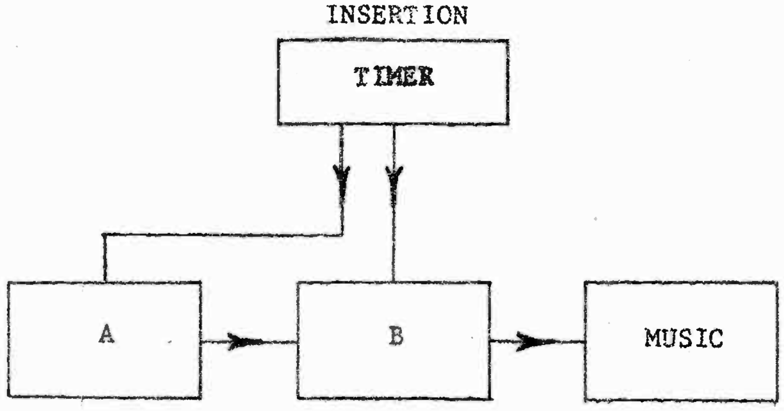


The advantages of the sequential system are several. It is quite easily understood by operators and maintenance personnel. Also, the operator always knows the exact order in which channels and, therefore, features will be played. In many program formats this is required. A good example is the use of multiple sources for unannounced music and a single source for music introductions. In this instance, an introduction must be followed by its appropriate music selection and no other program feature can be allowed to come between them.

At the same time, its disadvantages are several. Once set, the sequence never varies until manually changed. Some broadcasters feel this leads to a "canned" sound. If this is to be avoided, the sequence must be changed often, which, in turn, detracts from the "automatic" aspect of automation. Of course, some formats are designed to be repetitive and this is not a disadvantage at all. Also, careful attention must be paid to time in setting up the sequence to insure that a given segment is neither under-programmed or over-programmed. Changes, too, are generally harder to make with the sequential system than an insertion system. Thus, programming must be carefully considered before determining whether the straight sequential system is best for your station.

<u>Insertion System</u>

IGM has pioneered the development of a switching system which works on an "insertion" principle. A single music channel is used, generally containing all music and music introductions. This music becomes "home base" and non-music features are inserted between musical selections. Other programming features are loaded into the appropriate channels, each of which has a selector to permit it to be "readied" for insertion on a time base.

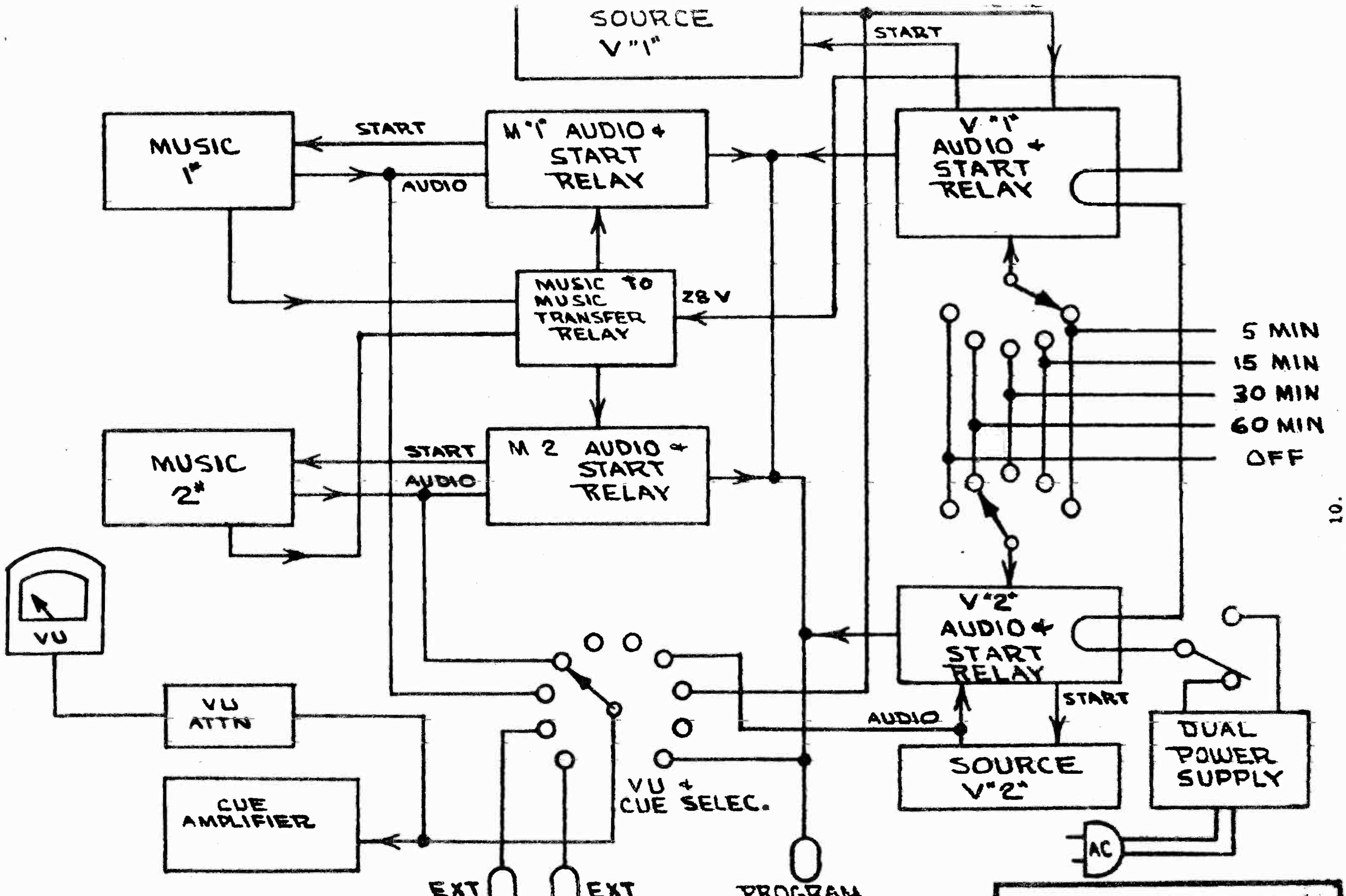


This time base may be repetitive, such as every 5 minutes, every 15 minutes or every 30 minutes from a simple timer. Or a clock may be used to ready a channel at any specified 5-minute interval throughout a 24 hour day. When any of the non-musical channels have been readied, a gate is opened to permit the next tone to insert these features at the end of the next musical selection. Where multiple channels are used, a simple priority is established whereby the most important channel will be inserted first, followed by the second most important channel and so on. Music is always the least important and will only play when nothing more important is ready. When no non-musical channel is ready, the switching tone is ignored and music selections are segued.

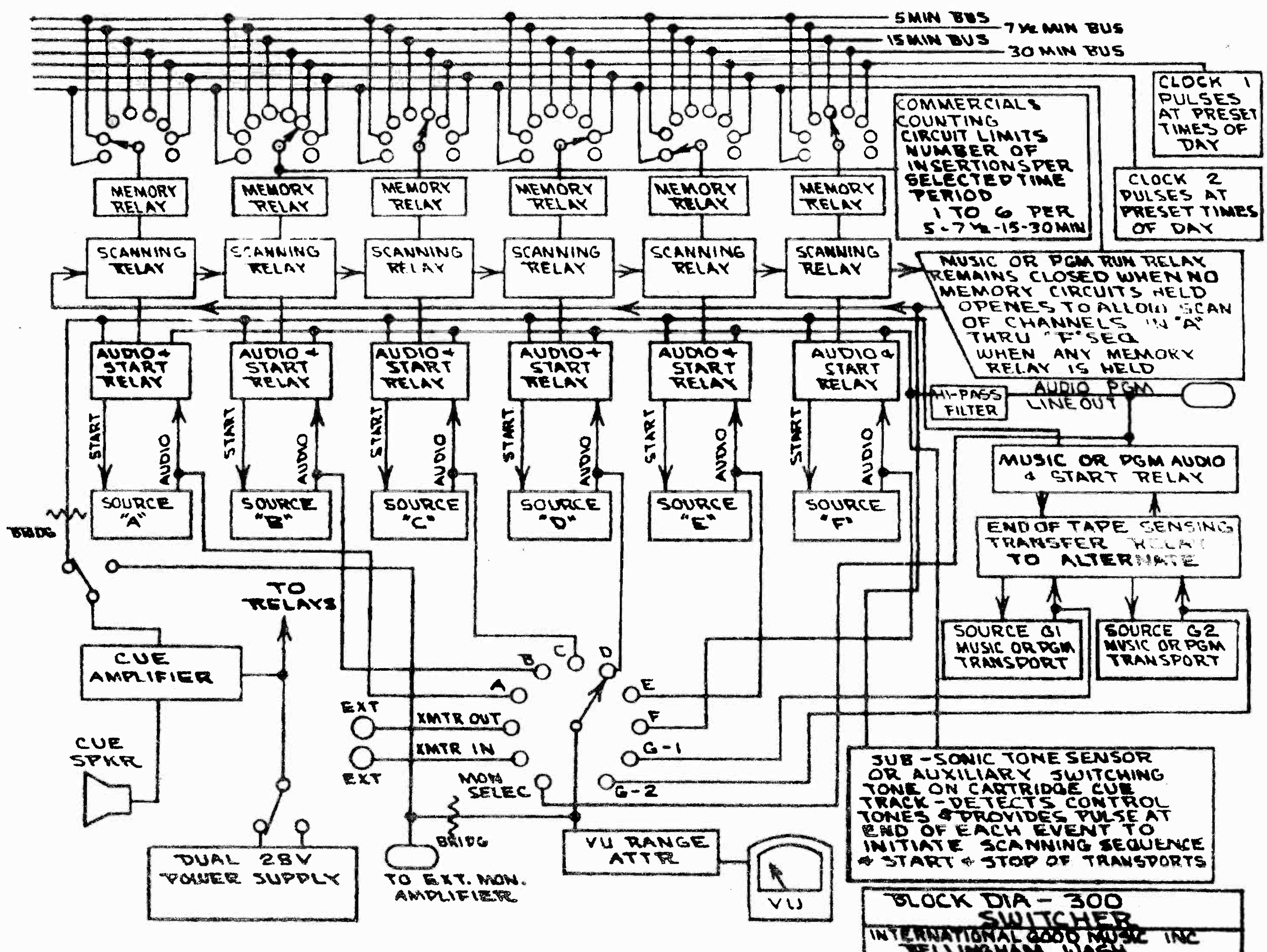
The IGM insertion system is modular and once the basic power supply, cue amplifiers and tone and silent sensing amplifiers, and timer are obtained, as many channels and clocks as are necessary to do an adequate programming job may be purchased. The main advantage in this type of system is its versatility and flexibility without loss of simplicity. For instance, the commercial load may be reduced from one after each musical selection to one every 30 minutes by simply turning one switch. Music will automatically fill up the unused commercial time. Each type of non-musical feature can be scheduled independently of all others in the same manner.

A second advantage is the varied programming sequence possible. Since scheduling and the clocks determine which channel will play next, the sequence can be constantly varied if desired. This avoids the "canned" sound objection which many broadcasters have towards the sequential system.

The main disadvantage of the insertion system is that music must be preprogrammed. Once recorded, the programming balance and mix cannot be changed without re-recording. Repetition of music tapes can in this instance be a problem unless enough tapes are provided. Most stations using an insertion system look to an outside source for at least part of their musical programs to minimize this problem.



IGM SERIES 200 CONTROL UNIT



5 MIN BUS
7½ MIN BUS
15 MIN BUS
30 MIN BUS
MEMORY RELAY
SCANNING RELAY
AUDIO + START RELAY
START
AUDIO
SOURCE "A"
SOURCE "B"
SOURCE "C"
SOURCE "D"
SOURCE "E"
SOURCE "F"
COMMERCIALS COUNTING CIRCUIT LIMITS NUMBER OF INSERTIONS PER SELECTED TIME PERIOD 1 TO 6 PER 5-7½-15-30 MIN
CLOCK 1 PULSES AT PRESET TIMES OF DAY
CLOCK 2 PULSES AT PRESET TIMES OF DAY
MUSIC OR PGM RUN RELAY REMAINS CLOSED WHEN NO MEMORY CIRCUITS HELD OPENES TO ALLOW SCAN OF CHANNELS "A" THRU "F" SEQ WHEN ANY MEMORY RELAY IS HELD
HI-PASS FILTER
AUDIO PGM LINE OUT
MUSIC OR PGM AUDIO + START RELAY
END OF TAPE SENSING TRANSFER RELAY TO ALTERNATE
SOURCE G1 MUSIC OR PGM TRANSPORT
SOURCE G2 MUSIC OR PGM TRANSPORT
BRIDG
TO RELAYS
CUE AMPLIFIER
CUE SPKR
DUAL 28V POWER SUPPLY
EXT
XMTR OUT
XMTR IN
EXT
MON SELEC
A
B
C
D
E
F
G-1
G-2
TO EXT. MON. AMPLIFIER
VU RANGE ATTR
VU
SUB-SONIC TONE SENSOR OR AUXILIARY SWITCHING TONE ON CARTRIDGE CUE TRACK-DETECTS CONTROL TONES & PROVIDES PULSE AT END OF EACH EVENT TO INITIATE SCANNING SEQUENCE & START & STOP OF TRANSPORTS
BLOCK DIA - 300 SWITCHER
INTERNATIONAL GOOD MUSIC INC
BELLINGHAM WASH

Random Select System

The various random select systems are undoubtedly the most versatile, but at the same time are generally more complex. In these systems any channel can follow any other channel in an ever changing pattern. There are four basic types of memory storage used in random select systems:

1. Audio tape.
2. Program log paper.
3. Punched paper tape.
4. Punched IBM-type cards.

At least one company uses different tones or sequences of tones recorded on an audio tape to store the sequence of events for the day. The tape transport can be either reel-to-reel or cartridge.

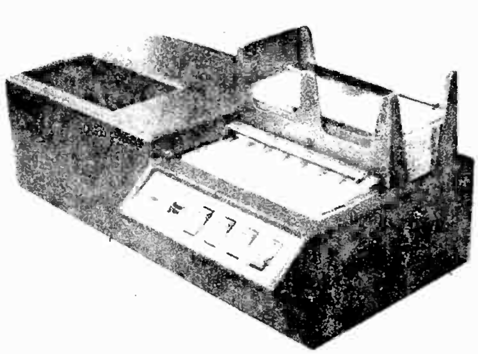
Another company uses a specially prepared program log to establish the channel sequence. An IGM machine codes the log paper. This in turn is loaded in a "playback" machine and the log moves through this machine, scheduling the various channels. Authentication of the log is accomplished at the same time.

Punched paper tape is another method of storage. Paper tape readers are inexpensive and quite reliable. Many tape punches are available in a price range of from $40 upwards of $5,000.

The main disadvantage of any of these systems is the difficulty with which changes are made. Each system has its own solution, but extensive changes are cumbersome at best. The audio tape and punched paper tape must be redone, often in their entirety. The program log paper must be corrected or done over where last minute changes are necessary.

IGM has been working with punched cards since 1958. Originally they were used to make up radio and television logs and for billing purposes. Recently we have developed an automation control system designed around a card reader manufactured by the National Cash Register Company. In its simplest form, each IBM-type card represents a particular channel. Cards are manually stacked in the desired order and loaded into the reader. The reader itself programs the order of the features as each card is brought to the read head. The sequence can be changed at any time by simply changing the order of the cards.

CARD READER



This basic system can be expanded in many ways. IBM punching equipment can be used to punch an alpha-numeric description of each feature into the card itself. All information necessary for traffic, the program log, accounting and billing goes into a single card.

IBM sorting equipment can then be used to sort the cards into their proper sequence. At this point the card reader takes over and programs the various audio sources in their proper order. As each audio source is put on the air, an electric typewriter types the program log, taking the accurate time from a digital clock and the program feature description from the card itself. The commercial cards can then be stored until the end of the month when they are used for billing and accounting on the appropriate IBM accounting equipment.

It can be seen that this system is the most versatile in that changes can be made easily right up to the last minute before air time. The system can be used with a program service designed for an insertion system, or with multiple music transports as in a sequential system. Each program feature is properly logged only when it has actually gone on the air. The tie-in with traffic, logging, accounting and billing also permits a fully integrated system with appropriate cost savings in all departments of the station. Its major disadvantage is that the equipment itself is more expensive and complex than the simpler insertion system. It requires a larger investment and better engineering personnel.

So much for a brief summary of the various methods of audio switching and control. In this discussion I hope I have supported our original contention that programming and engineering decisions are highly inter-related. Of particular importance is the method in which music is programmed. This is not surprising if you consider the fact that since music is some 60 to 90 percent of a given format, a workable method of programming must be found. The process of recording music for automation can be a most difficult and frustrating one. Yet, this is the most used element of the program format. Automation systems are known for consuming enormous quantities of tape.

We at IGM have been recording music for automation, first for our own use and subsequently for syndication, for over four years. The frustrations have been many. We find that it takes from two to three hours on the average to program and record a single hour of music. When the expense of time is added to the investment in recorders, reels, tape, and associated equipment, it is clear that an hour of recorded music costs from three to five times as much as it would if programmed live. Of course, pre-recording means that mistakes can be eliminated and complete control over programming is possible. But to gain these very important advantages, it is necessary to use a given hour of music at least three to five times before its cost can be recooped and any saving effected. In many cases, this kind of repetition is impractical due to format changes, the musical life of the selections themselves, errors in record, or audience reaction. Especially under these circumstances, people come to the conclusion that automation is not for them.

In addition to providing reliable equipment, training and the benefit of our years of experience as automated broadcasters, we at IGM also feel we can step into this "music gap" by serving as a music programmer and recorder for many stations. The net result is that each station can get more music at less cost and with many less headaches.

IGM produces music in two basic ways. The first we call a "program service." Here the music is fully programmed on a single reel of tape and announced by an IGM announcer-producer. Local station personnel can then concern themselves primarily with the production of non-music features, such as news, commercials, talk programs and the like. We produce programming services in the classical, pop-concert, middle-of-the-road, and country and western categories. These services are designed for use with insertion systems, though they can be used with a sequential system as well.

For those stations that prefer to mix their own distinctive musical blend and use their own local announcers for music introductions, IGM produces the Spectrum Series. In this case, music is partially programmed into two basic categories by arrangement and tempo. The categories necessary to make up a given sound, plus any locally produced specialty music, are then loaded on several music transports and automatically mixed on the air by the control unit. Introductions by local DJ's are added if desired. The musical spectrum from light classics to Top 50 is present in the "Spectrum Series." These tapes are designed for sequential and random select systems of all manufacturers.

A few technical words about program recording for automation are also in order. As indicated, the process can be tedious and frustrating. Leaving out programming consideration, the following are some of the problem areas:

1. False switching tones caused by distortion in recording or by failure to filter low frequencies when recording switching tones on the program track.

2. Unreliable switching caused by improper levels of switching tones. If recorded too high, tones distort and are heard on the air. If recorded too low, tapes fail to switch. A constant ratio between maximum recording level and tone level (we record tones 7 db below recording level) must be maintained.

3. Varying program levels. There is no operator to ride gain in automated systems, though leveling amplifiers give some help. Recording levels must be watched constantly and adjusted without adjusting switching tone levels. You need good production personnel.

4. Distortion, signal to noise ratio, turntable rumble frequency response and other factors which govern technical quality must be constantly checked to insure that an otherwise good tape need not be junked. This takes better engineering and particularly better preventative maintenance procedures.

5. Tone placement determines the on-the-air sound. Tone placement with regard to the end of the program material and cuing time left on tapes must be consistent. Again, good production personnel are needed.

6. Azimuth setting must also be standardized and checked regularly to insure maximum frequency response when recording and playing back on different transports. Loss of highs in music is more noticeable than lack of highs in speech.

These problems can be solved by good procedures and good people. All tapes produced by IGM contain a system of test tones to insure quality. Each tape contains a reference tone indicating maximum recording level, a burst of switching tones to permit setting of the sense amplifier, and an azimuth tone which can be used to set azimuth on each playback transport to insure maximum frequency response. High speed duplication equipment is used with excellent results. While there is a loss of frequency response inherent in high speed duplication, good equipment and good procedures can reduce this loss to negligible amounts. For example, our tapes run at 7½ IPS are flat within 2 db from 50 to 12,000 CPs, and within 4 db to 15,000 CPS. These standards are maintained from the recorder through the playback machine of the customer station.

So much for the present. What will the future bring in the way of new ideas and techniques? I am perhaps better at gazing into an oscilloscope than a crystal ball, but there are some recognizable trends at this point.

The first trend will most certainly be the expanded use of broadcast automation itself. Our best guess is that from 70 to 80 percent of all radio stations will be using some method of automatic switching and program control in five to seven years. Even without major new breakthroughs in switching and memory systems, today's knowledge is producing systems both practical and reliable enough for use by virtually all stations. The attitude that "we should wait awhile and see how this whole thing works out" is now largely out of date. The time for serious consideration of automation for AM and FM broadcasters is here.

I might add that if current economic trends continue, all of us will feel pressure to effect cost savings even more in the future.

Secondly, we look for a considerable expansion in the use of syndicated music services of various kinds. Better quality and lower cost of centrally produced music will dictate this trend.

Thirdly, with respect to hardware, we foresee a continuing improvement in storage methods. This applies to the transports upon which program material is recorded and stored, as well as the memory system for program control. Undoubtedly the broadcast industry will watch the space and data processing industries closely and steal ideas as they become practical and economical.

Can you imagine a program recording and playback device with complete random access but with no moving parts? These things sound farfetched today, but so did a moon shot ten years ago.

Perhaps the radio and television station of the future will use a small computer. Each time a contract is sold, this information and program schedule information will be fed to this computer, which, in turn, will completely schedule all elements of the program schedule, put them on the air, and do all the logging and billing. If this sounds farfetched, ask your airline travel agent how your plane reservations to this Convention were made.

Does all this frighten you? It shouldn't, unless progress itself is frightening. As to job security, automation in radio may well mean fewer jobs in radio, but they will be better jobs, held by better people, at better pay. And the public can be better served.

So, now that you all know all about automation, you can go home and hit the boss for a raise. As for me, I'm going to abandon my crystal ball and go back to my oscilloscope.

It's been a pleasure being here, and thank you for your attention.

PRACTICAL EXPERIENCE DERIVED FROM DUAL POLARIZED FM ANTENNAS

BY ROBERT M. SILLIMAN

THANK YOU, BOB, LADIES AND GENTLEMEN. I WILL GO RIGHT INTO DISCUSSION OF METHODS OF OBTAINING DUAL POLARIZATION WITH A BRIEF RESUME OF METHODS AND THEN RETURN TO THE PROBLEMS OF POWER DIVISION IN GREATER DETAIL.

FIGURE 1 SHOWS A SINGLE TRANSMISSION LINE UP THE TOWER LEADS TO THE POWER DIVIDER. SEPARATE ANTENNAS ARE USED TO RADIATE HORIZONTAL POLARIZATION AND VERTICAL POLARIZATION. ANY DESIRED POWER INPUT RATIO BETWEEN 1:8 AND 8:1 CAN BE OBTAINED BETWEEN THE VERTICAL AND HORIZONTAL INPUTS; HOWEVER, THE VERTICALLY POLARIZED EFFECTIVE RADIATED POWER MAY NOT EXCEED THE HORIZONTALLY POLARIZED RADIATION. THE SHORT LENGTH OF HELIAX IS TO PROVIDE SOME TOLERANCE IN THE MOUNTING. I WILL RETURN TO THE DESIGN PROBLEMS LATER.

MY NEXT SLIDE SHOWS AN EXAMPLE OF THE SYSTEM AS INSTALLED AT WGMS-FM IN WASHINGTON. IN CASE OF A LONGER ANTENNA SYSTEM, THE POWER DIVIDER MAY BE LOCATED IN THE CENTER OF THE ANTENNA. MY NEXT TWO SLIDES SHOW SUCH AN INSTALLATION AT KMSC-FM IN CLEAR LAKE, TEXAS, IN THE HOUSTON AREA.

FREQUENTLY, IT IS DESIRED TO MOUNT THE ANTENNAS WITH VERTICAL AND HORIZONTAL BAYS INTERSPERSED ALONG A SINGLE FEED LINE. FIGURE 2 OUTLINES THIS SYSTEM AND THE FOLLOWING SLIDE SHOWS SUCH A SYSTEM UNDER TEST AND NEXT WE SEE AN EXAMPLE (WMAL-FM IN WASHINGTON, D. C.). I REFER TO THE ANTENNA ON THE LEFT. THE ANTENNAS MAY ALSO BE FED IN PARALLEL AND THIS METHOD IS SHOWN ON FIGURE 3.

A THIRD METHOD SHOWN ON FIGURE 4 IS TO SUPPLY A SECOND POWER AMPLIFIER DRIVEN BY A COMMON DRIVER WHICH ALSO DRIVES THE POWER AMPLIFIER FEEDING THE HORIZONTAL ANTENNA. HERE A WORD OF CAUTION IS IN ORDER. THE PHASE RELATIONSHIP BETWEEN THE TWO FINAL AMPLIFIERS MAY BE VARIED MARKEDLY BY THE TUNING OF THE TWO FINAL AMPLIFIERS--WITHOUT TEST DATA TO SHOW THAT CONTINUALLY CHANGING THIS RELATIONSHIP WILL NOT PRODUCE A HARMFUL CONDITION, I AM SUGGESTING THAT SOME MEANS BE USED TO MAINTAIN A CONSTANT PHASE RELATIONSHIP BETWEEN THE TWO OUTPUTS. ONE METHOD FOR THOSE WHO WANT TO BE SURE THAT THE OUTPUTS ARE MAINTAINED IN A CONSTANT PHASE RELATIONSHIP WOULD BE TO DIPLEX THE OUTPUTS. FIGURE 5 SHOWS A SUGGESTED METHOD OF CONTROLLING PHASE WITHOUT DIPLEXING. THE PROCEDURE IS AS FOLLOWS:

1. TUNE BOTH TRANSMITTERS TO THEIR EXACT POWERS AND BEST OPERATING CONDITIONS.

2. WITHOUT FURTHER TOUCHING THE TRANSMITTER TUNING MINIMIZE THE METER INDICATION BY SELECTING THE JACK FOR CABLE A AT WHICH THE LOWEST READING CAN BE OBTAINED ON THE METER BY ADJUSTMENT OF THE VARIABLE INPUT AT B. INPUT B IS THEN LOCKED IN POSITION AND THE FINAL AMPLIFIERS ARE HENCEFORTH TRIMMED TO MAINTAIN THE MINIMUM READING ON THE PHASE INDICATING DIODE.

BASICALLY, THE SYSTEM FUNCTIONS BY BRINGING SAMPLES OF THE RF POWER FROM EACH FEED WHICH ARE EQUAL AND OUT OF PHASE TO A SINGLE RECTIFYING DIODE AND INDICATING INSTRUMENT.

PRACTICAL EXPERIENCE DERIVED FROM DUAL POLARIZED FM ANTENNAS (CONT'D)

Now I would like to show two slides of WMIT Black Mountain, North Carolina. The first shows an installation using separate feeds to the horizontal and vertical antenna systems. As shown in the second slide, the horizontal elements have been encased in radomes to protect them from the extreme ice conditions experienced at Mt. Mitchell. The antenna system is 6763' AMSL.

Power Divider Performance

I would like at this time to return to the subject of power divider performance. The performance of a power divider may be affected by the load impedance into which it works. Consider Figure 6, a typical power divider. All impedances into and out of the unit are 50 ohms. However, it contains two matching sections. Each transforms 50 ohms up to a higher impedance so that the two impedances added in parallel at the junction point return to 50 ohms with the desired power division.

At least for the moment I will, because of the short time available, pass over the method of calculating these sections. I will cover the calculation of power division in the printed notes and include an example. *I will go to the question of what happens if the terminating loads are not perfectly matched. Consider a power divider designed to produce a 50-50 power split. One output is exactly matched. Figure 7 shows the range of error under differing conditions of mismatch of the second output. Note that the curve shows the extreme ranges of error. The actual division could be exactly right or any division out to the shaded area beyond the curve depending on the chance rotation of the mismatched impedance--whether higher or lower than 50 ohms.

However, it is possible that the first load might also have some standing wave ratio other than unity. Figure 8 shows once again the range of error which may result with one input matched to 1.1 to 1 and various values for the other.

Figure 9 shows the same information with one input matched to 1.2 to 1 and with various values for the other. These slides will be furnished with the printed resume. I believe it is clear that rather good matches must be maintained to provide accurate power division. Note that with both inputs matched to 1.2:1 the maximum possible error in vertical field would be approximately plus or minus 18%.

Experience has shown that the antenna for horizontal polarization will be expected to show greater variation from 50 ohm impedance than the verticals which are basically very broad band. I believe you can reliably expect a vertical antenna to be within 1.2 to 1 as installed on your tower. Hence, one suggestion might be to field tune the horizontal antenna to an exact match measuring through the power divider with the vertical output of the power divider terminated in an accurate 50 ohm load. Then connect the vertical antenna and note the combined SWR. A little calculation and reference to the three graphs should give you the range of uncertainty in this particular case.

* See Appendix 1.

PRACTICAL EXPERIENCE DERIVED FROM DUAL POLARIZED FM ANTENNAS (CONT'D)

WHAT ABOUT THE ENGINEER WHO WANTS TO KNOW MORE CLOSELY? HE CAN SPECIFY THE INCLUSION OF A VARIABLE TRANSFORMER BETWEEN THE POWER DIVIDER VERTICAL OUTPUT AND VERTICAL ANTENNA INPUT. ONE IS SHOWN IN THE NEXT SLIDE. IF HE CAN MAKE THE PROPER CONNECTIONS, HE THEN CAN MATCH EACH LOAD TO EXACTLY 50 OHMS AND CONNECT UP; HE SHOULD THEN BE AS ACCURATE AS THE DESIGN OF THE POWER DIVIDER.

FOR THE EXPERIMENTER WHO IS STILL NOT SATISFIED, I SUGGEST THE INCLUSION OF A BIRD THRULINE WATTMETER IN EITHER OR BOTH FEEDS BETWEEN THE POWER DIVIDER AND THE ANTENNA INPUTS. THESE COULD BE REMOVED AFTER THE ADJUSTMENT.

THE QUESTION OF PHASE BETWEEN THE VERTICAL AND HORIZONTAL RADIATIONS IS AN INTERESTING ONE. FOR CIRCULAR POLARIZATION, THE HORIZONTALLY POLARIZED FIELD MUST NOT ONLY BE EQUAL TO THE VERTICALLY POLARIZED FIELD BUT MUST LEAD OR LAG IT BY 90° IN PHASE AND THIS CONDITION MUST HOLD IN ALL DIRECTIONS. NONE OF THE ANTENNAS DESCRIBED IN THIS TALK ATTEMPT TO ACCOMPLISH THIS PURPOSE.

ALTHOUGH WE WOULD LIKE CIRCULAR POLARIZATION IN THEORY WE ARE SO FAR ONLY ATTEMPTING TO MAINTAIN EQUAL VERTICAL AND HORIZONTAL FIELDS BUT NOT THE 90° PHASE RELATIONSHIP.

CONCERN HAS BEEN EXPRESSED OVER THE EFFECTS OF VARIATIONS FROM THE 90° PHASE RELATIONSHIP AND A NUMBER OF STATIONS HAVE INSTALLED PHASING SECTIONS IN THE FEED SYSTEM TO PERMIT EXPERIMENTATION WITH THE PHASE. UNFORTUNATELY, SINCE THE RADIATORS ARE NOT COAXIAL AND AT THE SAME VERTICAL POLSITION 90° PHASING CAN ONLY BE OBTAINED IN ONE OR TWO PARTICULAR DIRECTIONS.

TO MY KNOWLEDGE NO ONE HAS EXPERIMENTED EXTENSIVELY WITH THE PHASING, NOR HAVE ANY INSTANCES OF KNOWN DIFFICULTIES FROM IMPROPER PHASING OF THE COMPONENTS BEEN BROUGHT TO MY ATTENTION. PERHAPS SOMEONE WILL VOLUNTEER TO RESEARCH THIS PROBLEM OUT BEFORE THE NEXT NAB. THERE ARE ALWAYS MANY QUESTIONS AND FEW ANSWERS. AT THE PRESENT TIME THE BEST SUGGESTION I CAN MAKE IS NOT TO WORRY ABOUT THE PHASE BUT NOT TO LET IT VARY FROM DAY TO DAY. WHATEVER IT IS--HOLD IT.

AT THIS STAGE, A SPEAKER ON THIS SUBJECT IS EXPECTED TO PREDICT THE FUTURE SO THAT HE CAN BE REMINDED IN THE YEARS TO COME OF JUST HOW WRONG HE HAS BEEN. I WILL NOT BREAK WITH TRADITION.. THESE ARE MY PREDICTIONS.

1. AS FM INCREASES TO A DOMINANT POSITION, I BELIEVE NEARLY ALL STATIONS WILL GO TO DUAL POLARIZATION TO SERVE THE TABLE MODEL RADIOS AND THE AUTOMOBILE AUDIENCE.

2. ANTENNAS WILL BECOME MORE COMPLEX INCORPORATING BEAM TILT AND NULL FILL MORE FREQUENTLY AND OF COURSE DIRECTIONALIZATION.

3. STATIONS WILL BE INTERESTED IN POWER DIVIDING AND DIPLEXING SYSTEMS WHICH CAN BE SWITCHED TO PROVIDE EMERGENCY OPERATION IN CASE OF ANTENNA OR TRANSMISSION LINE FAILURE.

4. TV STATIONS ARE LIKELY TO SERIOUSLY CONSIDER ADDING VERTICAL POLARIZATION.

GIVEN AT THE 19TH NAB BROADCAST ENGINEERING CONFERENCE
ROBERT M. SILLIMAN - - MARCH 23, 1965

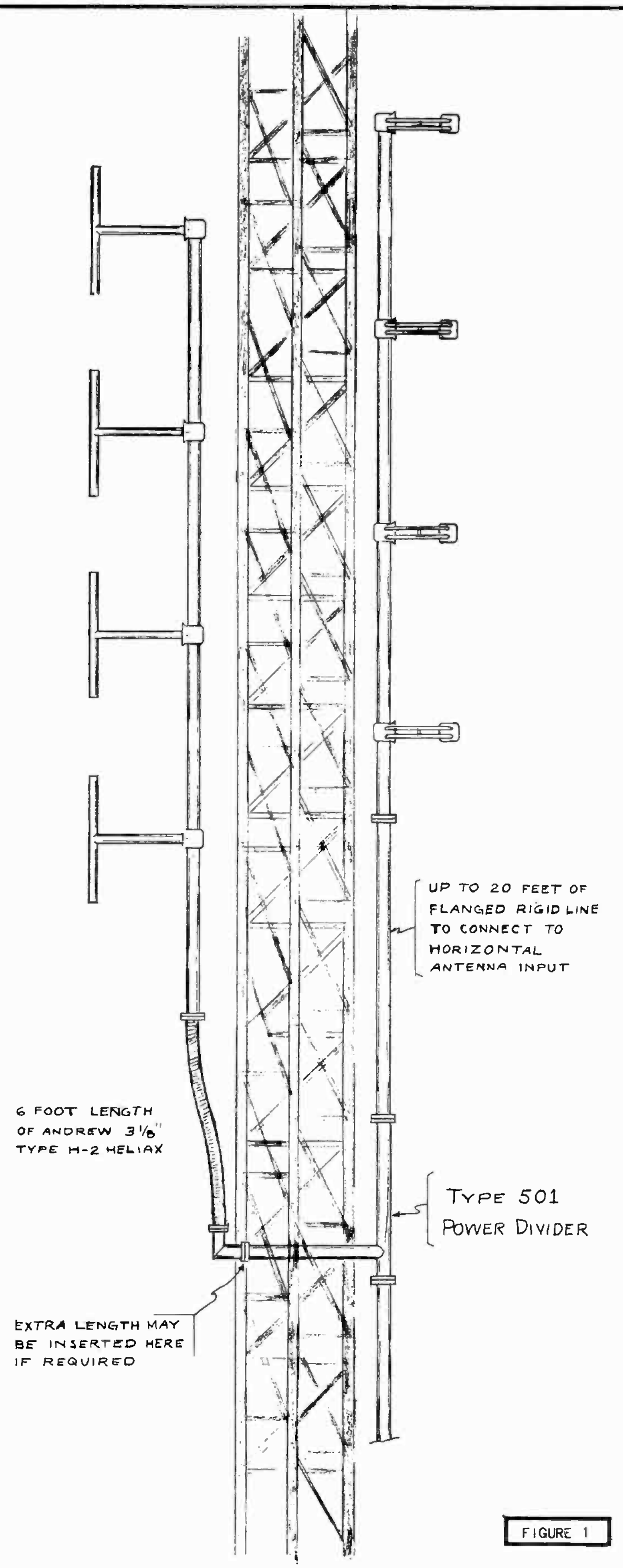


FIGURE 1

TYPICAL INSTALLATION*

*ANTENNA SUPPORT BRACKETS NOT SHOWN

METHOD OF OBTAINING DUAL POLARIZATION BY MOUNTING ANTENNA ALONG A SINGLE FEED LINE

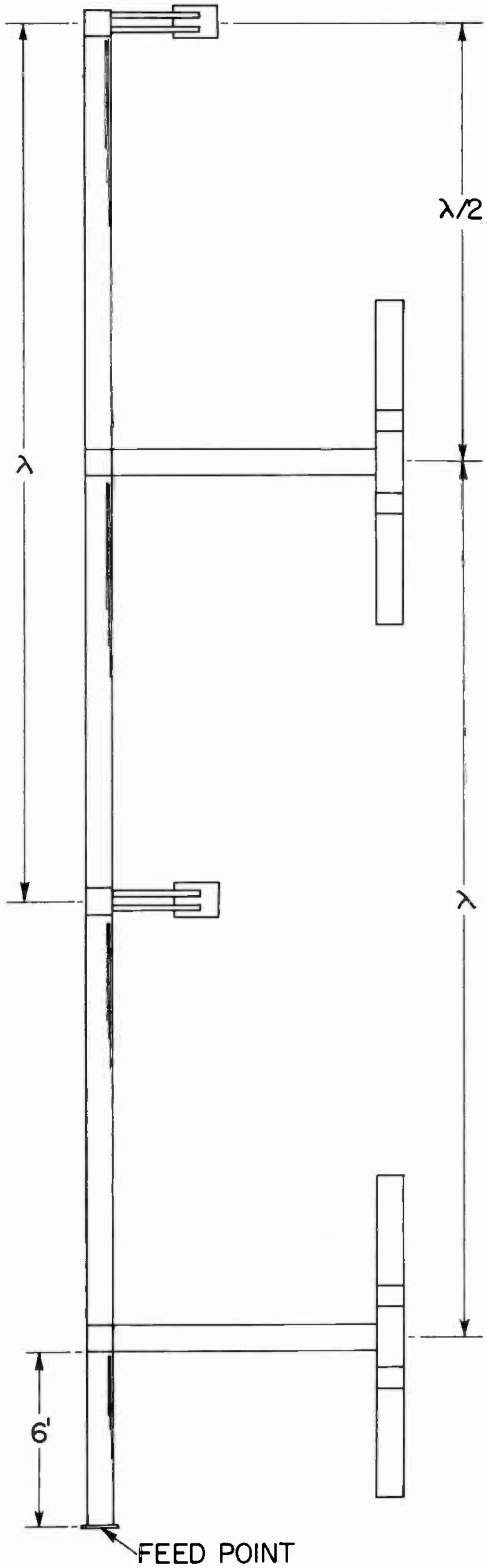


FIGURE 2

DUAL POLARIZATION BY PARALLELING ANTENNAS FROM A SINGLE POWER DIVIDER

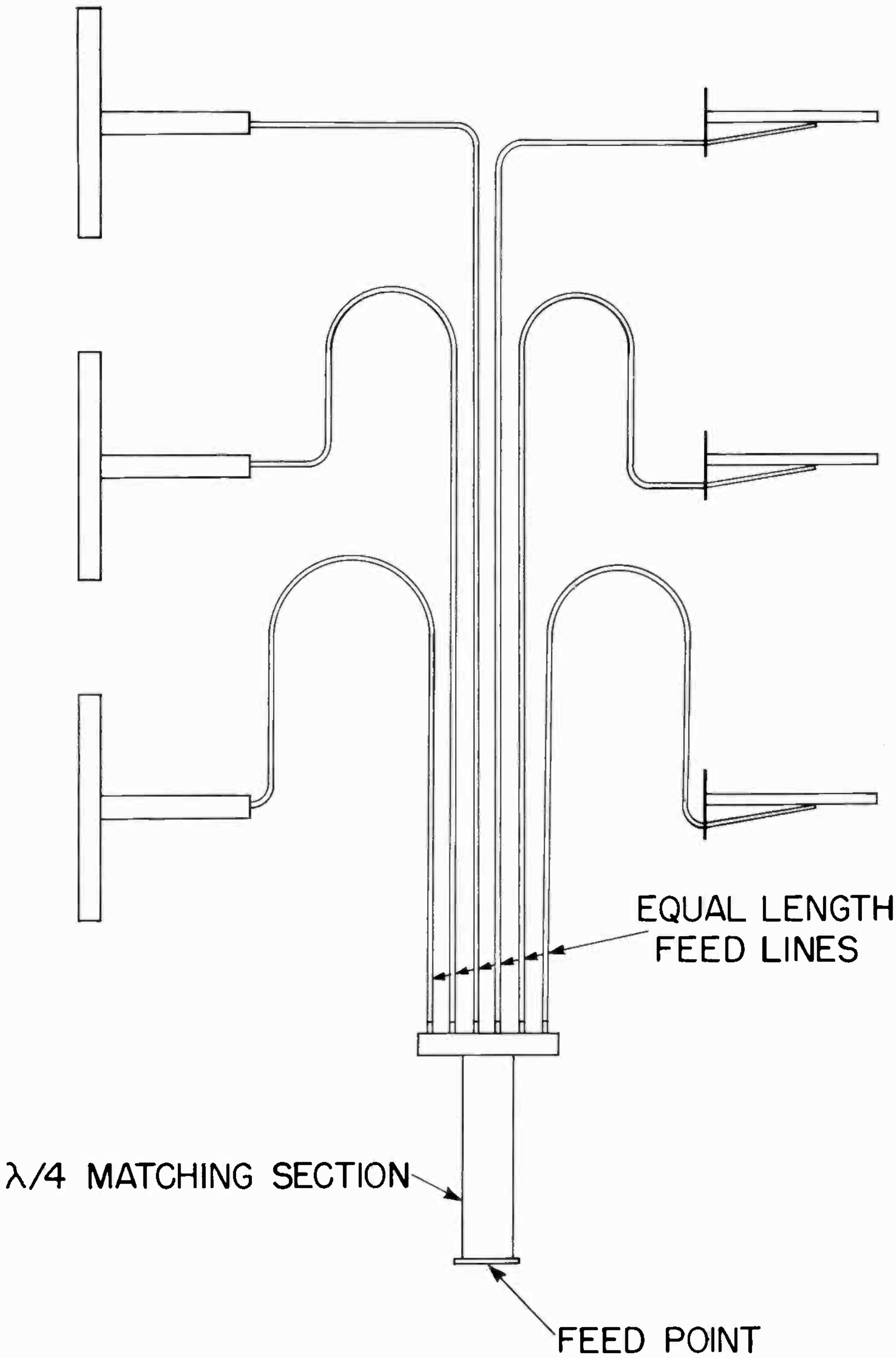


FIGURE 3

DUAL POLARIZATION THROUGH SEPARATE ANTENNA SYSTEMS WITH SEPARATE AMPLIFIERS DRIVEN BY A COMMON EXCITER

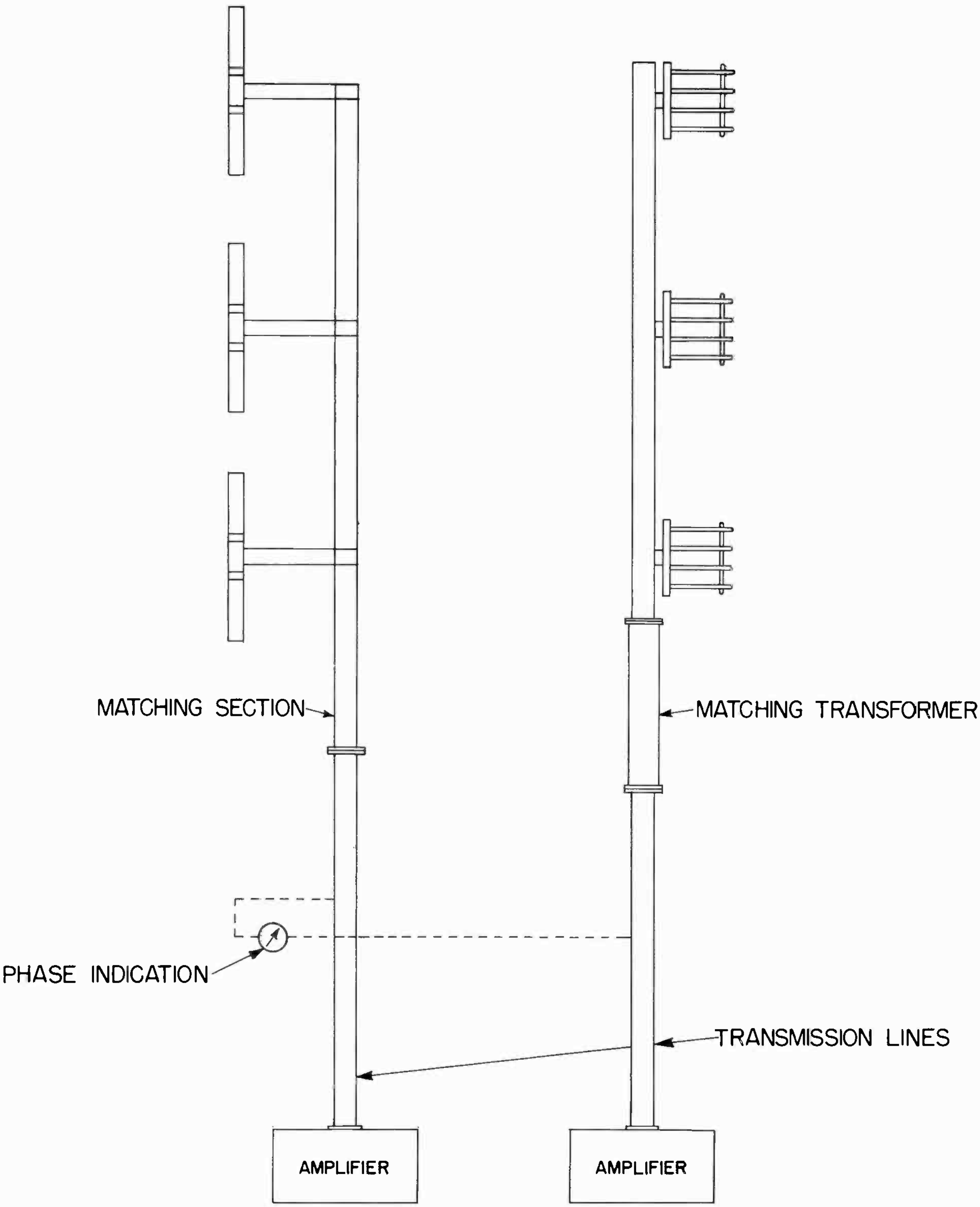


FIGURE 4

A SUGGESTED METHOD OF OBTAINING PHASE INDICATION FOR USE WITH NON-DIPLEXED AMPLIFIERS

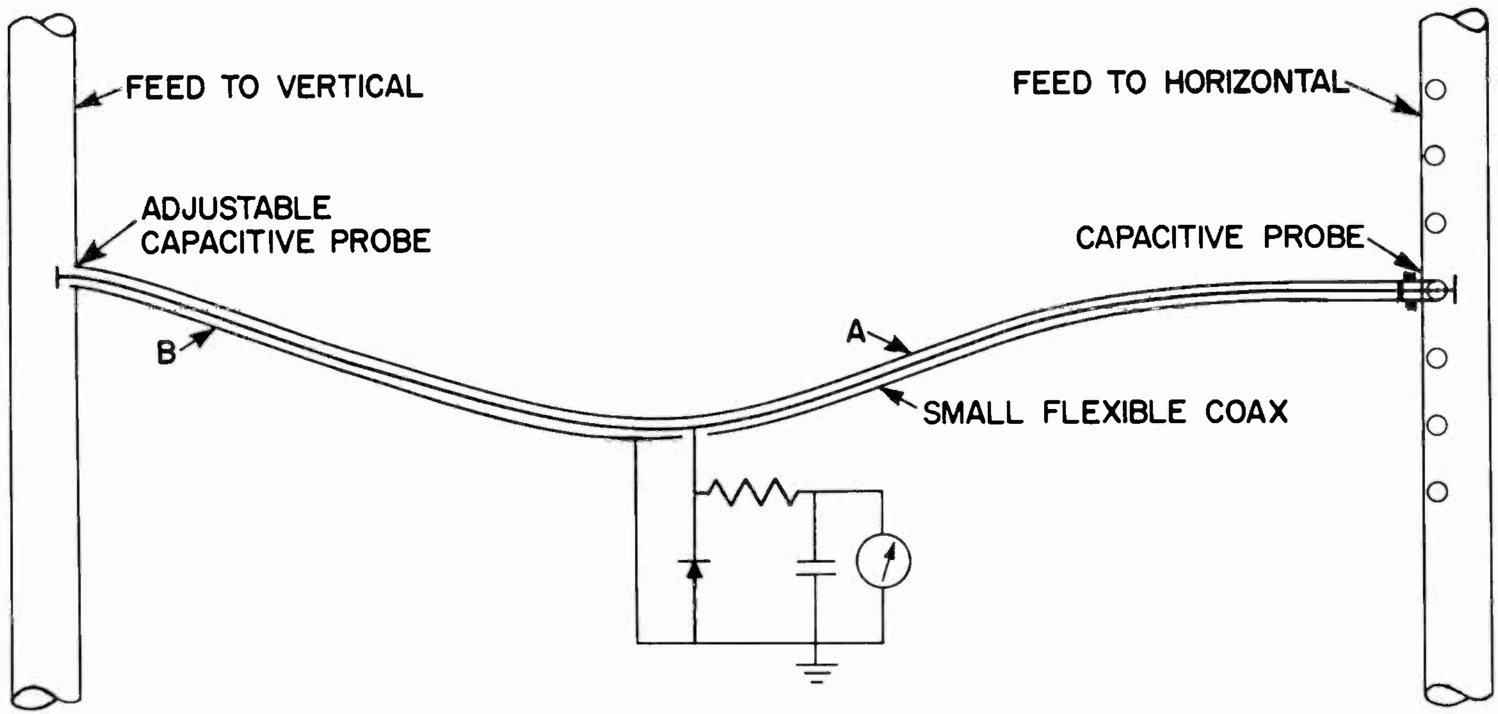


FIGURE 5

POWER DIVIDER DESIGN DETAILS

DIAMETERS V AND H DETERMINED BY FORMULA. THEY ARE CUSTOM FOR EACH UNIT. ALSO, $\lambda/4$ IS CUT FOR EXACT FREQUENCY.

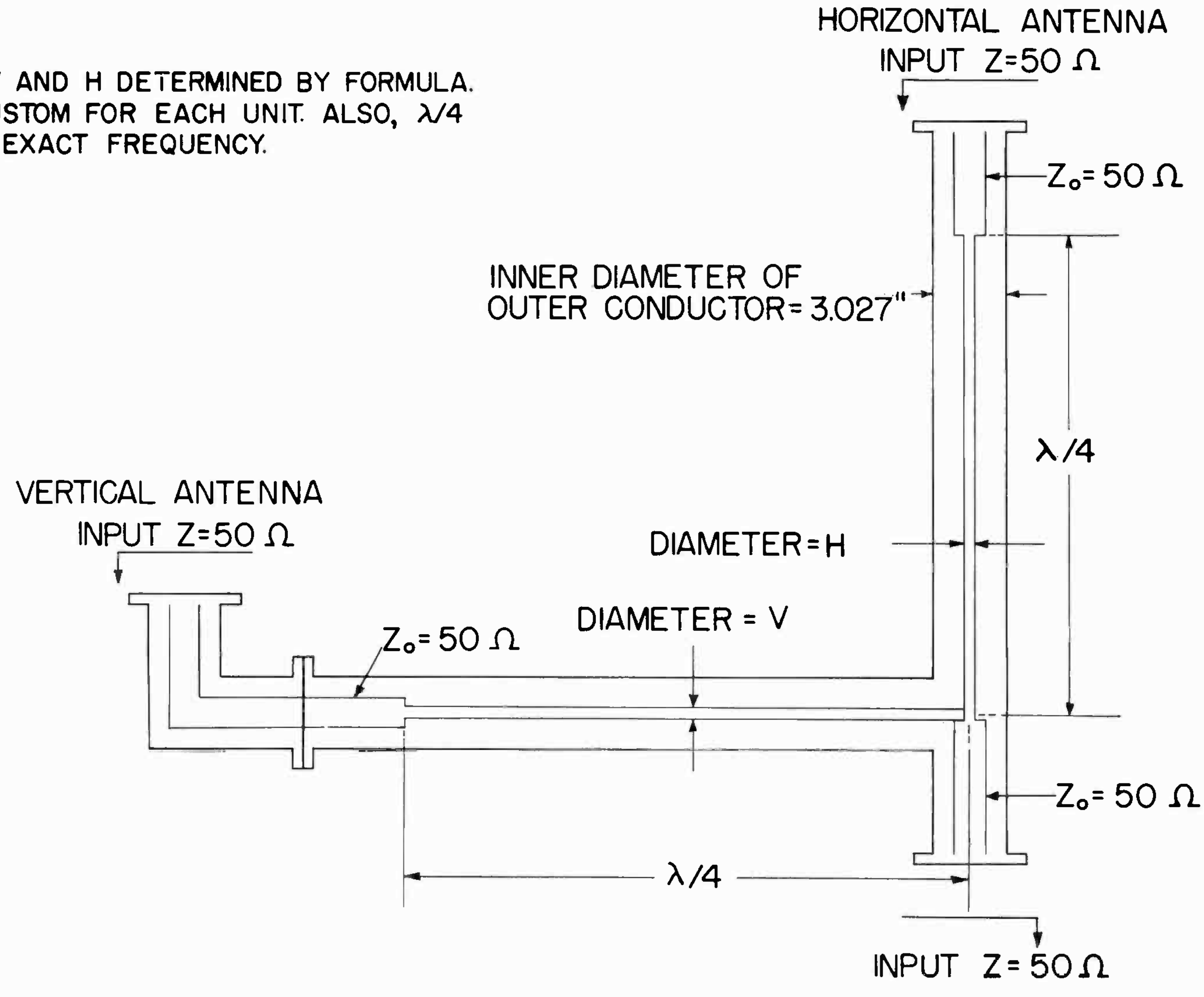


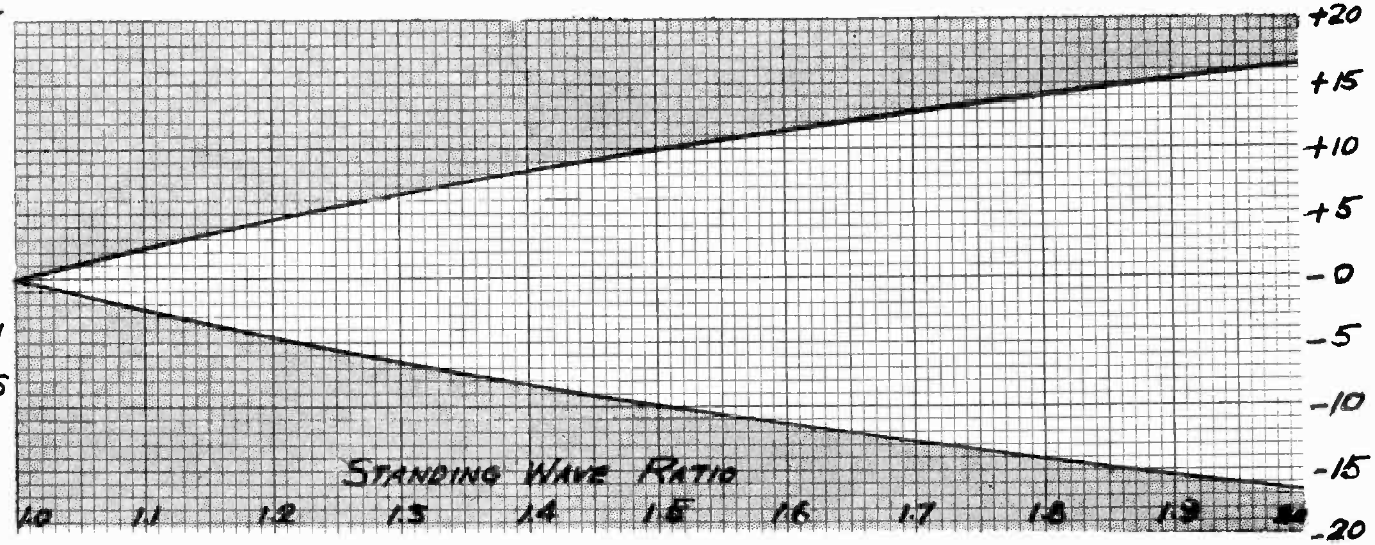
FIGURE 6

POWER DIVISION ERROR RESULTING FROM LOAD MISMATCH

ASSUMED CONDITIONS:

1- HORIZONTAL INPUT EXACTLY 50 OHMS

2- POWER DIVIDER DESIGNED FOR 50/50 DIVISION



VERTICAL POWER WILL FALL BETWEEN THESE % LIMITS	(50 / 50)	(49 / 51)	(47.7 / 52.4)	(46.5 / 53.4)	(45.3 / 54.5)	(40 / 60)	(36.3 / 63.7)	(33.3 / 66.7)
MAXIMUM % ERROR IN VERTICAL POWER	0	2	4.8	6.8	9.0	20	27.4	33.4
INPUT SWR TO VERTICAL ANTENNA	1.00 / 1.00	1.05 / 1.00	1.10 / 1.00	1.15 / 1.00	1.20 / 1.00	1.50 / 1.00	1.75 / 1.00	2.00 / 1.00

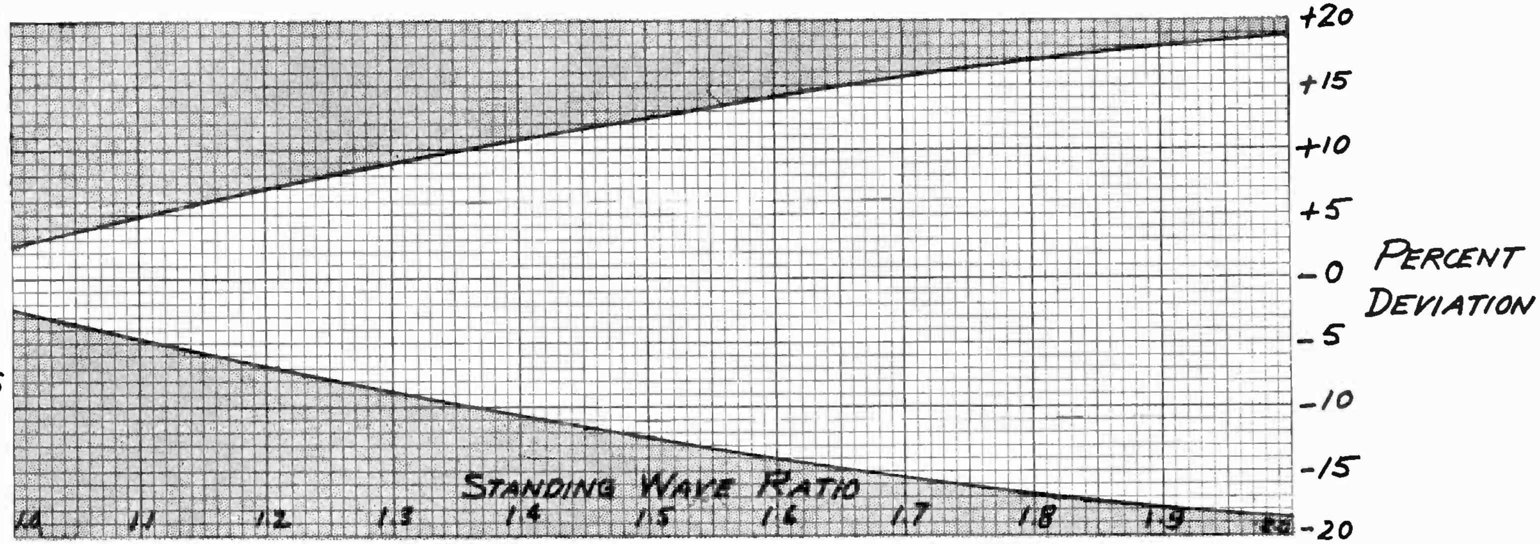
FIGURE 7

Power Division Error resulting from Load Mismatch

Assumed Conditions:

1- Horizontal Antenna Input SWR 1.1 to 1

2- Power Divider designed for 50/50 Division



Vertical Power will Fall Between these % Limits	(47.7) (52.4)	(46.3) (53.7)	(45.2) (54.8)	(44.1) (55.9)	(43.1) (56.9)	(37.7) (62.3)	(33.9) (66.1)	(31.3) (68.7)
Maximum % Error in Vertical Power	4.8	7.4	9.6	11.8	13.8	24.6	32.2	37.4
Input SWR to Vertical Antenna	1.00/1.00	1.05/1.00	1.10/1.00	1.15/1.00	1.20/1.00	1.50/1.00	1.75/1.00	2.00/1.00

FIGURE 8

POWER DIVISION ERROR RESULTING FROM LOAD MISMATCH

ASSUMED CONDITIONS:

1- HORIZONTAL ANTENNA INPUT SWR 1.2 TO 1

2- POWER DIVIDER DESIGNED FOR 50/50 DIVISION

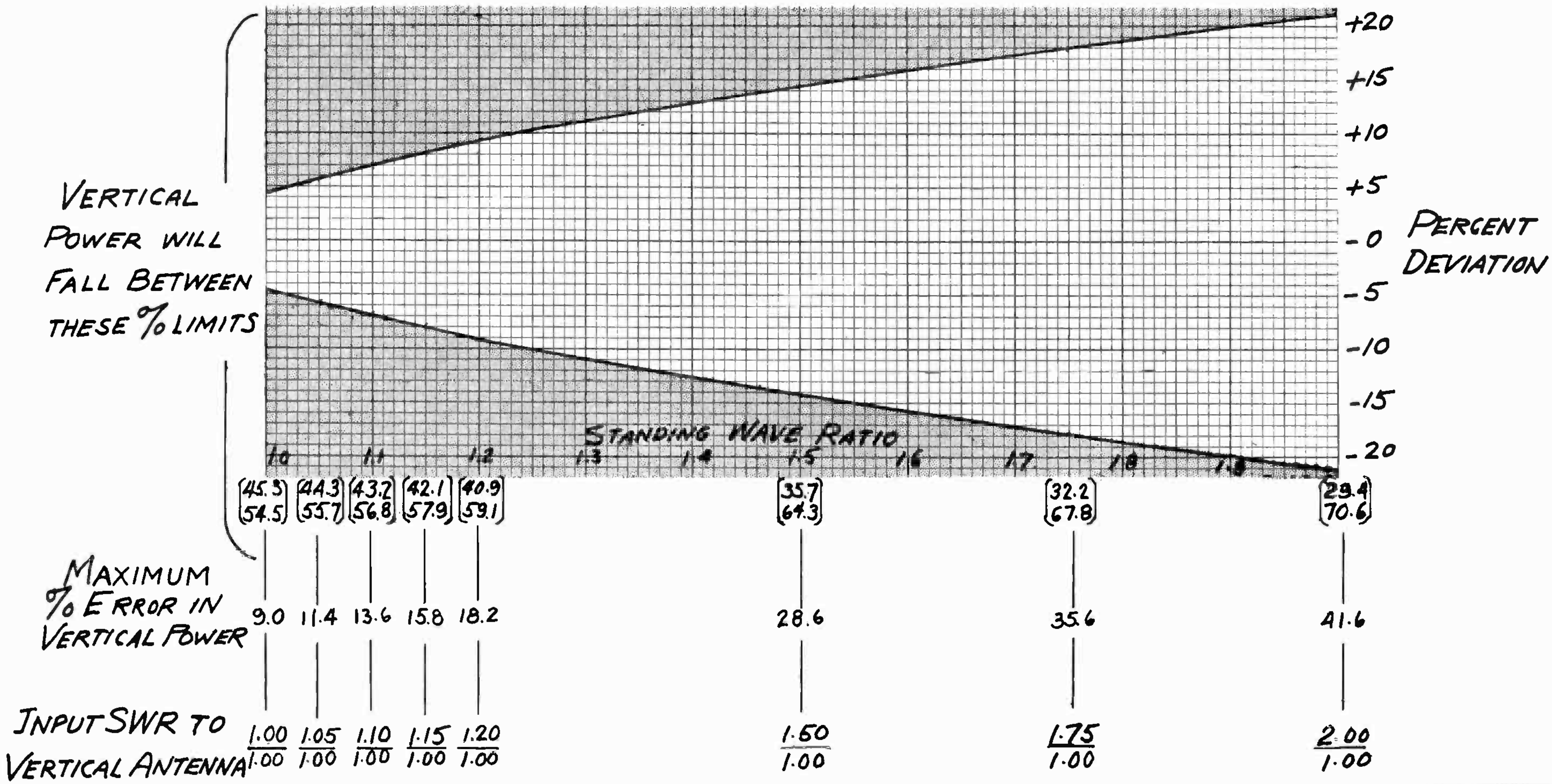


FIGURE 9

APPENDIX 1

POWER DIVIDER DESIGN

IN ORDER TO PROPERLY BUILD A POWER DIVIDER, THE FIRST PROBLEM IS TO GET ACCURATE INFORMATION ON THE EXACT DIVISION SPECIFIED BY THE CUSTOMER'S CONSULTING ENGINEER. THIS INFORMATION IS NORMALLY GIVEN TO THE SALES ENGINEER BY THE STATION'S CONSULTING ENGINEER OR MAY BE DERIVED FROM THE APPLICATION AS FILED WITH THE FCC. THIS INFORMATION IS THEN TRANSFERRED TO A POWER DIVIDER DESIGN FORM, AN EXAMPLE OF WHICH FULLY WORKED OUT IS INCLUDED HEREWITH. I BELIEVE IT WILL BE CLEAR FROM FOLLOWING THE EXAMPLE HOW THIS WAS WORKED OUT. THE END PRODUCT YIELDS A CUSTOM DIAMETER FOR AN INNER CONDUCTOR OF A MATCHING SECTION LEADING TO THE HORIZONTAL OUTPUT AND VERTICAL OUTPUT OF THE POWER DIVIDER. THE LENGTHS OF THESE SECTIONS ARE, OF COURSE, MADE A QUARTER WAVE AT THE CUSTOMER'S FREQUENCY.

POWER DIVIDER DESIGN

NAME OF APPLICANT: *Example*

CITY AND STATE: ________ CALL: ________ FREQUENCY: ________

ENGINEER'S NAME: ________ DATE: ________
(SUPPLYING INFORMATION BELOW)

REMARKS: ________

INFORMATION	SOURCE	HORIZONTAL	VERTICAL	TOTAL
ERP	FCC APPLICATION (OR CONSULTANT)	20 Kw	20 Kw	
POWER GAIN	ERI + Andrew	5.6	5,31	
REQUIRED INPUT POWER	(CALCULATED)	3.57	3.77	7.34
POWER RATIO	(CALCULATED)	0.486	0.514	1.00
CONDUCTANCE X 10^{-3}	(CALCULATED)	9,72	10.28	20,00
IMPEDANCE OHMS (RESISTIVE)	(CALCULATED)	103	97.3	50

FOR HORIZONTAL

Z_o OF MATCHING SECTIONS $\sqrt{50 \times 103} = \underline{71.9}$

$138 \log_{10} \left(\frac{3.027}{H} \right) = \underline{71.9}$

$\log_{10} \left(\frac{3.027}{H} \right) = \underline{0.521}$

$\frac{3.027}{H} = \underline{3.317} \therefore H = \underline{0.913''}$

FOR VERTICAL

$\sqrt{50 \times 97.3} = \underline{69.7}$

$138 \log_{10} \left(\frac{3.027}{V} \right) = \underline{69.7}$

$\log_{10} \left(\frac{3.027}{V} \right) = \underline{0.506}$

$\frac{3.027}{V} = \underline{3.205} \therefore V = \underline{0.945''}$

WHERE H = DIAMETER OF INNER CONDUCTOR IN QUARTER WAVE MATCHING SECTION WITHIN HORIZONTAL SECTION.

V = DIAMETER OF INNER CONDUCTOR IN QUARTER WAVE MATCHING SECTION WITHIN VERTICAL SECTION.

3-12-65

PRACTICAL EXPERIENCE DERIVED FROM DUAL POLARIZED FM ANTENNAS

1. INTRODUCTION

During the past two years a great amount of interest has been directed toward achieving more uniform coverage from FM Broadcast Stations through the use of dual polarized FM transmitting antennas. Such a dual polarized FM transmitting antenna was installed at Station WNHC-FM, in New Haven, Connecticut. The antenna feed system was modified to provide for radiation of horizontal polarization only, for radiation of vertical polarization only, or for radiation with a combination of horizontal and vertical polarization, to determine the effect, not only upon the service field created thereby, but also upon the interference potential of these fields.

2. DESCRIPTION OF EQUIPMENT EMPLOYED: TRANSMITTING

The transmitting antennas consisted of an 8-bay horizontally polarized antenna mounted on one leg of a 300 foot self-supporting tower and an 8-bay vertically polarized antenna mounted on an adjacent leg of the tower. The two antennas are separated by approximately 12 feet. The antennas are fed through a 50/50 power splitter with all the individual feed lines for each antenna originating from their own junction box. A coaxial switch was installed in the section of line between the power splitter and the vertically polarized antenna junction box so that the power being fed the vertical antenna could be switched into a dummy load. It was, therefore, possible to make field intensity measurements with only the horizontally polarized antenna excited or both the horizontally and vertically polarized antennas excited. The effective radiated power in the horizontal plane was 10 KW and in the vertical plane 9.5 KW. The gain of the vertically polarized antenna was slightly lower than the horizontally polarized antenna thus accounting for the difference in the effective radiated power. The VSWR of the system was 1.15 and remained the same for all modes of operations.

During the latter portion of the tests, the coaxial switch was moved to the section of the line between the power splitter and the horizontally polarized antenna, permitting the power normally fed into this antenna to be switched to a dummy load. By this means, it was possible to make measurements on the signals from the vertically polarized antenna alone.

3. DESCRIPTION OF EQUIPMENT EMPLOYED: RECEIVING

To assure accuracy of the measured fields from the dual polarized FM transmitting antenna, it was necessary to design a dual polarized receiving antenna that would measure the horizontal and vertical fields simultaneously. The design of this antenna consisted of a horizontal balanced dipole mounted on the bottom skirt of a coaxial vertical dipole. It was necessary to bring the coaxial cables from the dipole down through the bottom skirt of the vertical antenna to eliminate radiation from currents flowing in the coaxial sheath. Tests on this antenna indicated 37 db decoupling between the horizontal and vertical antennas. The antenna was designed and built by Shively Engineering Laboratories Inc. of Raymond, Maine.

Simultaneous horizontal and vertical fields were recorded by using two VHF Field Intensity Meters to feed two chart recorders. The antennas were raised to a height of 30 feet during all measurements. To assure a homogeneous field, measurements were recorded by making runs varying in length from 150 to 500 feet depending upon available clearances.

The service area fields were measured with the same equipment with the exception that four spot measurements were made at each location, instead of a continuous chart recording because of limited clearances in populated areas.

4. THE MEASUREMENT PROCEDURE

A. Close-in Measurements

A number of close-in (2 to 5 miles) measurements were made to determine the vertical component of the radiation from the horizontal transmitting antenna. Line-of-sight locations were chosen, which had Fresnel clearance, for these measurements. The vertically polarized component measured from 14.9 to 32.0 db below the horizontally polarized component of the field. The average of these locations showed the vertical field to be 22.2 db below the horizontal field.

A second set of measurements was made at these same measuring points with only the vertical antennas excited to determine the horizontal component of the radiation from the vertical transmitting antenna. It is interesting to note that the horizontally polarized component measured from 13.8 to 38.8 db below the vertically polarized component of the field, and the average of these locations showed the horizontal field to be 23.0 db below the vertical field.

B. Service Field Measurements

To determine the effect of the addition of the vertically polarized field to the horizontally polarized field in the service areas of WNHC-FM, a number of measurements were made in the Hartford and New Haven Areas. The Hartford Area is approximately 25 miles from the transmitting site. The transmission path is over terrain which produced varying degrees of shadowing starting with practically line-of-sight in West Hartford to moderate shadowing in East Hartford. The dual polarized antennas are mounted on the north face of the tower which is toward the City of Hartford. A grid system was laid over a city map of the Hartford Area so that most of the 49 grid points fell in the populated area shown on Map No. 1. Measurements were recorded at 29 of these grid points with the greatest concentration of measuring locations being in the downtown Hartford Area. The locations were chosen by going to the grid point and then finding a site nearest the grid point where the measuring antenna could be raised to 30 feet with sufficient clearance to move the vehicle approximately 60 feet. At each of these locations four spot measurements were recorded with the vehicle being moved about 20 feet between spots. At each location, measurements were recorded while transmitting with the horizontal and vertical antenna, the horizontal antenna only, and the vertical antenna only. The four spot measurements at each of the locations were then averaged and this data is tabulated in Table I.

Similar measurements were made in the New Haven Area, as shown on Map No. 2. The New Haven Area is approximately 9 miles from the transmitting site. Here the transmission path is over very rough terrain in that the City of New Haven is located at the base of a number of mountains which end abruptly and almost immediately before entering Long Island Sound. The terrain produced very severe shadowing in some areas, while in some parts of the City farther south, line-of-sight paths were obtained. The transmitting antennas, however, are mounted on the opposite side of the tower from the City of New Haven. A grid system with 30 grid points was used. Measurements were recorded at 20 of these grid points which fell in populated areas. The same procedure for making the measurements was followed as for the Hartford Area readings. This data appears in Table II.

5. DISCUSSION OF RESULTS

The problems sought to be resolved by the tests and measurements made upon WNHC-FM may be summarized as follows:

> Does the addition of a vertically polarized component of field, approximately equal in magnitude to the horizontally polarized component already present, result in a measurable improvement in the service provided by the FM station throughout its service area.

By plotting the Hartford Area measurements on probability paper, the following conclusions can be reached. While transmitting with horizontal polarization, the horizontal field at 50% of the locations was at least .440 millivolt per meter and increased .66 db to .475 millivolts per meter when dual polarization was transmitted. The vertical field at 50% of the locations was at least .365 millivolts per meter when vertical polarization was transmitted and increased .8 db to .400 millivolts per meter when dual polarization was transmitted.

These Hartford Area measurements show that the horizontal and vertical fields are approximately equal and change very little when the vertically polarized component is added to the horizontally polarized component.

The New Haven Area measurements tell a completely different story when plotted on probability paper. The horizontal field at 50% of the locations was at least 1.90 millivolts per meter when transmitting with horizontal polarization but increased 2.4 db to 2.43 millivolts per meter when transmitting with dual polarization. However, much to our surprise, the vertical field at 50% of the locations was at least 7.50 millivolts while transmitting with vertical polarization and this field did not change when dual polarization was transmitted. It is interesting to note that at 50% of the locations the vertical field is 9.8 db greater than the horizontal field.

After analyzing the New Haven Area measurements, several interesting observations can be made. At 90% of the locations the horizontal field improves when the dual polarized antenna is used. The vertically polarized field at 80% of the locations was higher than the horizontally polarized field when transmitting with the dual polarized antenna.

6. CONCLUSIONS

Since these observations deal with the service fields from an FM station, their time variation factor is not so important, and consequently, conclusions can be drawn on the basis of a single set of measurements. We might, therefore, conclude somewhat as follows:

A. In the absence of shadowing or diffraction effects, transmission of a vertically polarized component adds very little to the signal received on a horizontally polarized receiving antenna.

B. When receiving antennas having a substantial vertical component are employed, a correspondingly substantial improvement in over-all service can be expected.

C. The vertical component appears to have substantial value for users of automobile FM radios and portable FM receivers.

D. In the presence of shadowing or diffraction effects, spots which have very low signal strength when horizontal polarization alone is transmitted, tend to find a substantial improvement in the horizontally polarized component of the field in such shadowed areas.

TABLE I

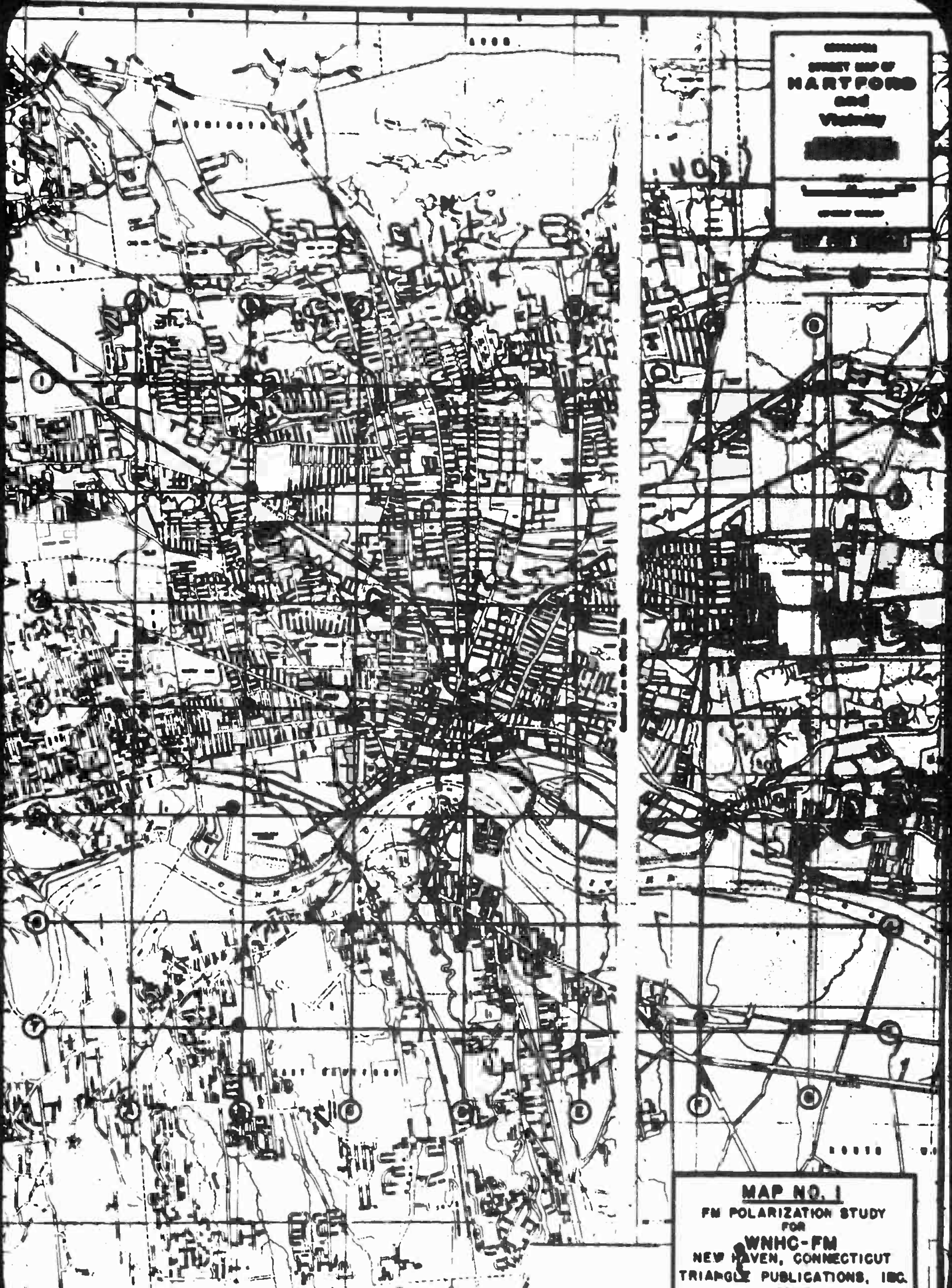
Hartford Area Measurements

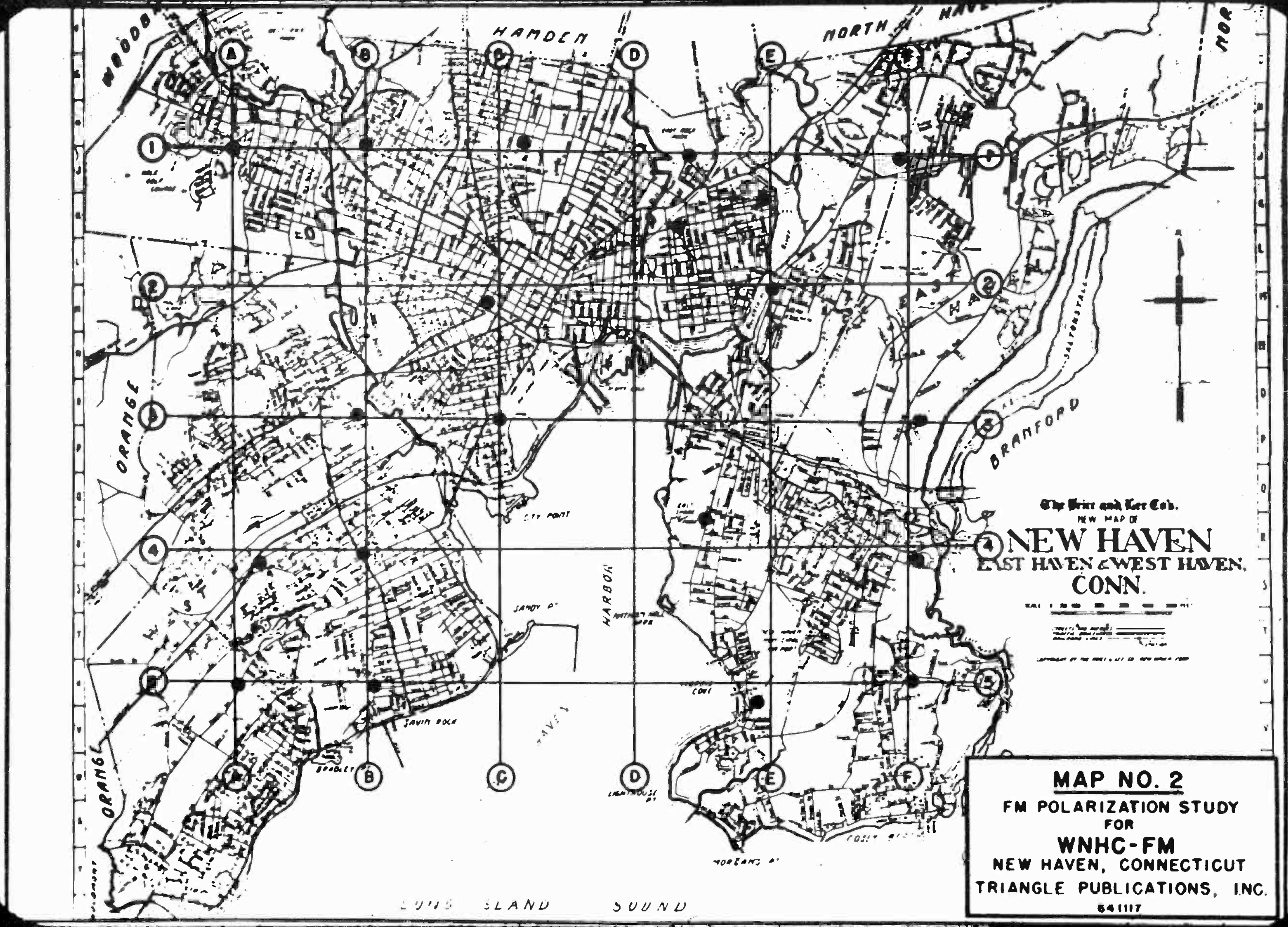
Point No.	DUAL ANTENNA Horizontal Field (mv/m)	DUAL ANTENNA Vertical Field (mv/m)	HORIZ. ANTENNA Horizontal Field (mv/m)	HORIZ. ANTENNA Vertical Field (mv/m)	VERT. ANTENNA Horizontal Field (mv/m)	VERT. ANTENNA Vertical Field (mv/m)
A1	.360	.720	.330	.095	.079	.740
B1	.960	.995	.935	.140	.290	1.100
D1	.260	.245	.235	.038	.032	.235
F1	.370	.190	.280	.034	.070	.210
G1	.730	.360	.650	.090	.086	.340
B2	.580	.370	.510	.060	.130	.300
E2	.750	.890	.780	.190	.280	.770
A3	.280	.190	.240	.040	.064	.110
B3	.250	.240	.220	.050	.090	.180
C3	.960	.720	.900	.140	.130	.455
D3	.260	.089	.170	.038	.090	.120
E3	.740	.530	.670	.112	.180	.490
G3	.295	.215	.240	.029	.070	.250
A4	.560	.420	.560	.104	.057	.340
B4	.120	.160	.138	.036	.044	.120
C4	.160	.130	.150	.026	.032	.100
D4	.210	.190	.190	.022	.064	.160
E4	.500	.400	.490	.120	.150	.330
G4	.745	.320	.650	.093	.120	.230
A5	.350	.300	.300	.078	.045	.180
B5	.490	.590	.480	.080	.083	.525
F5	.360	.335	.330	.073	.045	.298
G5	.395	.420	.350	.047	.110	.370
C6	.350	.610	.370	.057	.095	.570
D6	.430	.390	.400	.065	.080	.355
A7	1.640	1.100	1.630	.050	.140	1.240
B7	.820	.510	.850	.150	.093	.360
F7	.380	.400	.420	.065	.100	.340
G7	.200	.205	.180	.018	.056	.210

TABLE II

New Haven Area Measurements

Point No.	DUAL ANTENNA Horizontal Field (mv/m)	DUAL ANTENNA Vertical Field (mv/m)	HORIZ. ANTENNA Horizontal Field (mv/m)	HORIZ. ANTENNA Vertical Field (mv/m)	VERT. ANTENNA Horizontal Field (mv/m)	VERT. ANTENNA Vertical Field (mv/m)
A1	1.950	3.100	2.500	0.210	1.360	2.900
B1	3.100	5.250	2.375	0.420	1.160	5.200
C1	2.650	10.900	1.900	0.450	1.310	8.400
D1	0.960	0.890	0.415	0.110	0.810	1.230
E1	6.600	20.250	6.100	0.460	5.600	20.750
F1	1.600	6.180	0.865	0.103	1.500	6.230
C2	3.100	11.300	1.640	0.320	2.180	10.750
D2	1.250	3.500	0.680	0.135	0.790	4.500
E2	2.560	8.750	1.425	0.265	1.850	10.200
B3	4.450	6.600	4.300	0.480	1.880	10.100
C3	1.650	4.480	0.850	0.131	0.990	5.730
F3	1.100	5.100	0.280	0.056	1.000	5.650
A4	1.950	1.950	1.900	0.150	0.360	2.350
B4	1.100	4.330	0.805	0.110	0.695	4.880
E4	6.150	13.500	5.500	0.580	0.800	15.100
F4	2.080	5.300	0.640	0.070	1.650	5.620
A5	6.430	4.280	4.850	0.370	1.230	3.730
B5	4.180	4.150	1.100	0.080	2.350	4.130
E5	1.060	7.930	1.710	0.130	0.980	7.930
F5	2.100	15.480	1.450	0.115	2.200	17.150


HARTFORD
MAP NO. 1
FM POLARIZATION STUDY
FOR
WNHC-FM
NEW HAVEN, CONNECTICUT
TRIANGLE PUBLICATIONS, INC.



The Price and Lee Co.
NEW MAP OF
NEW HAVEN
EAST HAVEN & WEST HAVEN,
CONN.
HAMDEN
NORTH HAVEN
ORANGE
BRANFORD
HARBOR
CITY POINT
SANDY PT
SAVIN ROCK
MORGANS PT
LONG ISLAND SOUND
MAP NO. 2
FM POLARIZATION STUDY
FOR
WNHC-FM
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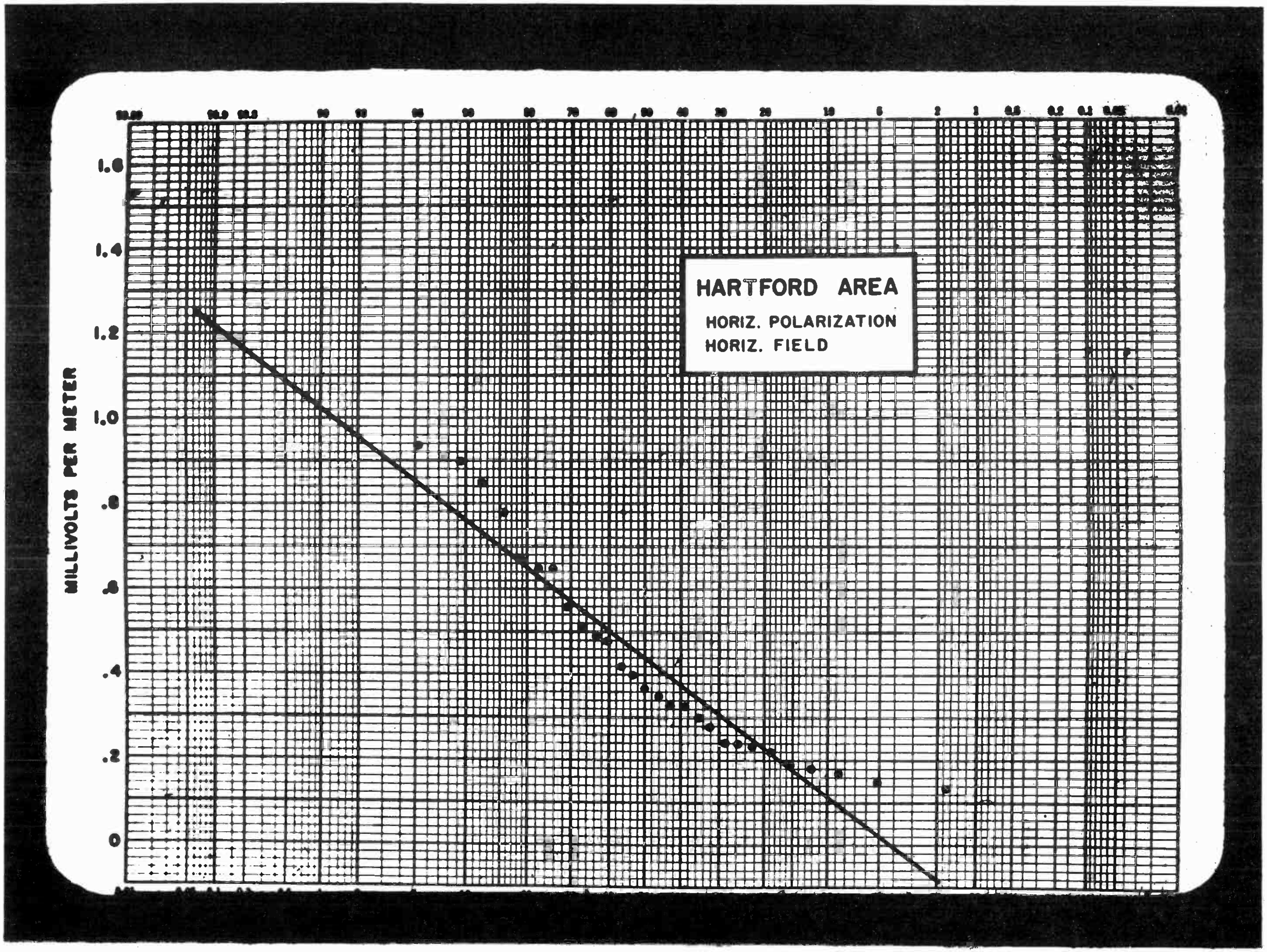
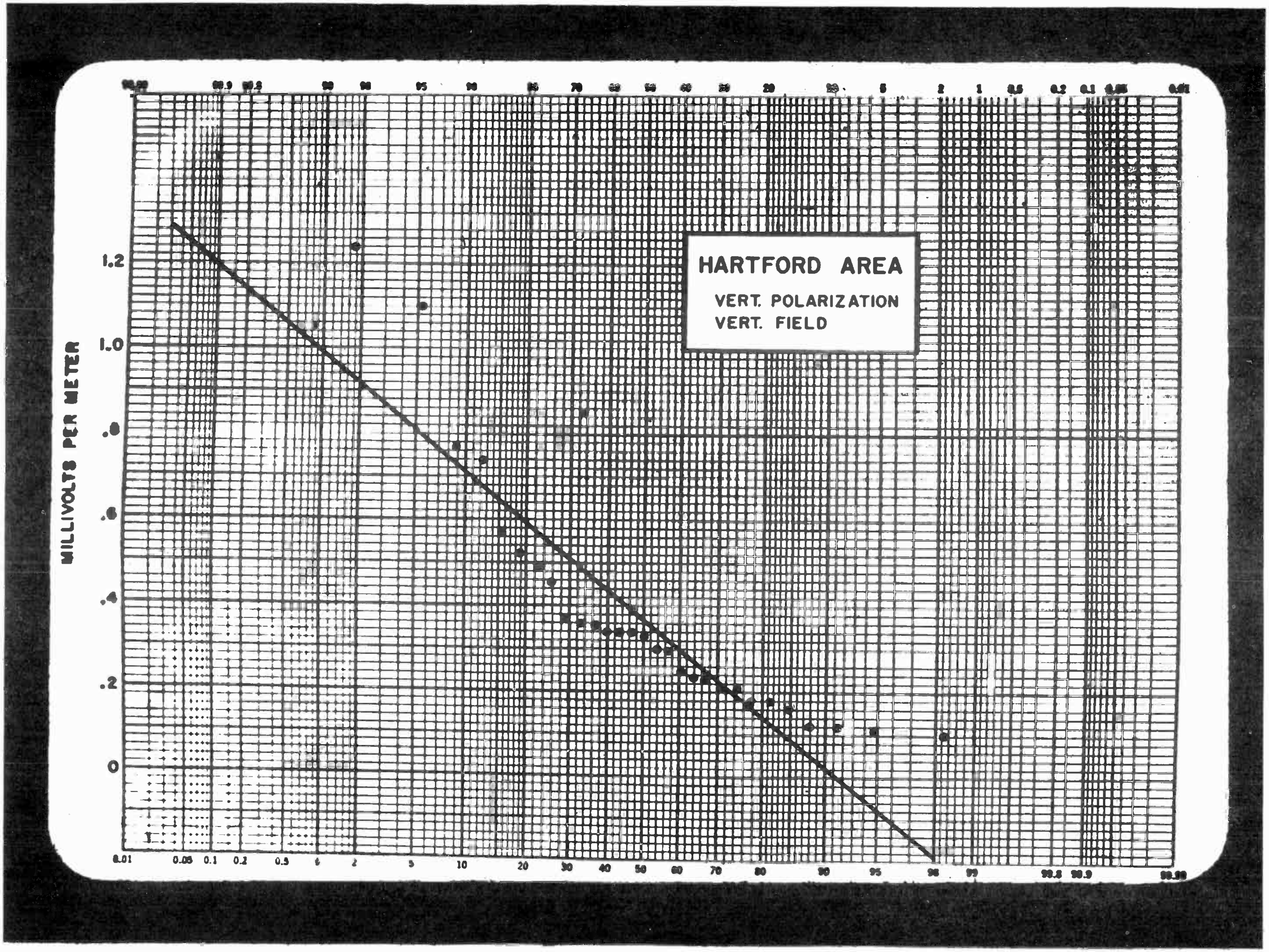

HARTFORD AREA
HORIZ. POLARIZATION
HORIZ. FIELD
MILLIVOLTS PER METER
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1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VERT. POLARIZATION
VERT. FIELD
MILLIVOLTS PER METER
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1.0
.8
.6
.4
.2
0
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
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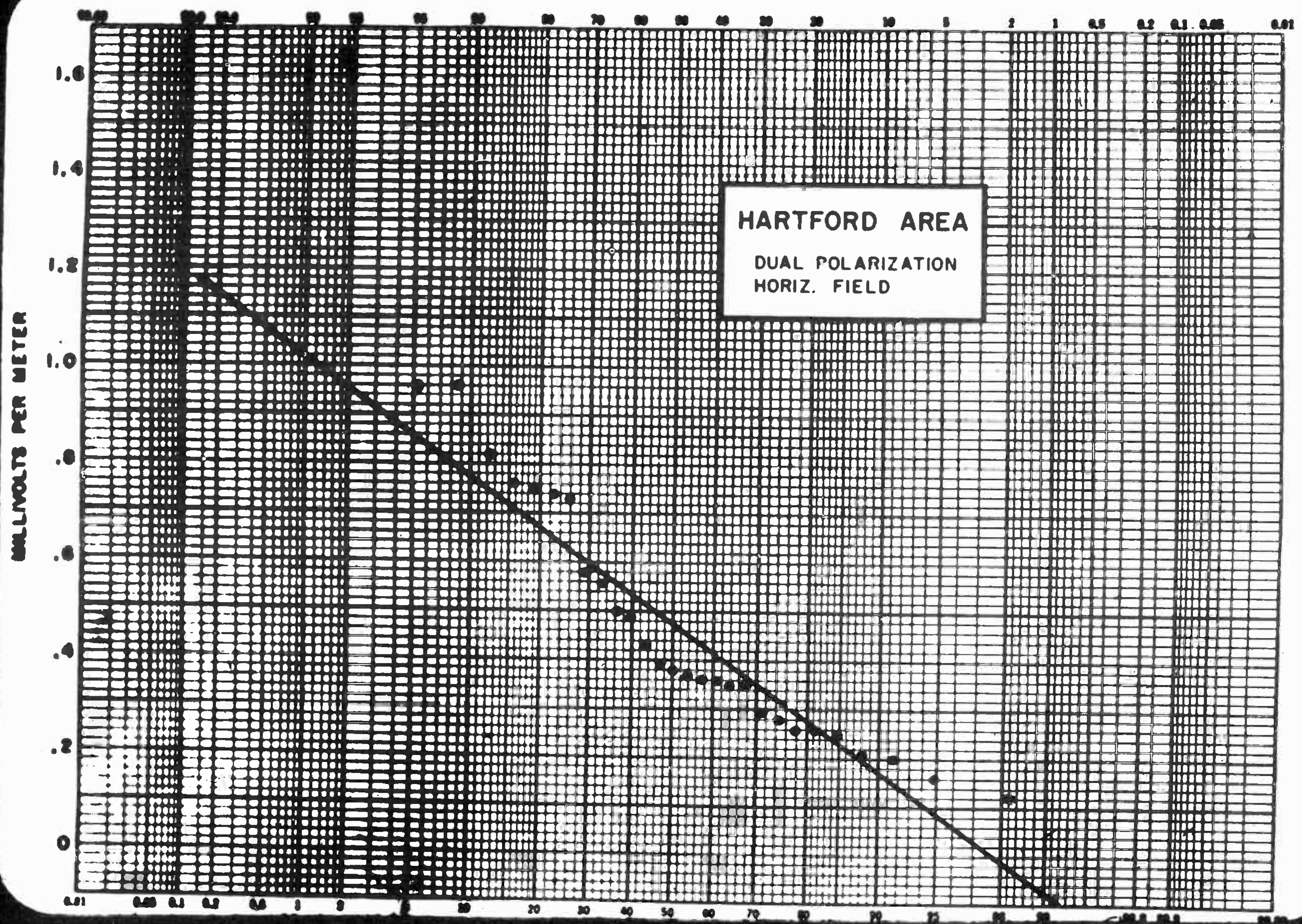
60
70
80
90
95
98
99
99.8
99.9
99.99


HARTFORD AREA
DUAL POLARIZATION
HORIZ. FIELD
MILLIVOLTS PER METER
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1.4
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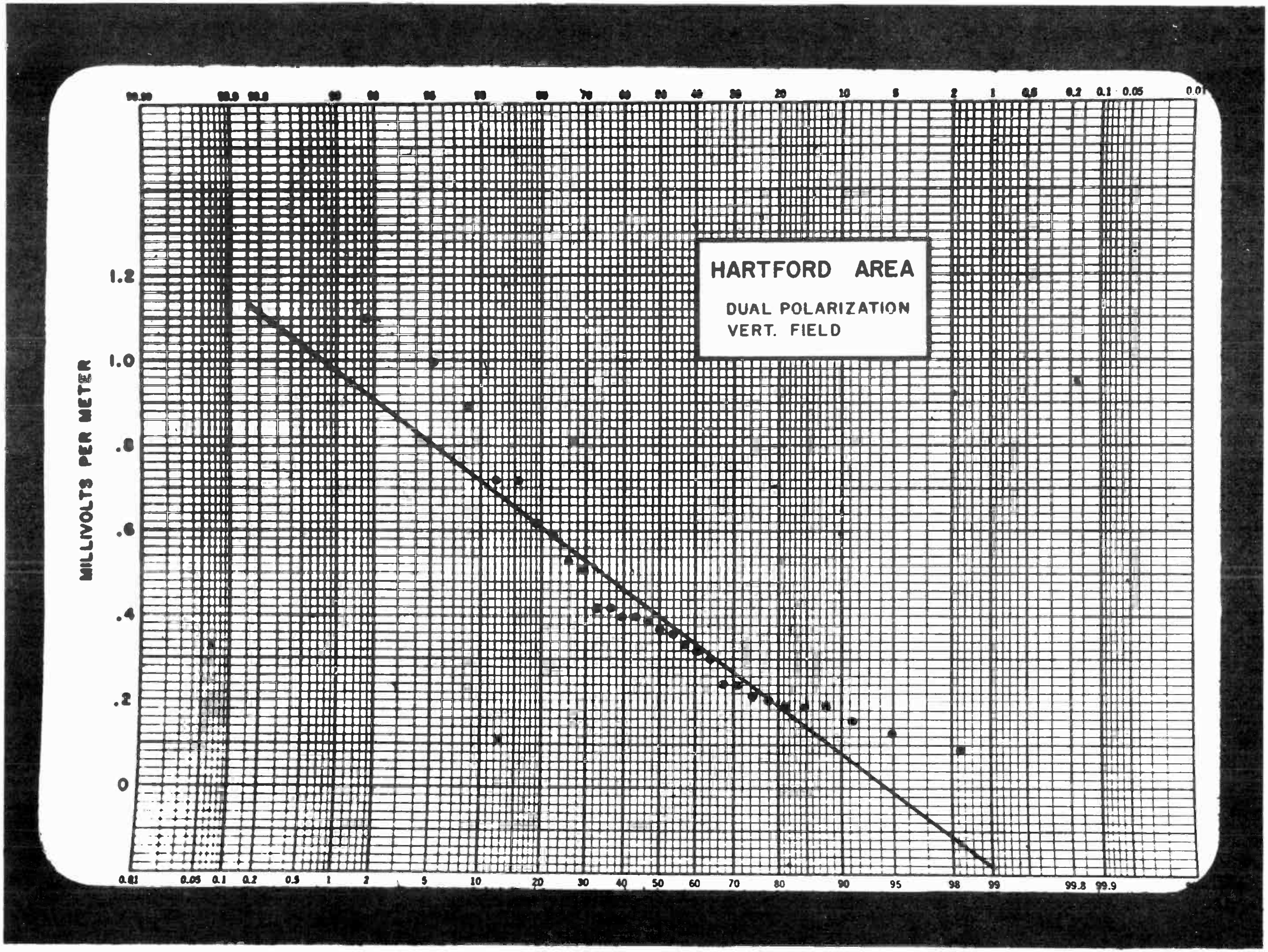
.2
0


HARTFORD AREA
DUAL POLARIZATION
VERT. FIELD
MILLIVOLTS PER METER
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1.0
.8
.6
.4
.2
0
0.01
0.05
0.1
0.2
0.5
1
2
5
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80
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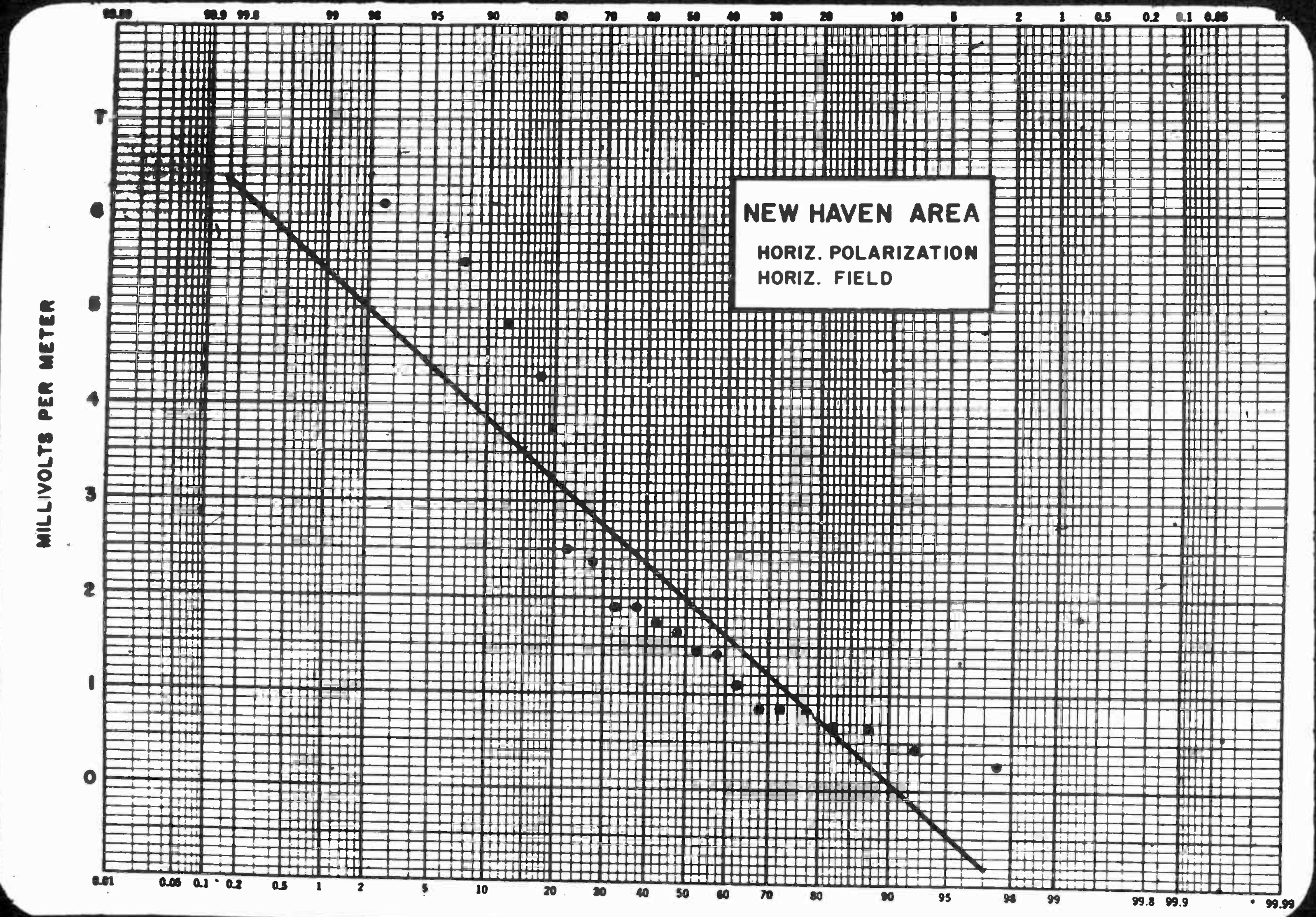
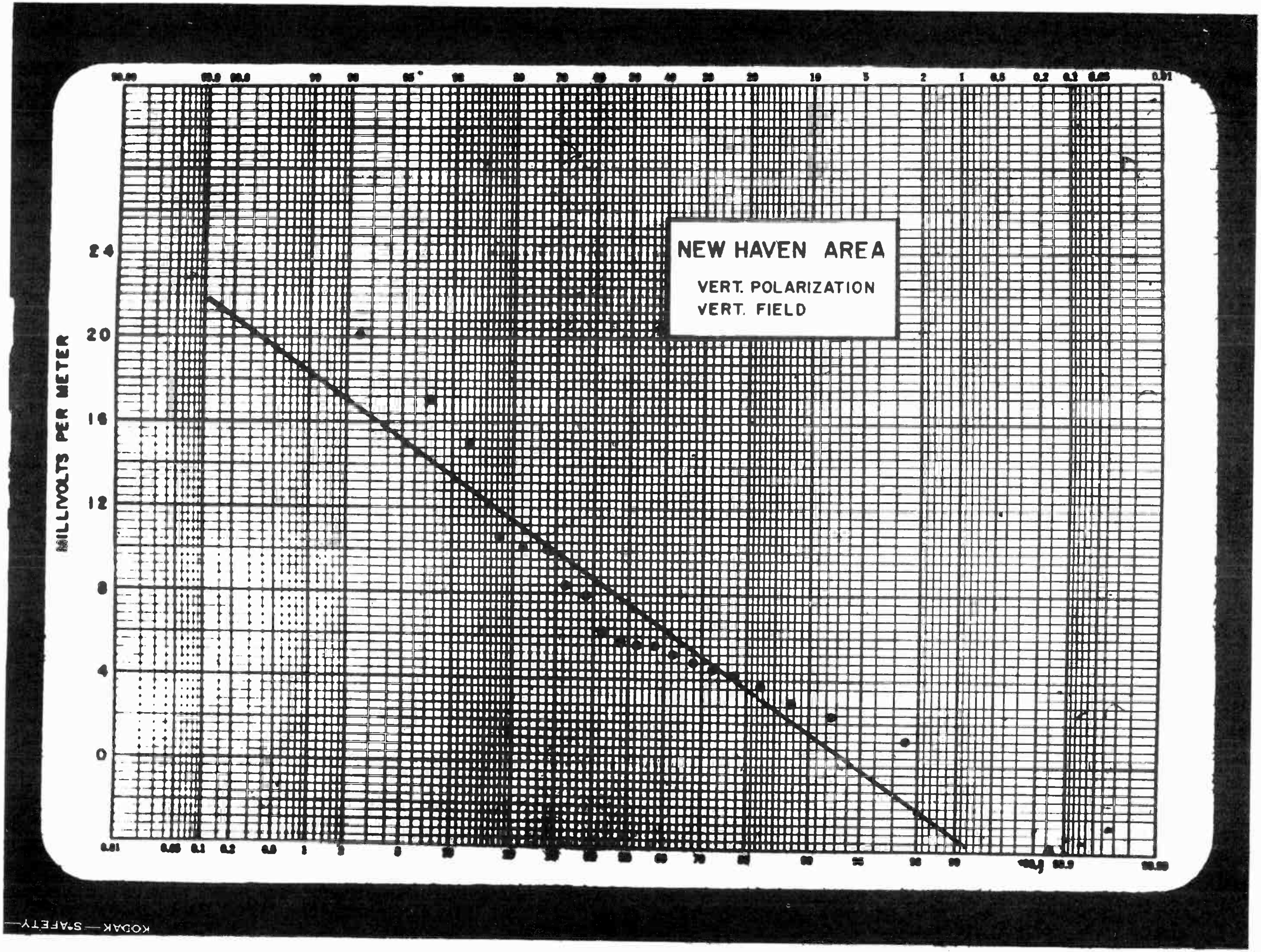
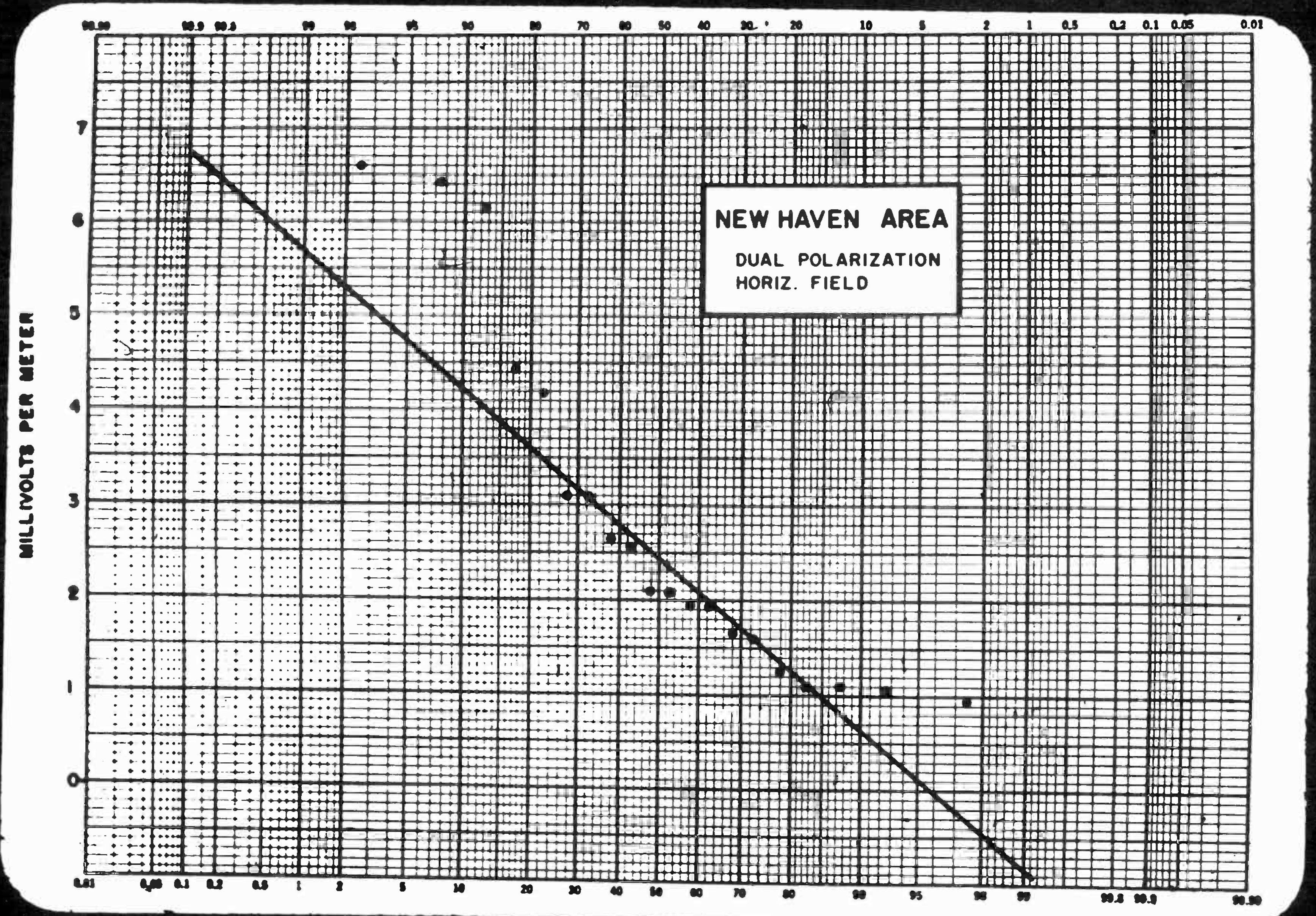
95
98
99
99.8
99.9


NEW HAVEN AREA
HORIZ. POLARIZATION
HORIZ. FIELD
MILLIVOLTS PER METER


NEW HAVEN AREA
VERT. POLARIZATION
VERT. FIELD
MILLIVOLTS PER METER
24
20
16
12
8
4
0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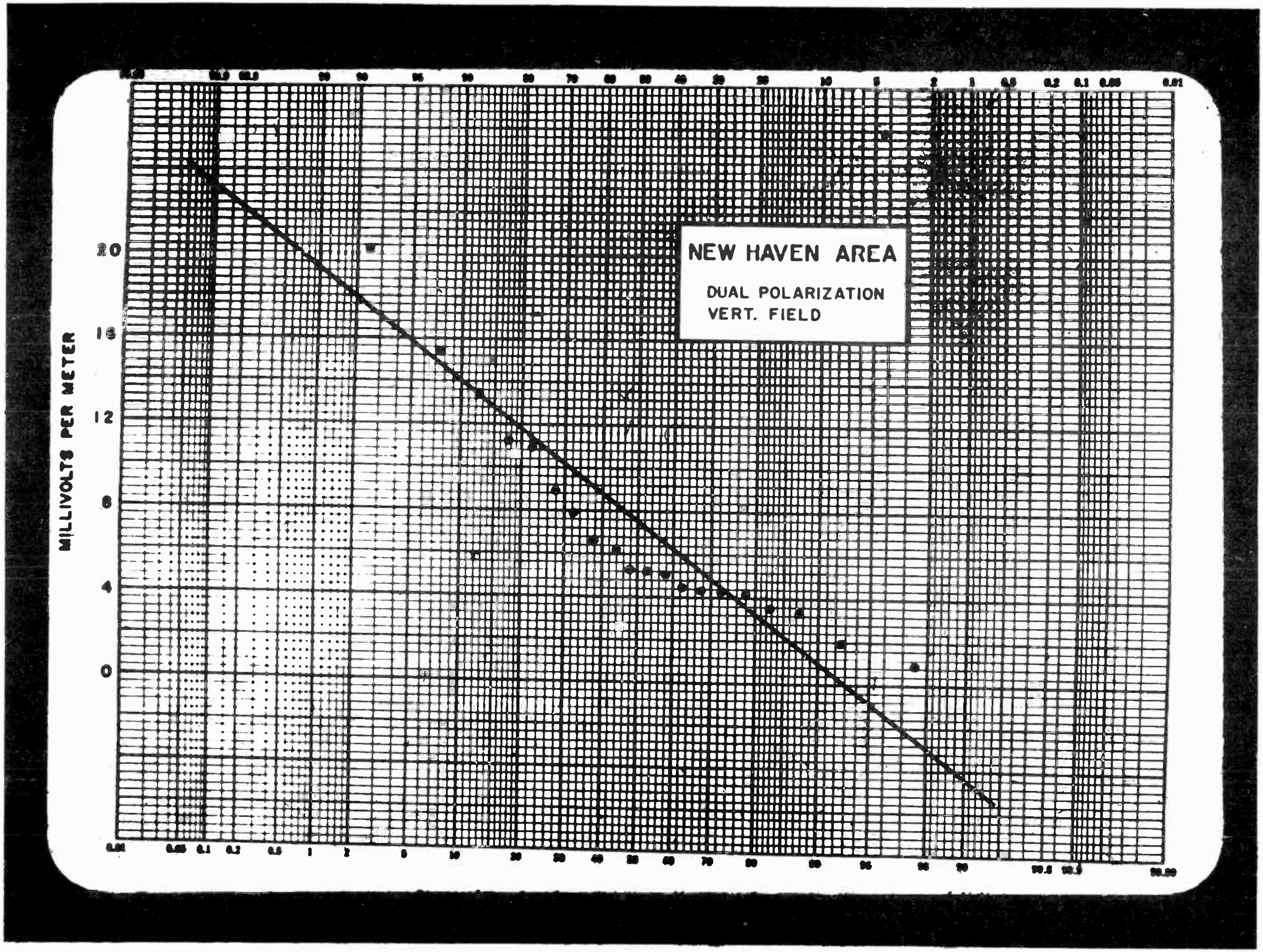
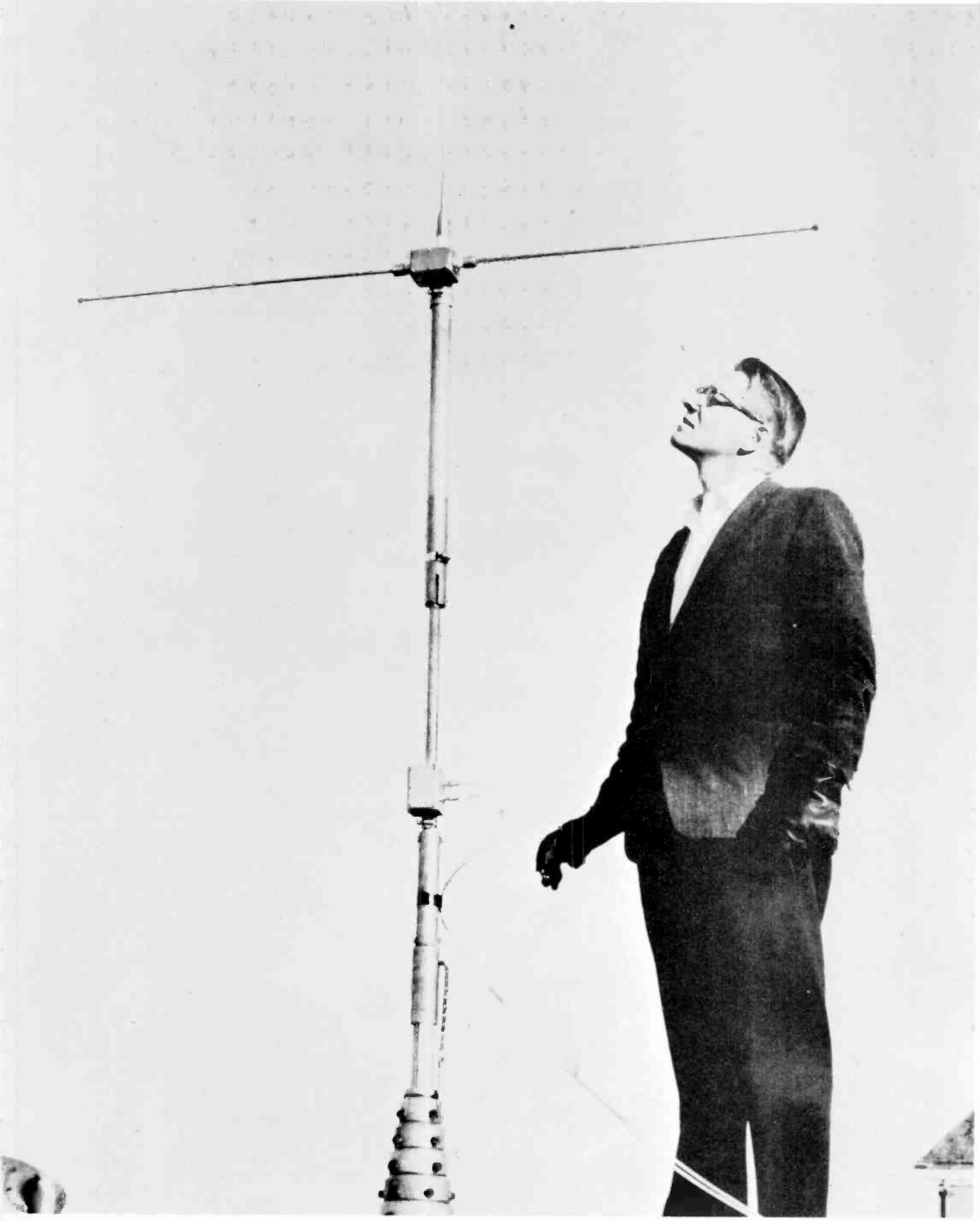
HORIZ. FIELD
MILLIVOLTS PER METER


NEW HAVEN AREA
DUAL POLARIZATION
VERT. FIELD
MILLIVOLTS PER METER
20
16
12
8
4
0



STEREOPHONIC TRANSMISSIONS VIA
RELAY II SATELLITE

Carl R. Rollert

COLLINS RADIO COMPANY

DALLAS, TEXAS

I. It is the hope of the U. S. delegation to the current meeting of Study Group X of the CCIR that the U. S. stereo standards will be adopted internationally. At this very time they are in session in Vienna and this is one thing on the agenda. There are two systems being considered, the U. S. "Pilot-tone" and the Russian "Polar Modulation".

This paper concerns a project initiated to demonstrate the feasibility of long path transmission of the U. S. system. A good way to obtain such a path and be able to have the same personnel be at the transmitting and receiving ends at the same time is to use a satellite capable of relaying the stereo composite signal. The satellite Relay II was determined to best fit the requirement and arrangements were made by Harold Kassens of the FCC and Joe Peters of NASA to use two passes of Relay II, one each on February 2 and February 3 of this year. The tracking station where we did the work was the NASA Relay site in the Mojave desert some 50 miles from Barstow, California. The results were up to our expectations and, we feel, proved our contentions regarding the U. S. system.

II. Figure 1 is a block diagram showing the equipments used. Those in red are the NASA supplied equipments.

The test tones and test program were played back from tape through the Collins 786M-1 Stereo Generator where the wide band composite signal was generated, then run through a Collins 27E-7 amplifier/modulator. This unit was simply used as an impedance "changer", if you will, to go from the 786M-1 output at 600 ohms to the 72 ohms needed to feed the transmitter.

This slide shows the antenna used to receive the signal from the beacon transmitter aboard Relay II. This signal was received several minutes before capture could be achieved by the big dish. The equipment is turned on from the ground when proper time comes. The battery condition is telemetered to the ground control and when discharged to a certain point the equipment is turned off, even if the experiment is not complete.

The 10 kw transmitter operating on 1725 mc was fed into this 60 foot dish. The ERP of the transmit system was just over 150 megawatts with a .3 degree beam angle. Relay II receives the signal and without demodulating changes the frequency to 4170 mc, triples the deviation and retransmits at a power level of 10 watts. This is in turn captured by the same 60 foot dish with a receive gain of 51 db and is fed to a parametric amplifier, then to the receiver. The input signal level is in the order of magnitude of -95 DBM. Later I will show a plot of the actual received levels.

The maximum deviation transmitted on 1725 mc is 4.19 mc peak to peak. Since the satellite triples the deviation, the received deviation is 12.57 mc peak to peak maximum. We operated somewhat under this to keep the peak distortion at a minimum. However, assuming one-half deviation, we had a deviation ratio of over fifty to one.

The output of the receiver was fed into the stereo demodulating circuitry of the Collins 900C-1 stereo monitor and then recorded on an Ampex 351 recorder.

III. Since the amount of time the satellite is available on each pass is in the order of 30 minutes, a simulator was made available for set up and check out of the system. The satellite simulator is located on a tower 11,000 feet away from the transmitter site, and is adjusted so that system levels are for all intent the same as when relaying through Relay II.

We had indicated to NASA we would need a system bandwidth in excess of 150 kc and the first trial was made with the narrow band modulator and demodulator which have a 300 kc pass band. Figure 2 shows the results. About here we were about to pack up and go home. However, we did decide to try the wide band equipments. We had been reluctant to use the wide band modulator (12 mc bandwidth) because it was felt the S/N ratio to the relatively narrow band signal would be unsatisfactory. However, after the poor results obtained with the narrow unit we had little to lose by giving it a try. The noise measured -48 db which was adequate, so we proceeded with the separation check. Figure 3 shows the results. You will note at the low end the degradation, which is attributed to the relay system phase and audio frequency response problems, at frequencies below 200 cps.

Above 200 cps we were able to maintain separations in excess of the required 29.7 db. If a system had been used that was phase linear within 3 degrees and flat within .5 db throughout the frequency range we are certain the results would show the path length doesn't enter into the problem.

With the above results from the simulator we were confident that the results obtained through the satellite would be satisfactory.

As you can see from Figure 4, our assumptions were correct. Path length had no measurable effect. The distance at the start of the experiment was 6300 miles or a total path of 12,600 miles and at the conclusion the path length was 8200 miles. Still deficient at the low end and good above 200 cycles. The transmitter/receiver frequency response part of the system is plotted in Figure 4 to explain the low end separation readings. The phase linearity can be assumed to deteriorate due to steep slope of audio response. The signal as fed into the system from the 27E-7 amplifier was measured and plotted here in Figure 5 with the same frequencies after going to the satellite and back.

Of additional interest, I believe, is the plot in Figure 6 of the S/N ratio during the run. The readings were taken with the tape recorder still running with the nonmagnetic leader passing over the pickup head. They were taken at the times indicated during the pass on February 2.

Plotted also in Figure 6 is a typical signal strength versus time curve. The actual start time was 1455 GMT and the time at end of the plot was 1535. It will be noted the S/N curve shows little correlation to the signal strength variations we encountered. To those of us not normally working with transmitting and receiving equipment of this type, the performance of the circuit was fantastic. 12,000 miles in two hops with an increase of noise level of 3 db seemed unbelievable.

Now I want to play 5 minutes or so of a tape as received back from Relay II and recorded from the pass on February 3. Copies of this tape are being send by NASA to all stations broadcasting FM stereo for their use if they so desire.

Acknowledgements

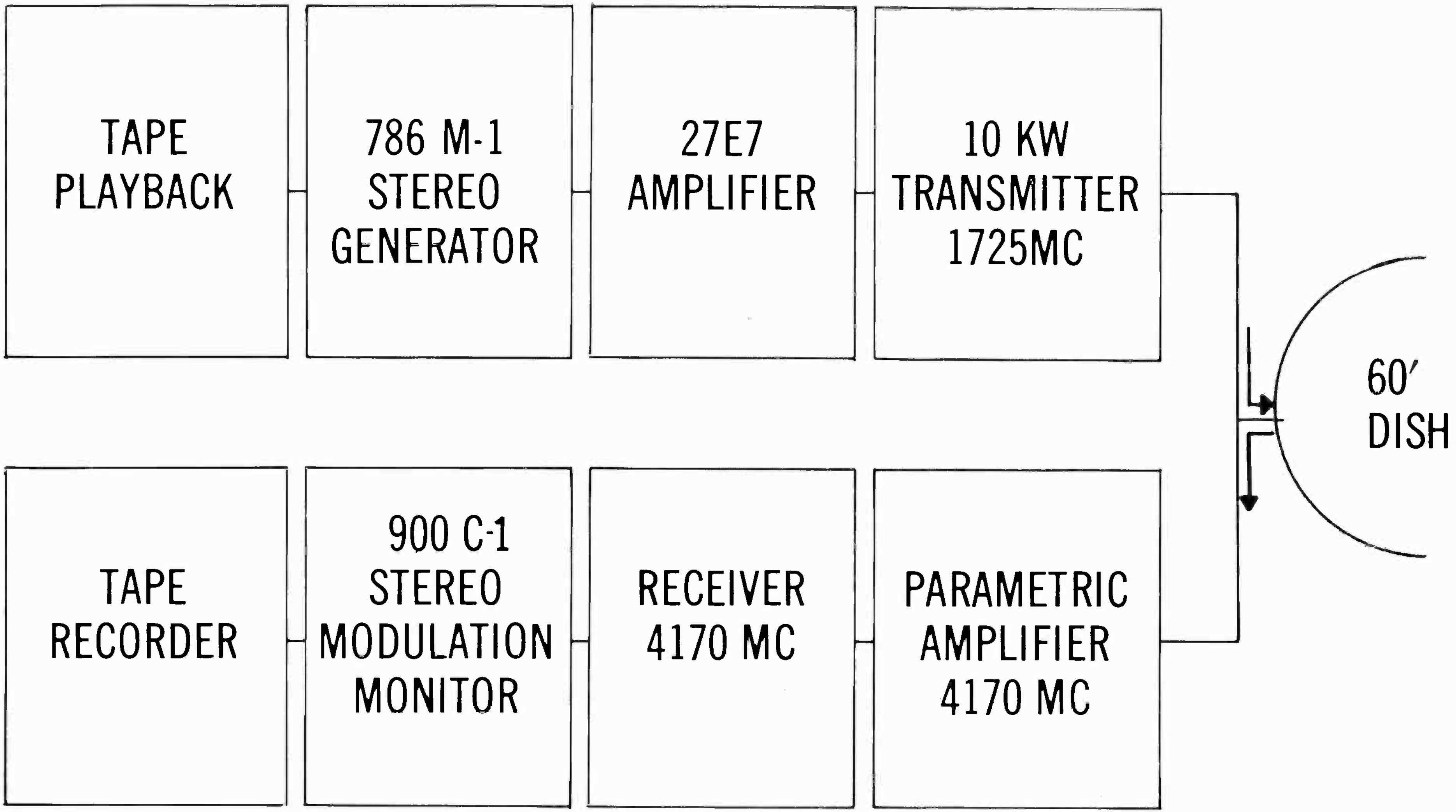
I want to gratefully acknowledge the assistance of NASA personnel both in Washington and at the tracking site. The group in California was under the direction of Jim Crane and Deputy Director was Richard Coan. The project was coordinated by Joe Peters of NASA and Harold Kassens of the FCC.

We were fortunate in having Everett Gilbert of Collins Field Service to assemble the equipment and get the system to operate in so satisfactory a manner.

Schafer Electronics in the person of Paul Schafer supplied and operated the recording equipment. Paul also made up the program tape which you just heard a part of after relay.

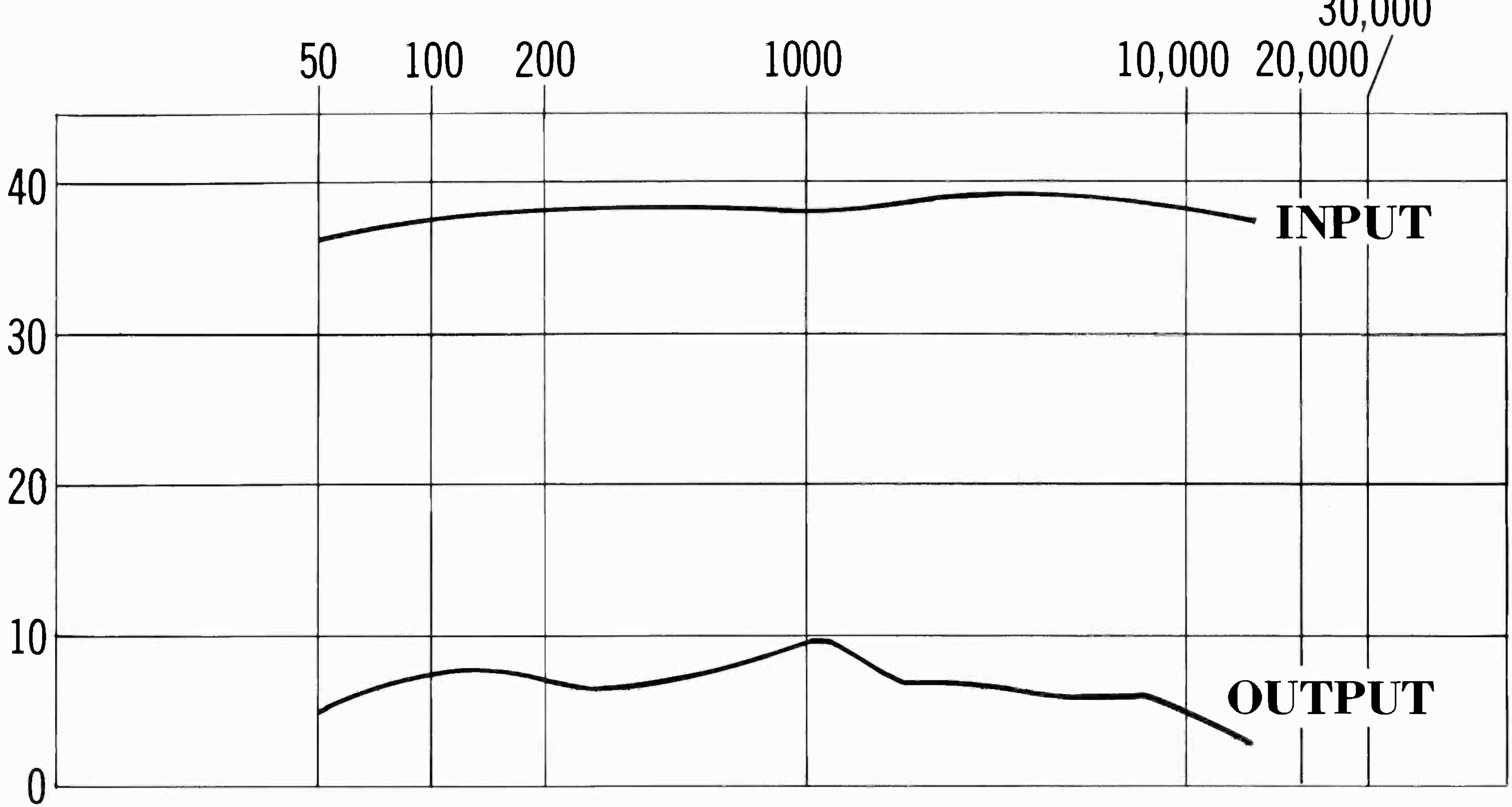
We want to thank Ampex Corporation for the use of the playback machine in use here.

Do we have time for questions, if any?



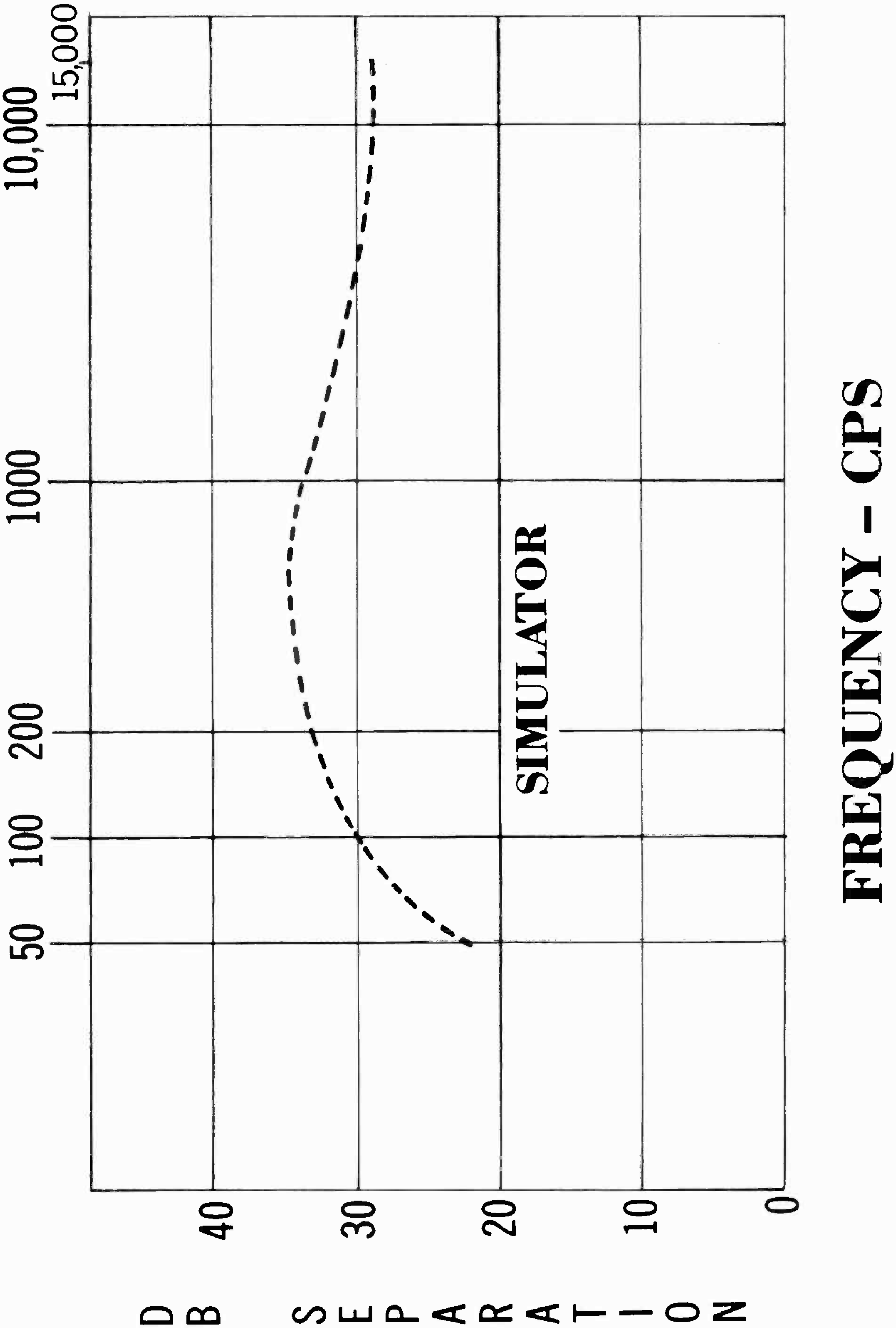
BLOCK DIAGRAM EQUIPMENT

Figure 1



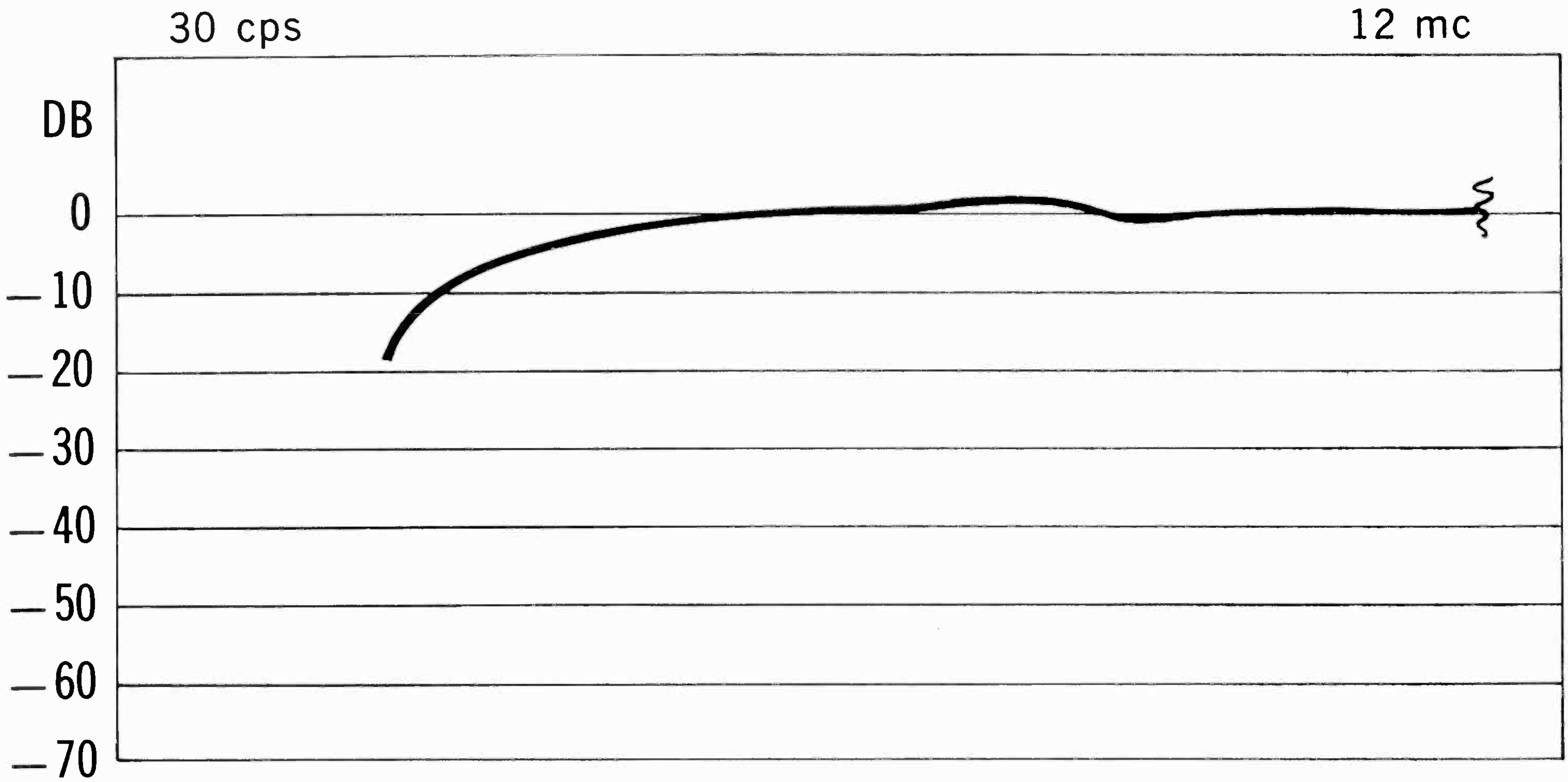
NARROW BAND SEPARATION

Figure 2



FREQUENCY - CPS
50
100
200
1000
10,000
15,000
SIMULATOR
DB SEPARATION
0
10
20
30
40

Figure 3



TX/RX FREQUENCY RESPONSE WIDE BAND

Figure 4

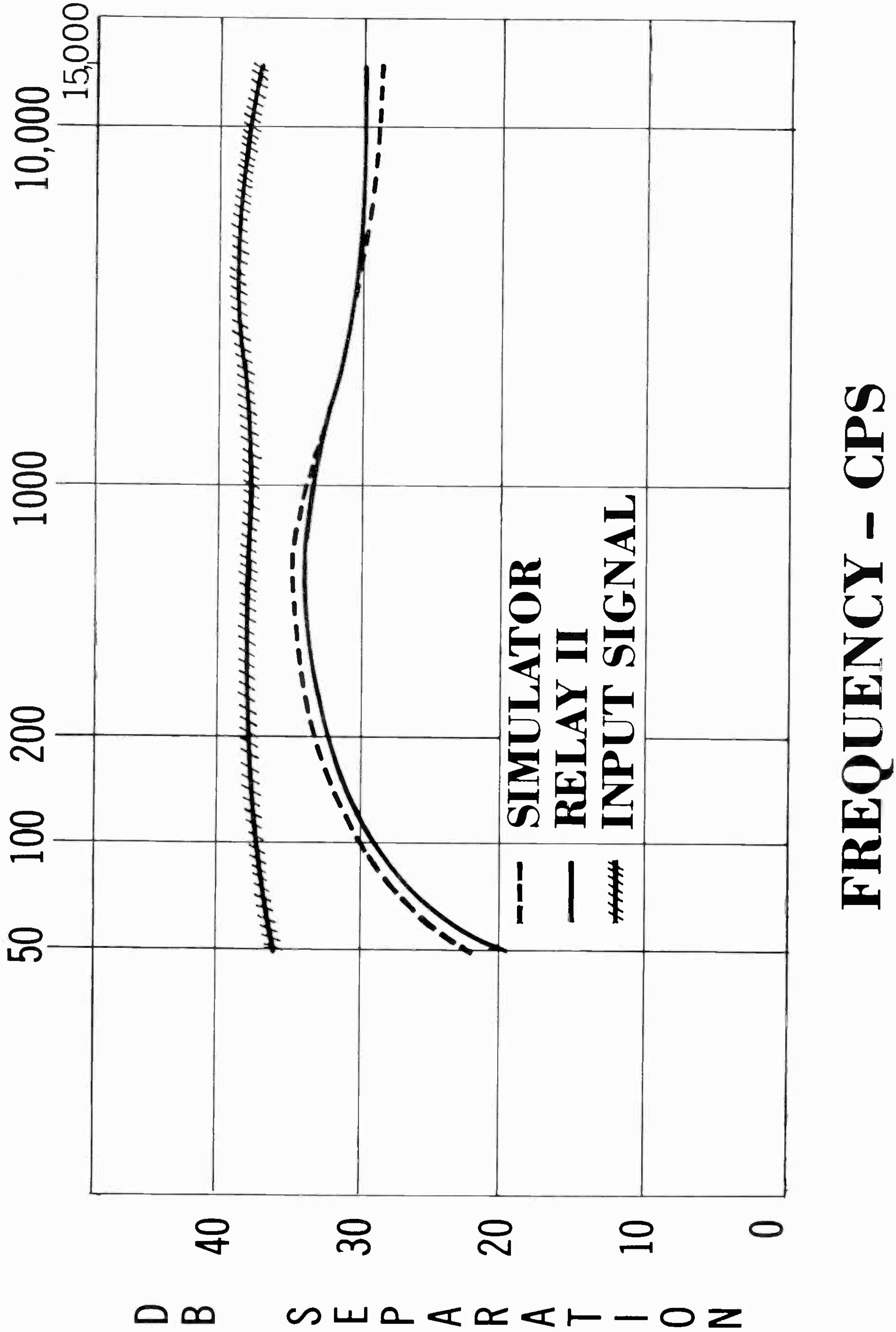

DB SEPARATION
0
10
20
30
40
50
100
200
1000
10,000
15,000
SIMULATOR
RELAY II
INPUT SIGNAL
FREQUENCY - CPS

Figure 5

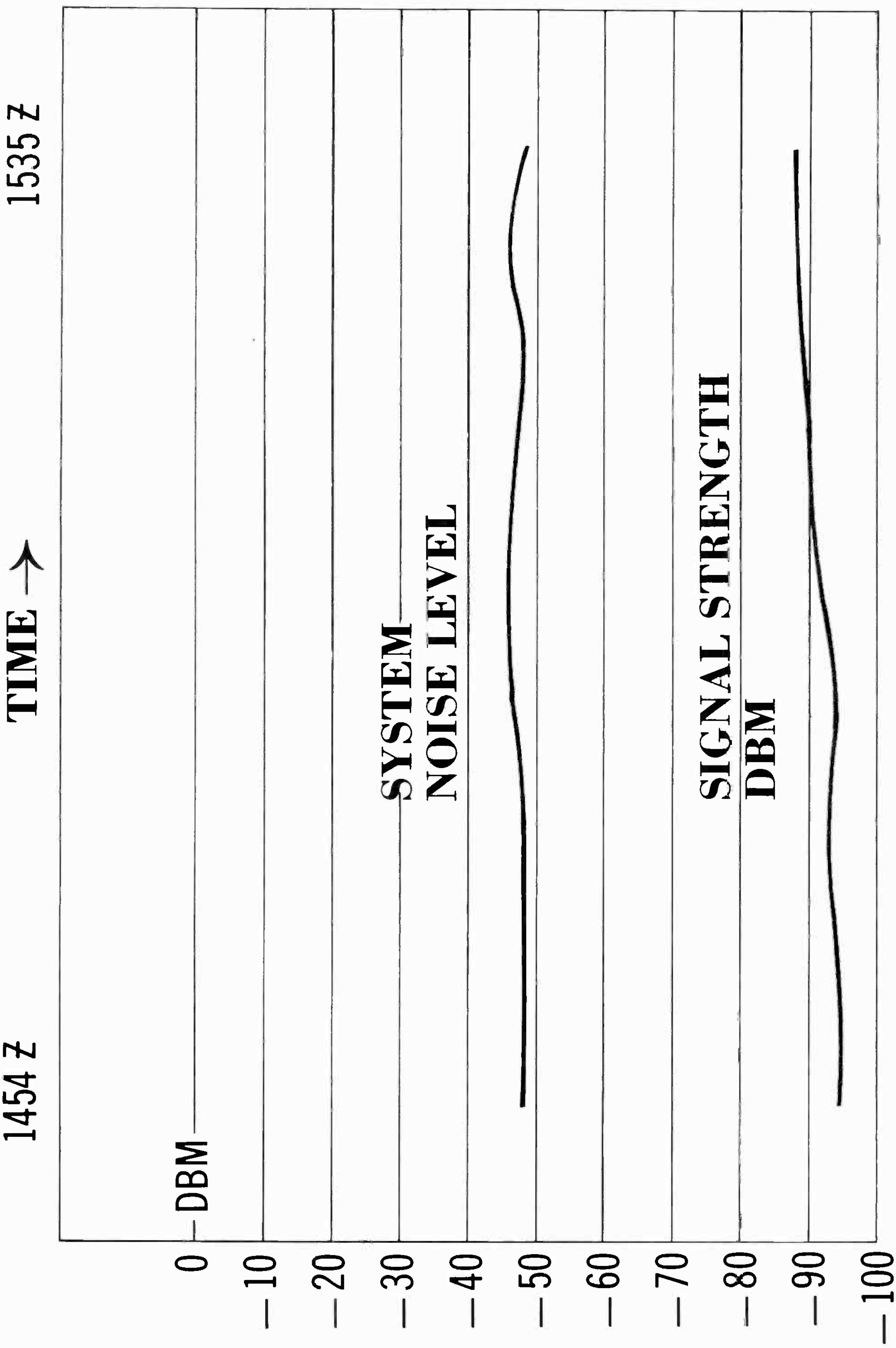

TIME →
1454 Z
1535 Z
DBM
0
−10
−20
−30
−40
−50
−60
−70
−80
−90
−100
SYSTEM NOISE LEVEL
SIGNAL STRENGTH DBM

Figure 6

Testing Standard Broadcast Transmitter Sites

19th Annual

BROADCAST ENGINEERING CONFERENCE

NATIONAL ASSOCIATION OF BROADCASTERS
March 1965
Washington, D.C.

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CONSULTING RADIO ENGINEERS
DENVER, COLORADO · 345 COLORADO BLVD. · 80206
phone (303) 333-5562

TESTING STANDARD BROADCAST TRANSMITTER SITES

...............Vir N. James

With our cities and metropolitan areas rapidly expanding, it is important that proper sites be chosen for new broadcast stations or for the relocation of existing stations. Existing stations frequently find that they are forced to move their transmitter sites farther from the center of their city, and the Federal Communications Commission has become more critical of city coverage requirements. The more distant sites coupled with expanded city limits make it increasingly essential that transmitter sites be chosen where ground conductivities are such as to provide adequate city coverage.

FCC Section 73.188 (m) states:

> While an experienced engineer can sometimes select a satisfactory site for a 100-watt station by inspection, it is necessary for a higher power station to make a field-intensity survey to determine that the site selected will be entirely satisfactory. There are several facts that cannot be determined by inspection that make a survey very desirable for all locations removed from the city. Often two or more sites may be selected that appear to be of equal promise. It is only by means of field-intensity surveys taken with a transmitter at the different sites or from measurements on the signal of nearby stations traversing the terrain involved that the most desirable site can be determined. There are many factors regarding site efficiency that cannot be determined by any other method. When making the final selection of a site, the need for a field-intensity survey to establish the exact conditions cannot be stressed too strongly. The selection of a proper site for a broadcast station is an important engineering problem and can only be done properly by experienced radio engineers.

Field strength measurements taken from existing stations toward the proposed site are of interest, but the FCC insists that these measurements do not always reflect the coverage which may be obtained from the actual site toward the city. Also, many times there is no suitable station from which such measurements may be taken. For these reasons, it is frequently essential to conduct field measurements from the proposed site.

Preliminary calculations of city coverage are usually made using FCC Figure M-3 ground conductivity values in the absence of actual measured ground conductivities. Actual ground conductivities may differ widely from those values specified in the M-3 maps. In addition, the many buildings and structural steel construction, as well as many power and telephone lines which are usually abundant in cities, lower by absorption the radio signal serving the cities. This is especially true in the industrial, and to a lesser extent, in the commercial areas. Hence, while Figure M-3 conductivities may show an adequate city coverage, the actual coverage may be appreciably lower. The only way to ensure adequate city coverage is to make measurements through the city on several radials before extensive transmitter antenna installations are constructed.

After choosing the best possible site based on recommendations contained in the FCC rules, actual test transmissions from the site should be conducted. For these measurements, test transmitters having powers of from 100 to 250 watts have proved adequate. There are several types of transmitters available on the surplus market, which with modifications, may be operated on a suitable frequency in the broadcast band. Typical types are BC-75E, ART-13, BC-610 etc. A Heathkit DX 100 also may be modified by means of the addition of loading coils to operate very satisfactorily on the standard broadcast band frequencies.

Naturally the best power supply for the test transmitter is obtained by running a temporary extension from the regular 115 volt 60 cps power line service. However, most of the time we have utilized a gasoline powered AC generator.

To provide a ground system, ground radial wires of approximately 1/4 wavelength are laid upon the ground. They are soldered to a ring at the antenna base with the far ends usually wrapped around nails or spikes which are pushed into the ground to secure the wires. The number of ground radial wires we have used has varied from 30 to 90. In order to reduce the cost of such a test ground system, we find it desirable to use bare copper wire of #16 or #14 size. Although the less expensive #18 has been used, it is too easily broken to be recommended. Wire larger than #14 becomes unnecessarily costly.

The test antenna is of prime importance. Vertical TV type towers have been erected having heights of 70 to 120 feet. Where a short tower height can be tolerated, this method of supplying a test antenna is the most satisfactory. It is the most stable and dependable. Short antenna lengths yield low impedances which may present some problems in coupling to the transmitter. A top loaded or a folded unipole type of antenna also may be used.

Crank-up temporary towers of the types shown in Figure 1a have been constructed which extend to heights of approximately 70 feet. Such towers are generally of steel construction. Previously, crank-up towers made of aluminum have been available at increased cost. The aluminum type is of sufficient light-weight to be especially useful for transmitter site testing. The height of these units may be increased by an addition of a 10-foot aluminum pipe on the top section. Thus, a transportable crank-up antenna may be had with a height approaching 100 feet. This antenna height, although usable for site testing, still may show evidences of some shadowing in hilly or mountainous terrain in excess of that which would be obtained by a tower of normal height. Such antennas are relatively inexpensive.

Special crank-up towers are available in heights up to 122 feet. They are rather expensive, approximately $1700, heavy and bulky. A trailer is available for transporting this type tower, as also shown in Figure 1a. Another convenient feature of this type tower is the method of installing the guys before the tower is cranked up to full height.

Fold-over towers are available with heights up to some 70 feet. To the top section, an additional 10 or 15-foot pipe may be added to increase the height to 80 or 85 feet. Here again, the height is such as to yield shadowing of signals in hilly country over and above that which may be expected from regular broadcast antenna heights. This type tower is shown in Figure 2b.

Push-up tower construction has been employed for tower heights up to 250 feet. This system utilizes a special bottom section, or a very heavy temporary base pole, with a system of pulleys or a winch to raise the tower. The top tower section is first raised high enough so that the second section can be bolted to the bottom of the top section. The two top sections are then raised high enough so that the third section can be bolted on to the second one. Guys are attached as required. Each time the sections are raised to add another section on the bottom, the guys must be loosened to permit raising the assembled sections. With this system of erecting a tower, it is essential that there be no wind since the guys must be very loose to enable the assembly to be raised. This tower assembly requires five men, together with careful choice of weather conditions. Erection of the tower may be accomplished in about three days if no wind develops. The higher the tower is constructed, the more difficult it becomes to raise the tower to add another section. Because of the possibility of a sudden build-up of wind, this method of tower erection can become tricky and hazardous.

Another type of temporary tower which has been used is called the telescoping mast. These masts are relatively easy to erect although their height has been limited to 50-100 feet. Some of these masts may be erected by a hydraulic system. The greater heights are of course quite expensive.

A 250-foot construction crane, insulated by rubber tires, has been considered as a temporary test antenna. Unfortunately, the costs of renting such a crane to serve as an antenna have so far been found prohibitive.

Among the most recent developments applicable for use as a temporary antenna mast or tower is the inflatable mast. See Figure 2.

Inflatable masts up to 100 feet in height and having diameters of 6 to 12 inches have been developed. These masts are fabricated of a layer of mylar covered with a layer of dacron scrim or other plastic with a very thin sheet of aluminum between the plastic layers for antenna conductivity. The masts are inflated to approximately 10 pounds per square inch pressure and are guyed with nylon cords. Such inflatable masts have been developed which fold to a very tiny package with an overall weight of about 15 pounds for the mast, guys, hand or foot pump, base, grounding connection, etc., combined. Although 100-foot inflatable masts have been developed, they are not yet commercially available. It is believed that by the use of special cellular construction, it will be possible to develop inflatable masts in heights of over 150 feet which would be very useful for temporary test antennas. The Kearfott Division of General Precision, Inc. is engaged in development work on inflatable towers, transmission lines and antennas which are very light weight and compact when folded.

Many measurements which have been made in hilly or mountainous terrain with short towers have yielded lower measured ground conductivities than have actually been measured after installation of regular towers of greater heights. The measured lower conductivities with the shorter towers may be attributed to an increase in shadowing.

Excessive shadowing may be avoided by using an antenna height equal to the height of the proposed tower. However, providing a temporary tower of height equal to the proposed tower may become quite expensive, especially when low frequencies are involved.

In an endeavor to obtain as close a value of measured conductivity as that which might be expected from the actual permanent tower, we have used several methods of suspending a vertical antenna wire having lengths of 1/4 wavelength or more.

Ben Franklin utilized a kite to suspend a wire. Since the early Franklin tests, vast improvements have been made in the performance of kites.

Balloons likewise have suspended 1/4 wavelength antenna wires. Balloons, in the absence of wind, hold the antenna wire in a vertical position. Figure 3e shows a balloon suspending a 1/4 wave vertical antenna. However, as winds appear, the balloon is pushed horizontally, and with variable winds, the antenna moves continuously. Its angle with respect to the surface of the earth as well as with respect to a measuring point changes with the winds. Another drawback to this system is that the sun in the vicinity of mile-high Denver is so intense that ordinary balloons develop bulges on the sun-exposed side which may continue to expand to the bursting point. The inset in Figure 3e pictures the balloon with a sun-bulge.

In calm, overcast weather these balloons will do the job. However, in Denver we couldn't get FCC permission for a test period long enough to get two overcast days! – at least not 2 days overcast, without wind, and with suitable visibility so that the balloon would not be an aeronautical hazard. Two, three or more balloons have been used simultaneously by one Washington consultant to support a vertical wire antenna. Adding one or more balloons increases the lift, tending to reduce the horizontal movement caused by wind.

Vast strides in the development of kites have been made in connection with missile re-entry problems. A kite constructed so as to form an airfoil, of cellular wing section shape, shown in Figure 4, has been used. This kite has no rigid member. It consists merely of a very light fabric. Wind flows into the cells filling them and causing the kite to assume an airfoil shape similar to a section of an airplane wing. These kites develop tremendous thrust! A kite weighing only 2 pounds was found capable of breaking an antenna wire of copper plated steel. In fact, our field engineer, who weighed 150 pounds, was dragged along the ground by this 2-pound kite even with his heels dug into the earth. In these tests, it was necessary to use a 500# test nylon line. The kite operates at an attitude angle of 60° so that a vertical wire may be suspended from the nylon line as shown in the illustrations in Figure 4. This kite suspension is ideal where winds of over 12 knots are blowing steadily. However, you may find that by the time you receive approval from the FCC to conduct the tests, that the weather will decide to remain calm! In mountainous terrain, winds may be gusty and quite turbulent, causing the antenna wire to move around considerably. The line tethering the kite should be made fast in a direction toward the wind. These amazing airfoil or parafoil kites which may suspend antenna wires in winds of from 10 to 75 knots were developed by Domina Jalbert of the Jalbert Aerology Laboratory.

Another form of antenna supporter (we term it antenna suspender) is a kite which is inflated by filling with hydrogen or helium to maintain its airfoil shape. See Figures 5, 6 and 7. This device may be used to hold up an antenna wire in winds from 0 to 30 or more knots. With zero wind, the hydrogen provides enough lift to support the wire, and as wind develops, the airfoil shape of the kite creates increased lift which opposes the horizontal motion of the kite. These kites, because of their airfoil configuration, develop increased lift with increased wind. The tail forms a stabilizer, keeping the kite always headed into the wind, thus reducing the surface exposed to the wind thereby reducing horizontal motion. The added lift created by the wind also opposes horizontal motion of the kite since it is tethered. The illustrations show the shape of this inflated kite as it supported a 220-foot antenna wire.

With a kite or balloon it is often convenient to adjust the length of the antenna wire until zero reactance is obtained. The antenna resistance is then of a value which may be connected directly into a short coaxial cable and thence to the transmitter. During measurements the power as indicated by the antenna ammeter should be maintained constant.

The first step in assembly of this kite is the insertion of the stabilizer stiffeners as shown in Figure 6b. The following illustrations show the progressive stages of inflation of the kite. Finally, the kite is shown suspending the antenna wire.

This form of kite readily permits supporting vertical or near vertical wires having lengths up to 5/8 wavelength. Nylon cord having over 700-pound test strength should be used for tethering. Again, this device was developed by Jalbert Aerology Laboratory.

The antenna wire may be an aircraft copper clad steel antenna wire of about #16 gauge; 400 feet of this wire weighs under 2 pounds. Suitable swivels should be placed at each end of the antenna wire to eliminate any undue strain from the movements of the kite.

Be sure to use a static drain choke with any of the kites or you may rediscover Ben Franklin's electric shock!

FCC Section 73.36 specifies the rules under which special field test authorizations may be issued by the Federal Communications Commission.

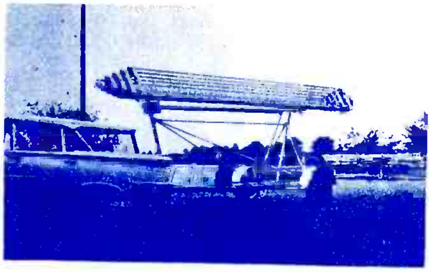
In conclusion, it should be remembered that low height antennas in some types of terrain do not give accurate conductivity or coverage measurements when compared to regular broadcast antenna heights. Various systems of temporary antennas are available for use in testing a new transmitter site. When conventional types are not of adequate height, or are not practical for other reasons, antenna-suspending kites may be used with very satisfactory results.

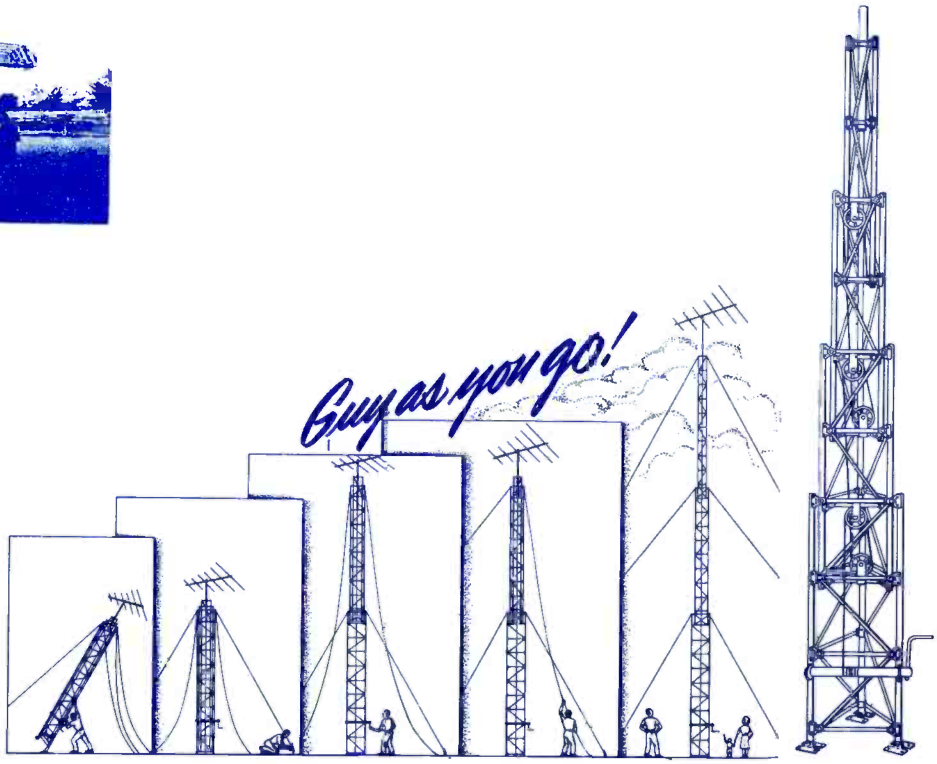
* * * * * *

Figure 1

CONVENTIONAL TEMPORARY TOWERS

A. CRANK-UP TOWER.





B. FOLD-OVER TOWER.

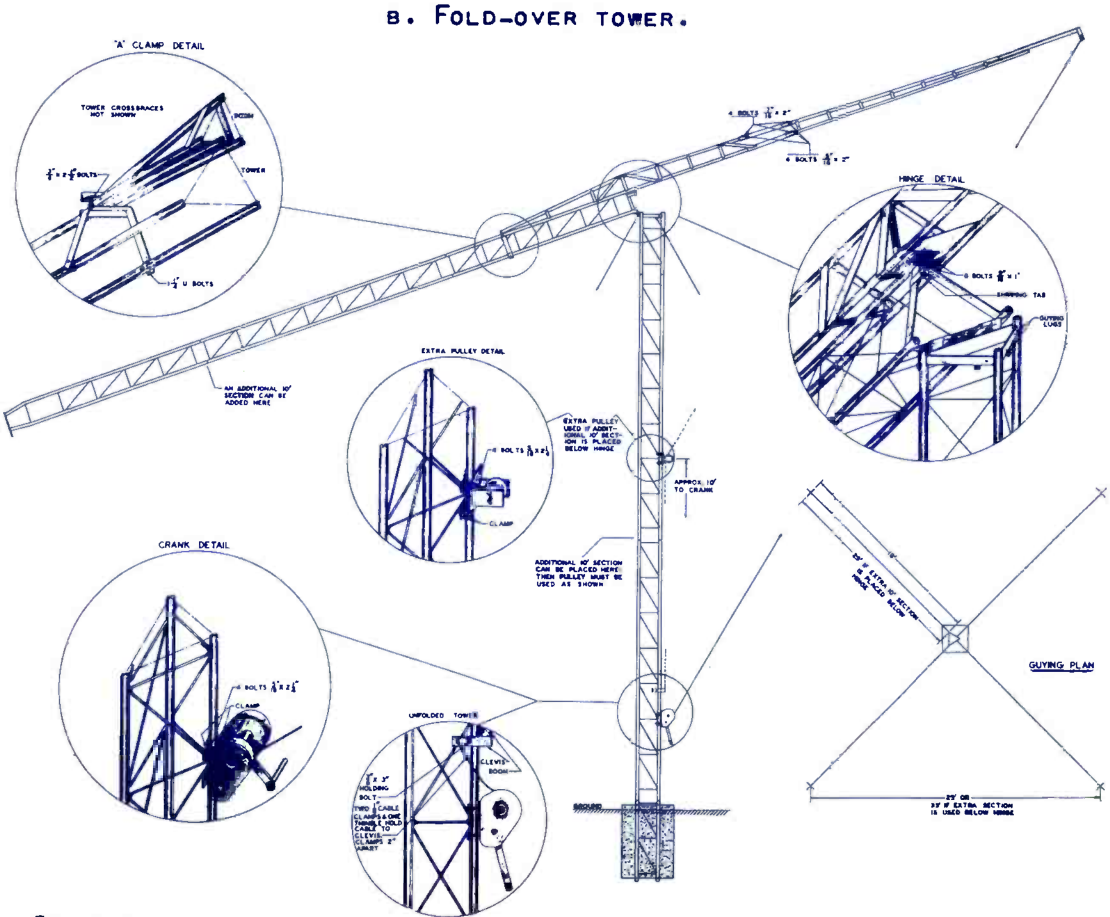
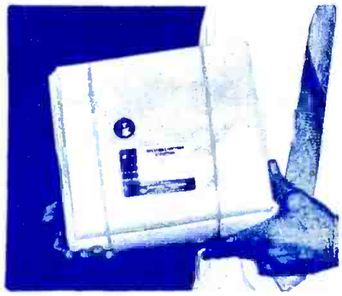
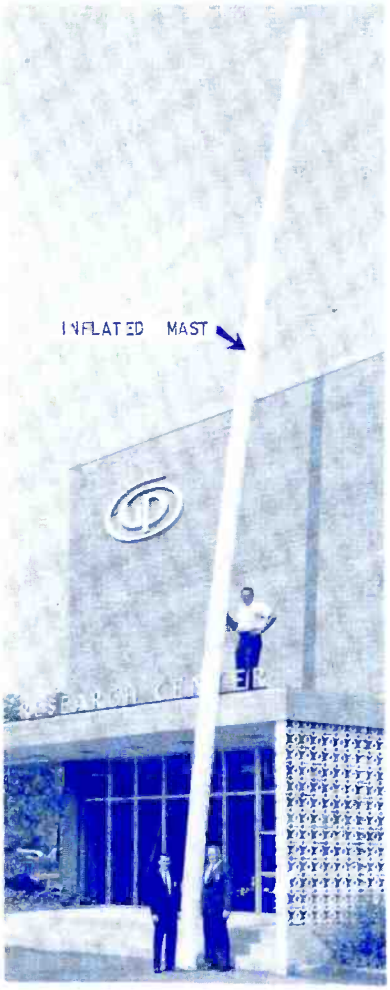


Figure 2

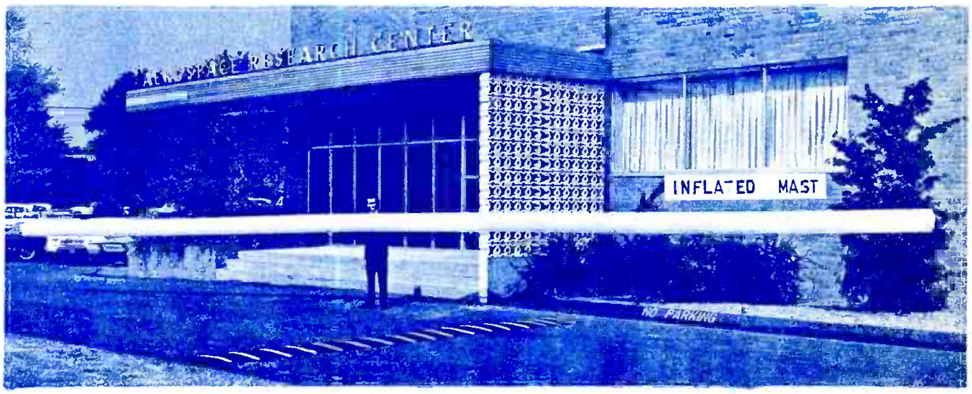
INFLATABLE ANTENNA MAST



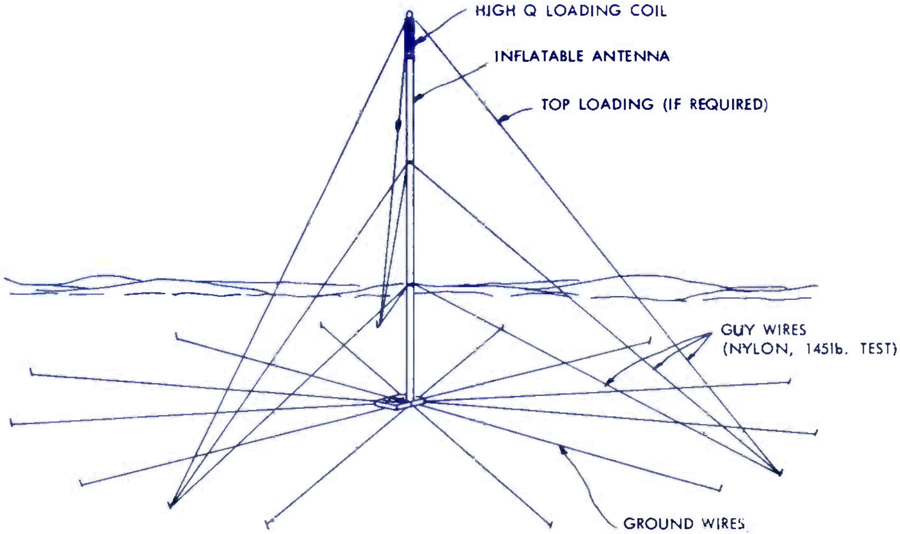
A. Folded into small package.



B. Inflated antenna mast.



C. Lightweight inflated mast.



D. Typical inflated antenna setup.

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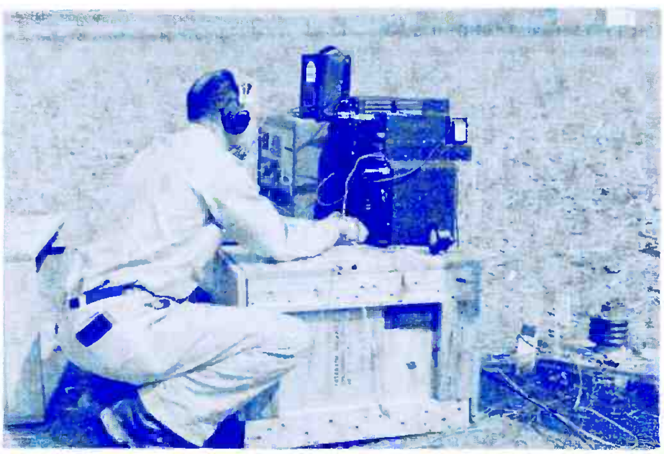
Figure 3

BALLOON ANTENNA SUSPENDER

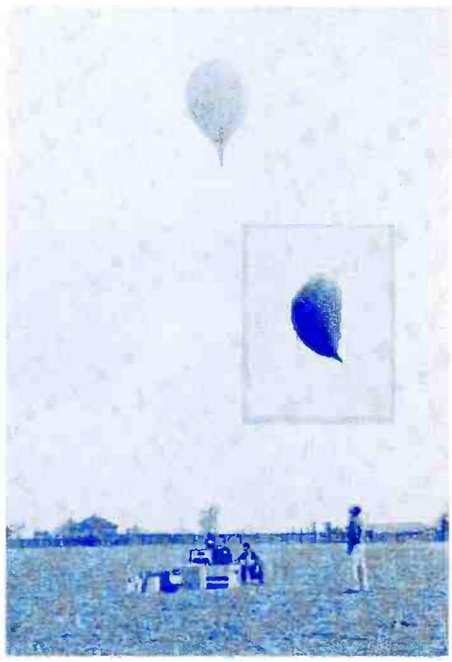
A. INFLATING BALLOON FROM CYLINDER OF HYDROGEN.

B. PARTIALLY INFLATED BALLOON.



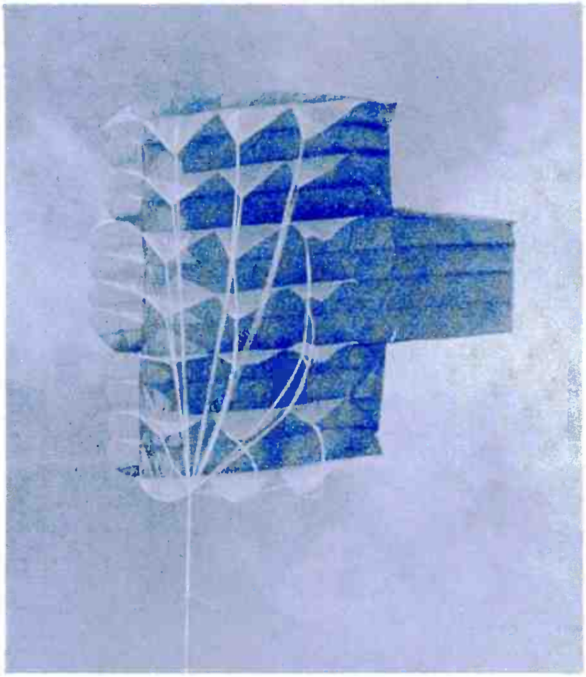
C. MEASURING ANTENNA RESISTANCE.

D. ATTACHING BALLOON TO COPPER WIRE ANTENNA.

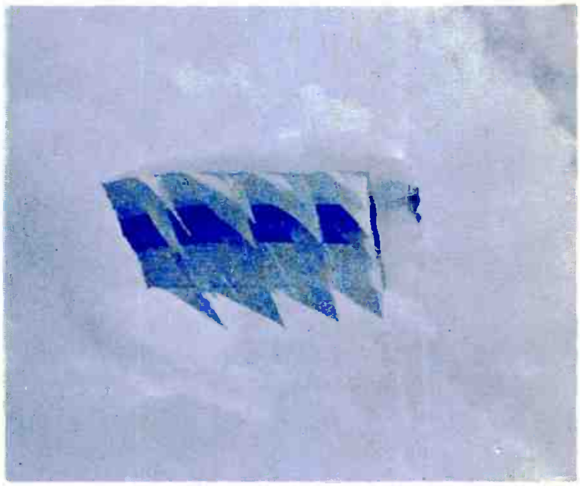


E. LAUNCHING BALLOON AND ANTENNA WIRE. (INSET - SUN-INDUCED BULGE.)

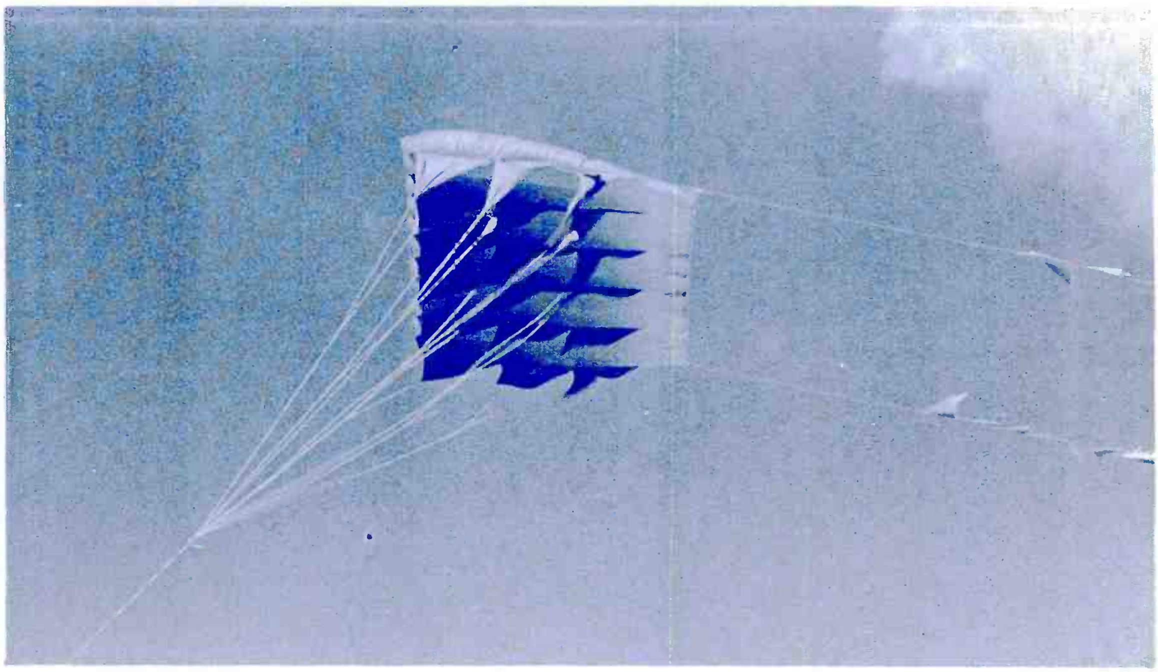
CELLULAR AIRFOIL KITES FOR ANTENNA SUPPORT



A



B

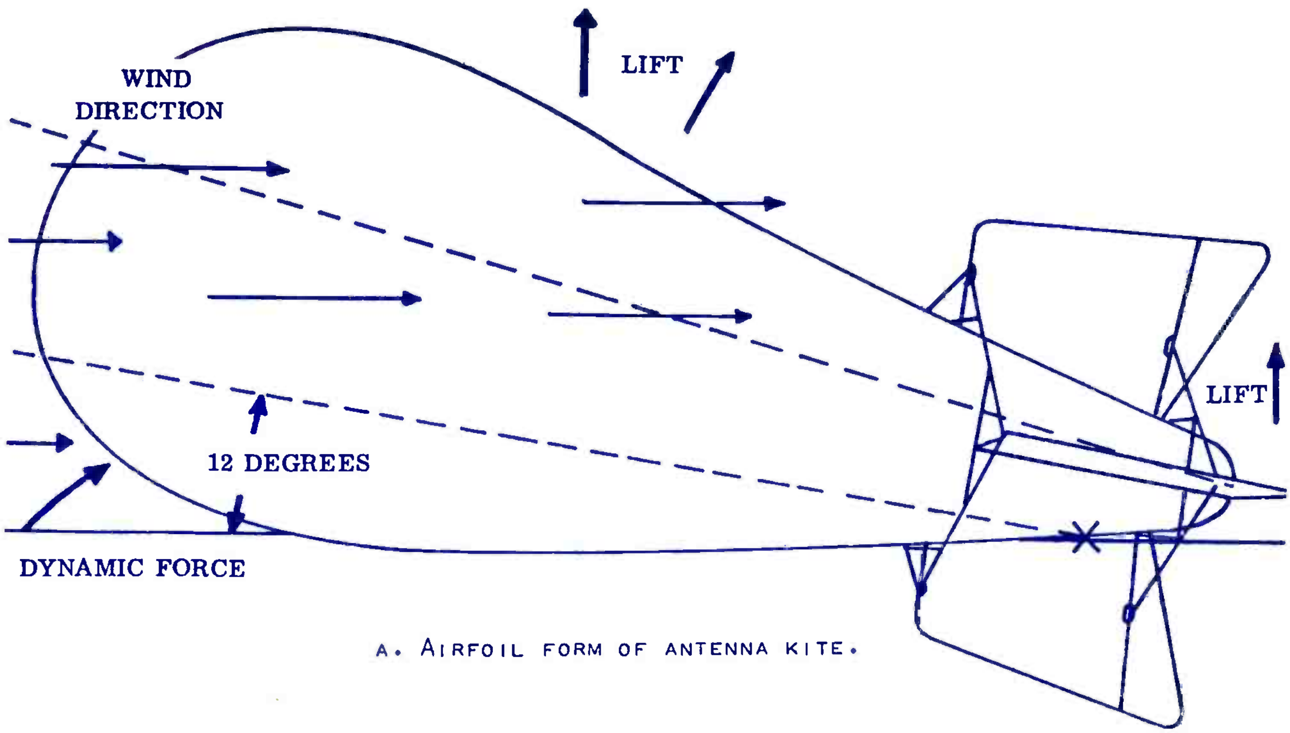


C

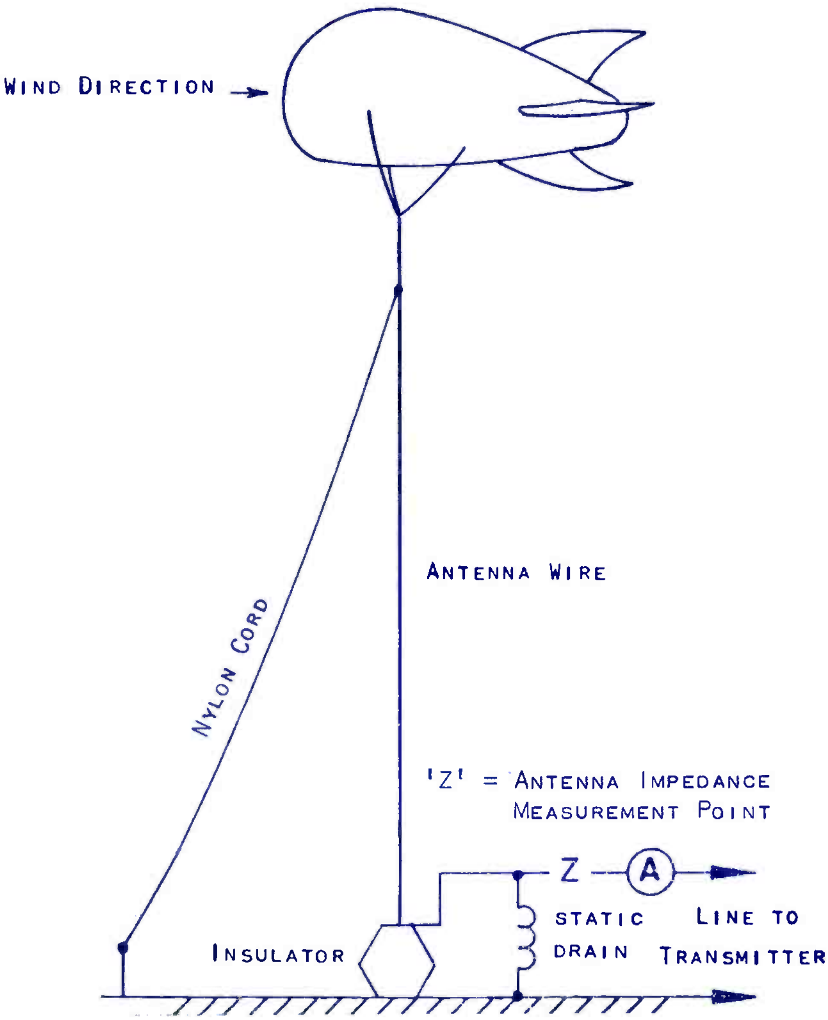
Vir James CONSULTING RADIO ENGINEERS **DENVER, COLORADO • 345 COLORADO BLVD. • 80206 • *phone* (303) 333-5562**

ANTENNA SUSPENDING KITE

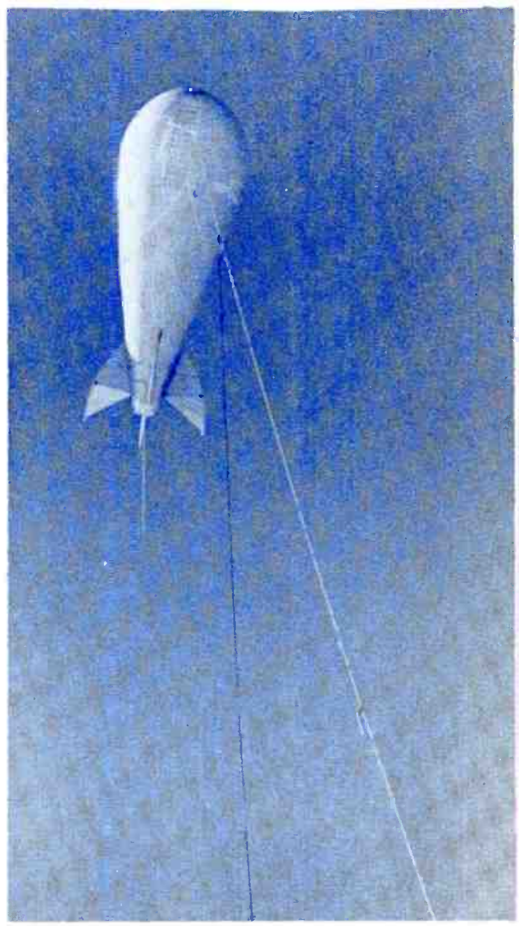
Figure 5



A. AIRFOIL FORM OF ANTENNA KITE.



B. SCHEMATIC OF KITE SUSPENDED ANTENNA
AND ANTENNA CONNECTIONS.



C. KITE SUSPENDING ANTENNA.

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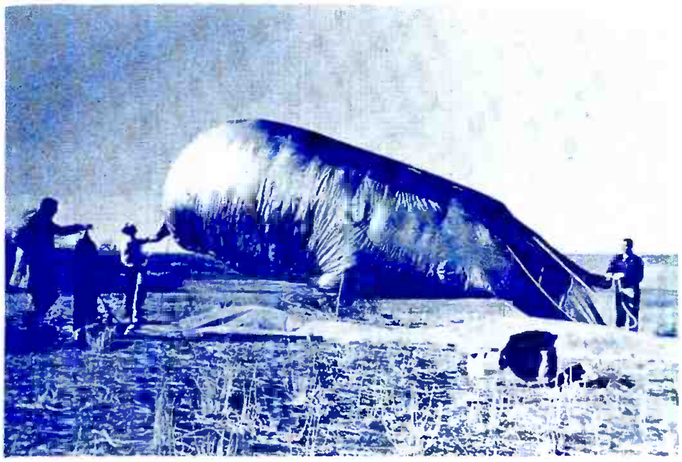
SETTING UP ANTENNA SUSPENDING KITE

A. The kite kit.

B. Assembling the kite tail.

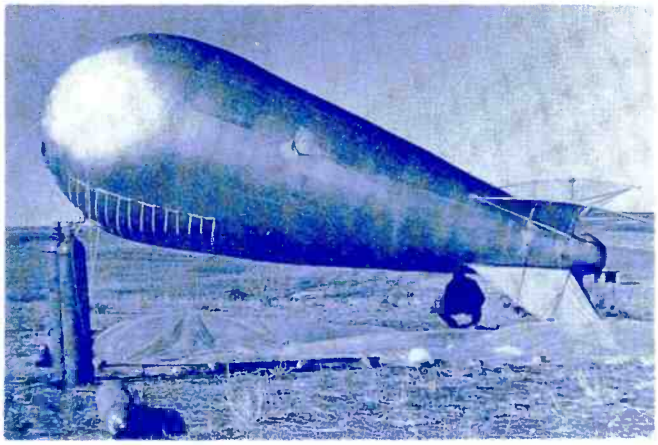
C. Inflating the kite with hydrogen.



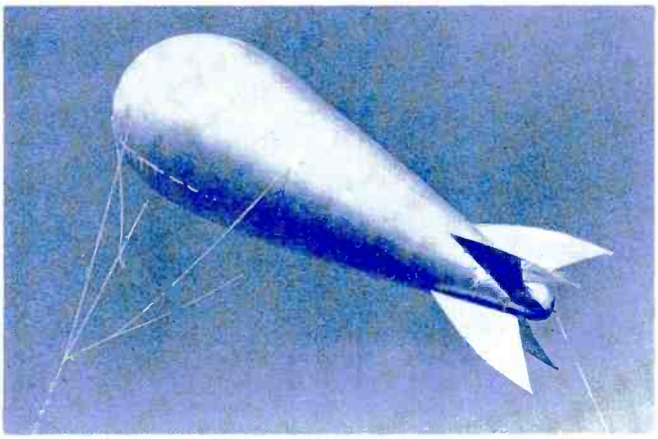
D. Further inflation of kite.

Figure 7

ANTENNA SUSPENDING KITE IN OPERATION

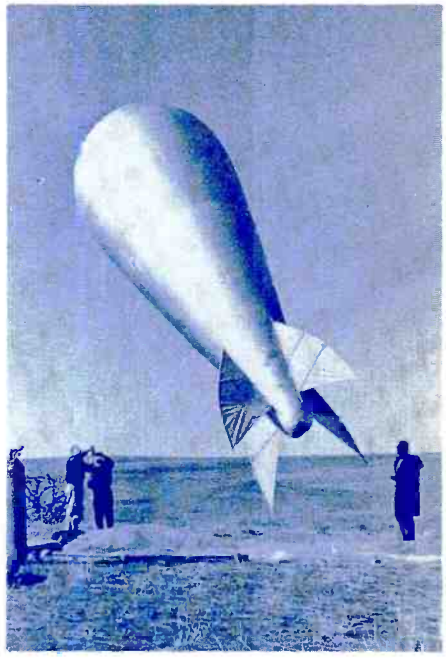


A. INFLATION COMPLETED – KITE READY TO FLY.



B. THE INFLATED KITE.

C. MEASURING ANTENNA RESISTANCE.



D. ATTACHING ANTENNA WIRE TO KITE.

E. FLYING KITE SUPPORTING ANTENNA WIRE.

PREVENTING FM OVERMODULATION

SUMMARY: With the advent of better broadcasting and recording systems, and the liberty enjoyed by today's recording artists, the high frequency signals programmed into the FM transmitter are often of sufficient amplitude (after pre-emphasis) to cause gross overmodulation. The optimum placement of the peak limiting amplifier and the use of auxiliary protective devices are discussed.

INTRODUCTION: Through the years there has been considerable controversy about the wisdom of pre-emphasizing the signal fed into the FM transmitter. The reason for the pre-emphasis was that the signal-to-noise figure was enhanced by the attenuation of the high frequency part of the audio spectrum in the receiver. Since there was appreciably less energy in the upper section of the 30 to 15,000 cps. region than in the part below 1,000 cps., a 75 microsecond pre-emphasis curve was adopted to take advantage of this distribution.

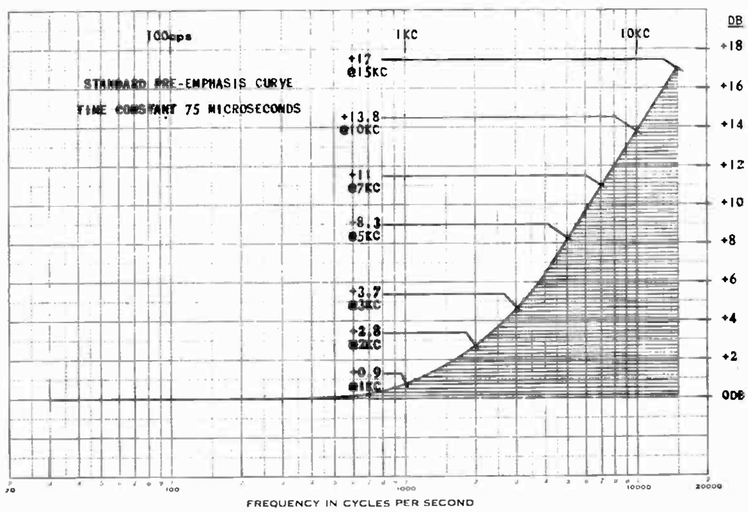


FIGURE 1

The standard 75 microsecond curve, shown in Fig. 1, is flat below 200 cps., rises to +0.9 db @ 1KC, +8.3 db @ 5KC, +13.8 db @ 10KC and +17 db @ 15KC. As the graph shows, this is quite a severe curve. When it was adopted, there must have been very little anticipation of the kind of effects that are programmed today! Also, the Broadcaster was expected to operate his FM transmitter with rather low values of average modulation to allow transmission of the full dynamic range of even classical music. Competition in FM Broadcasting was not too keen and programming was not stressed too highly in most areas. So, the low average modulation concept was generally practiced. In fact, many FM Stations did not employ a peak limiting amplifier, or any type of automatic levelling amplifier, due to the several reasons covered.

FM Broadcasting is becoming competitive! Programming is becoming commercial, and FM Stations are showing a profit! This is healthy for the general public and broadcaster alike, because it will permit better coverage of many areas and a wider choice of programs in every area.

Nearly all of the practices that helped prevent FM overmodulation in the past are being modified, in a direction that contributes to overmodulation, today. Peak limiting amplifiers are being used extensively today. Yet, more and more FM Stations are being cited for overmodulation. This has caused many station engineers to believe that their limiting amplifiers are defective, or that the attack time is much too slow. However, their limiting amplifiers limited on a flat response curve, where the high frequencies did fall below the threshold of limiting, and the amplifiers were operating correctly. The problem was caused by the pre-emphasis of the signal after it was processed through the limiting amplifier. It was typical FM overmodulation.

ANALYSIS OF PROBLEM: If the high frequency content of any part of the day's programming never exceeds the curve shown in Fig. 2, the peak limiting amplifier could feed into the FM transmitter pre-emphasis filter (assuming a fast limiter attack time) and no overmodulation would occur. Good microphones, tape machines, phono cartridges and recordings make this very unlikely, however. This curve is complementary to the standard pre-emphasis curve, and is the one that should be used in the receiver to de-emphasize the signal to restore the original frequency response.

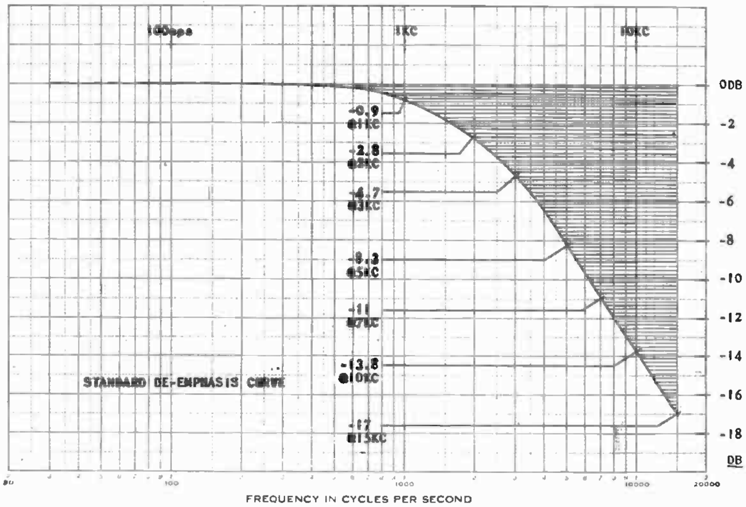


FIGURE 2

However, if any of the high frequencies do exceed the limits of the curve shown in FIG. 2, and go into the shaded area - overmodulation will result.

A good FM transmitter can tolerate extensive overmodulation without excessive distortion. The bandwidth is extended very rapidly from the maximum allowable ±75KC, however. A program peak of only 6 db will amplify the bandwidth to a very illegal ±150KC! We have reports of FCC citations with relatively low percentages of overmodulation. Many receivers and tuners cannot tolerate excessive overmodulation without serious distortion because of bandwidth and/or discriminator curve linearity restrictions. They frequently suffer from a type of base line shift that can cause perceptible distortion in the audible frequency range. Thus, the Broadcaster has a two-fold reason to stop overmodulating his FM transmitter.

An extensive search of current publications failed to reveal the distribution of spectral energy of modern recordings or of broadcast programs. After some reflection, this was readily understood. The extensive use of program equalizers, graphic equalizers and other frequency response shaping units, in not only the original programming - but in subsequent reproduction as well, eliminate any chance of two stations (or even one on a regular basis) having a typical curve. The limitations of recording media are even circumvented to a large extent by a judicious use of levels.

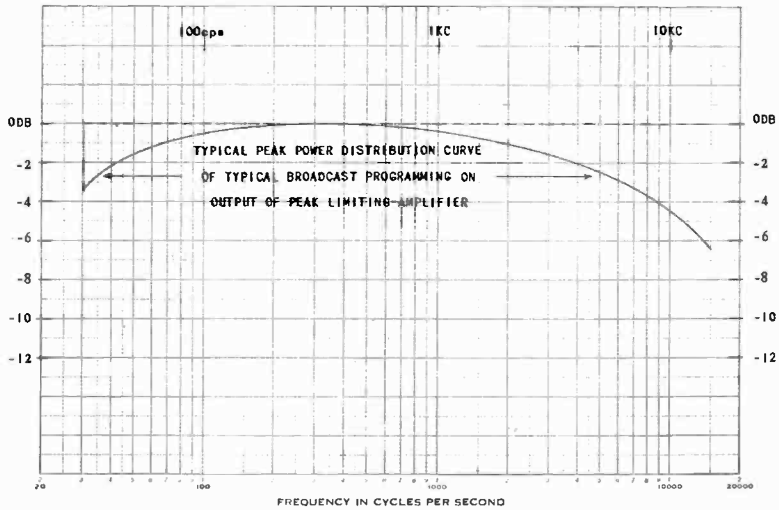


FIGURE 3

However, this study requires at least an arbitrary curve for an illustration. Various spectrum analyzers and wave analyzers were employed in approximating the typical peak power distribution curve shown here. This is a composite curve of the peaks observed in many types of programming over an appreciable portion of the broadcast day in a typical FM station. A conventional limiting amplifier maintained a constant mid-range level. The very high and very low frequency peaks occurred much less frequently than the intermediate high and low frequency peaks. Yet, they were frequent enough to fully understand why stations are being cited for overmodulation! It is safe to assume that nearly every FM Station will have a peak power distribution curve that will approach or exceed that shown, unless drastic preventive steps have been instituted.

Perhaps the first step taken by many stations was to simply reduce the level of modulation to an average of 50%, effectively reducing the average program power to 1/4th the maximum allowable station power. Fig. 4 shows the result of 50% modulation of the low and mid frequencies. No overmodulation occurs below 5KC on the typical peak power distribution curve. It is possible, however, to overmodulate as much as 70% at 15KC - which constitutes an engraved invitation for a citation! The 10KC point shows up to 150% modulation under the conditions described. Obviously, an even lower level of mid-frequency modulation is necessary to prevent high frequency overmodulation. This is true, in spite of the fact that the mid-frequencies are controlled with a limiting amplifier.

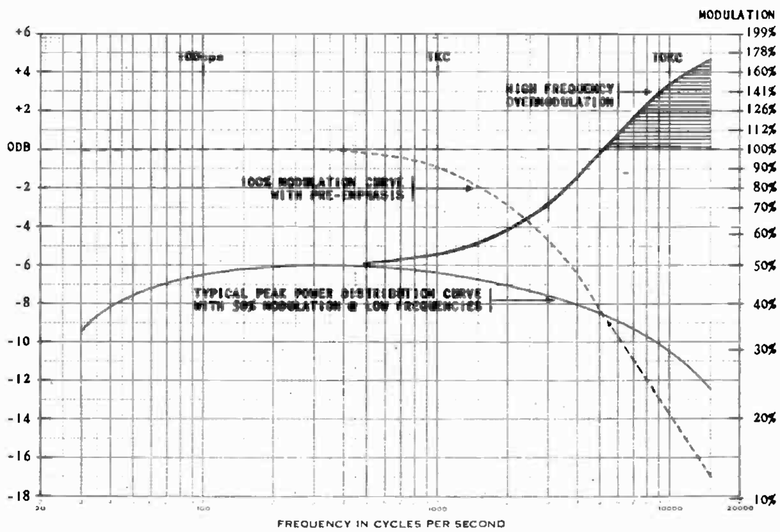


FIGURE 4

After this part of the study was completed and the levels shown in Fig. 5 were established, the manager of our engineering section responsible for FM transmitters was asked what mid-frequency modulation level was required to prevent high frequency overmodulation with average programming. His prompt reply was, "Around 30%". Fig. 5 shows that this study was in full agreement, it resulted in a figure between 29% and 30% modulation. However, certain types of programming could still cause more than 100% modulation at high frequencies, even with 29% mid-frequency modulation. Thus, even lower levels of modulation are required to be sure that no overmodulation will occur.

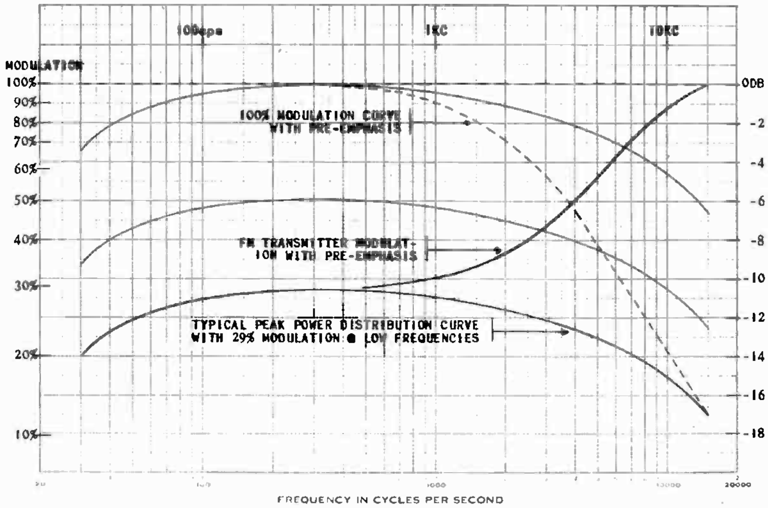


FIGURE 5

With 30% average modulation, the program power output of the station is approximately 1/10th of the maximum allowable power! Many of the program peaks that are causing the reduction in modulation are so high that some receivers will not even pass them, and some listeners are incapable of hearing them. Also, they are relatively very scarce in most programming, so the wisdom of using very low modulating levels is questionable.

PRE-EMPHASIS AHEAD OF LIMITING AMPLIFIER: The second step considered by many stations is to place the pre-emphasis before the limiting amplifier, so it can limit the high frequencies as well as the mid and low ones. If the program level is maintained carefully at a point that is generally well below the threshold of limiting, this method will produce fairly acceptable results. However, certain types of programming will still cause quite un-natural effects, as shown in Fig. 6.

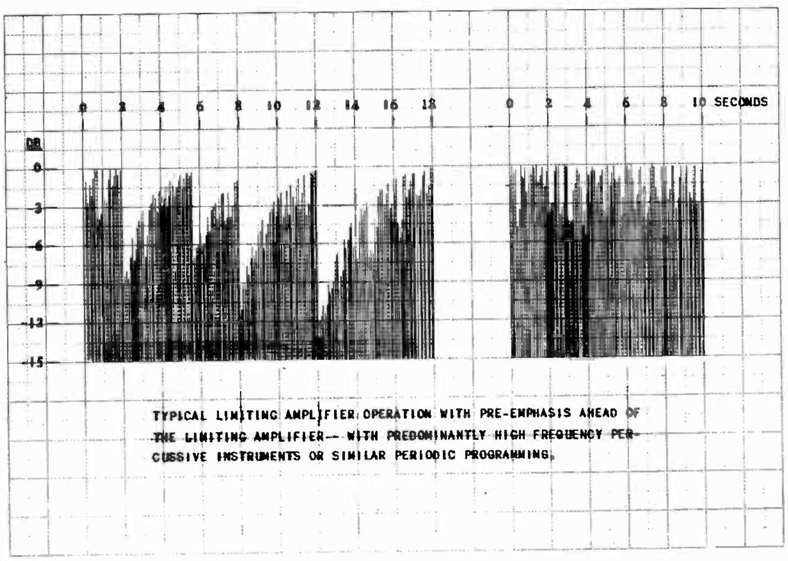


FIGURE 6

A conventional peak limiting amplifier with an attack time of approximately one millisecond and a 90% recovery time of around two seconds will have an output similar to that shown in Fig. 6, with certain types of programming. This is a result of high pre-emphasized high-frequency peaks exceeding the threshold of limiting, causing the attendent gain reduction of mid-frequencies. When the resultant signal is de-emphasized it sounds like the limiting amplifier could be undergoing a blocking type of oscillation, where the gain suddenly drops for no audible reason, then recovers on the normal R-C slope. This is an excellent way to gain a large group of irate listeners, which will soon degenerate into a much smaller group of irate listeners!

The right hand portion of Fig. 6 shows the same type of programming without pre-emphasis ahead of the limiting amplifier. Only the upper half of the waveforms are represented in both portions, since this a sketched representation of the scope display observed under the two conditions covered.

METHODS OF CORRECTION: If the typical peak power distribution curve shown in Fig. 3 were never exceeded the problem could be eliminated by the installation of a low pass filter, such as shown in Fig. 7. A listening test of quite a few FM stations indicate that some must be using this method. Unfortunately, this performance is easily surpassed by the majority of the AM stations with modern transmitting and programming equipment.

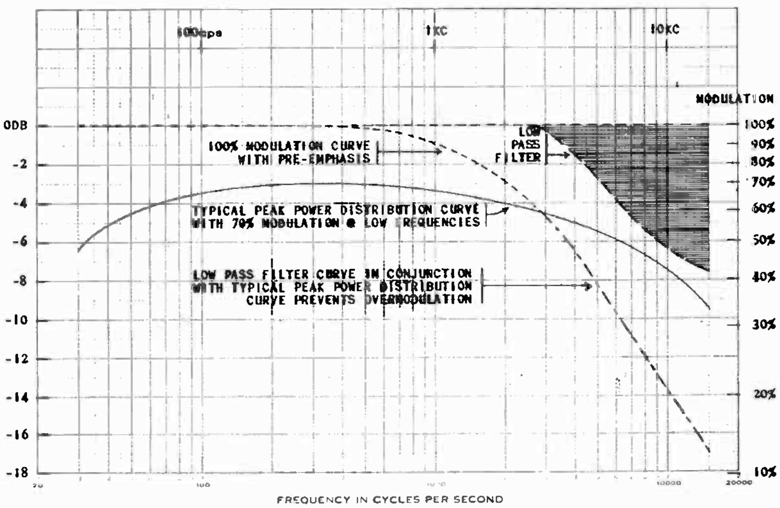


FIGURE 7

A low pass filter indiscriminately curtails all signals that fall on the filter slope - thus, degrading all programming just to protect the station from a relatively few overmodulation peaks. This "shotgun" approach cannot be considered as an effective cure for the FM overmodulation problem for many reasons.

One corrective method that does merit serious consideration is to simply repeal the decision to pre-emphasize FM signals in the transmitter! There have been many advances in the state of the art since the original decision and the original noise reduction requirement could probably be solved with modern components. With stereophonic operation becoming more prominent, with the unusually severe phase balance requirements from L+R to L-R, the injection of pre-emphasis and de-emphasis is a big handicap. It is the opinion of many in this field that a better overall system would result with the elimination of pre-emphasis.

Since so many existing receivers are involved in the proposed elimination of pre-emphasis, perhaps it would be best to consider a graduated reduction of pre-emphasis. For example, after July 1st. of this year, the pre-emphasis could be reduced from +17 db @ 15KC to +12 db @ 15KC. Nearly all of the decent existing FM systems have tone controls that could effectively compensate for the reduction of high frequency pre-emphasis.

In 1970 the 15KC peak could be reduced from +12 db to +6db. The systems sold in the five year interim could compensate with their tone controls. Older systems (the majority of them would be more than ten years old) could have a simple and economical change in the de-emphasis circuit to make them compatible with the 6 db standard.

In 1975 the pre-emphasis could be completely eliminated. All of the FM systems sold in the preceeding five years, and all of the older systems that had been modified to the 6 db standard, could again compensate with their tone controls. Only the sets manufactured to the 12 db standard would need a simple change to make them fully compatible with the new 0 db standard. Thus, in a controlled ten year program the pre-emphasis problem can be wiped out without causing anyone a great hardship. The Broadcaster should have no real objection to buying a new pre-emphasis filter every five years. In fact, the old one could probably be modified by simply installing a factory specified shunt resistor.

ACTION WHILE AWAITING THE DOCTOR: It is somewhat doubtful that the proposal outlined above will be adopted soon enough to immediately solve the FM overmodulation problem. There surely must be a method of controlling the high frequency peaks, yet permitting decent levels of modulation with full quality. This problem is not unique in the FM broadcasting industry. Disc recorders have been faced with an almost identical problem, and a product has been marketed that certainly has the correct approach to the problem. It essentially pre-emphasizes the signal along a slope that corresponds to the problem area of the device that it eventually feeds, wipes out any peak that exceeds this slope, de-emphasizes in a complementary slope to give an overall flat response. Fig. 8 shows the advertised curves in solid lines, plotted in the same scale as all of the previous figures in this study. This graph is advertised for use with a 75 microsecond pre-emphasis curve in FM transmitters. The standard 75 microsecond pre-emphasis curve is shown in the dotted

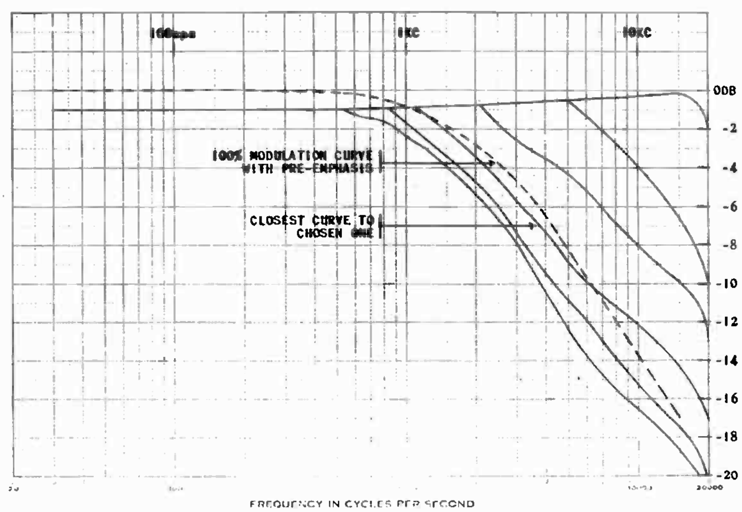


FIGURE 8

line on the graph. One of the curves falls remarkably close to the standard 75 microsecond curve and would eliminate FM overmodulation with much of the standard programming. Selecting one of the two more severe curves would surely eliminate the problem. However, they would cause unnecessary reduction of all frequencies above 600 to 900 cps. with some resultant degradation of signal.

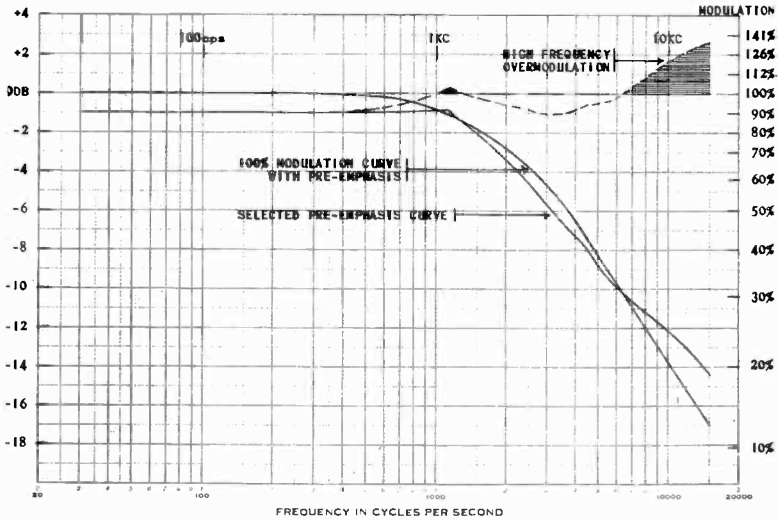


FIGURE 9

Fig. 9 shows the amount of overmodulation possible with the curve that falls closest to the 75 microsecond curve. With the low frequencies held to approximately 90% modulation by the peak limiting amplifier (which should preceed this unit for best control), it is possible to get a small amount of overmodulation in the 1100 to 1200 cps. area. Then, it is possible to get a serious amount above 6500 cps, with up to 130% @ 15KC. Another apparent deficiency occurs in the 2KC to 5KC region, where the Networks and larger stations generally install circuitry to give the system a gentle hump for "presence effect". The curves shown will give an almost opposite effect.

The system that would apparently give the least degradation of signal, yet yield full protection against FM overmodulation is shown in Fig. 10. The signal is pre-emphasized with a standard 75 microsecond curve and any random program peak that exceeds this curve is clipped off. Then, the signal is fed through a standard 75 microsecond de-emphasis curve to give an overall flat response.

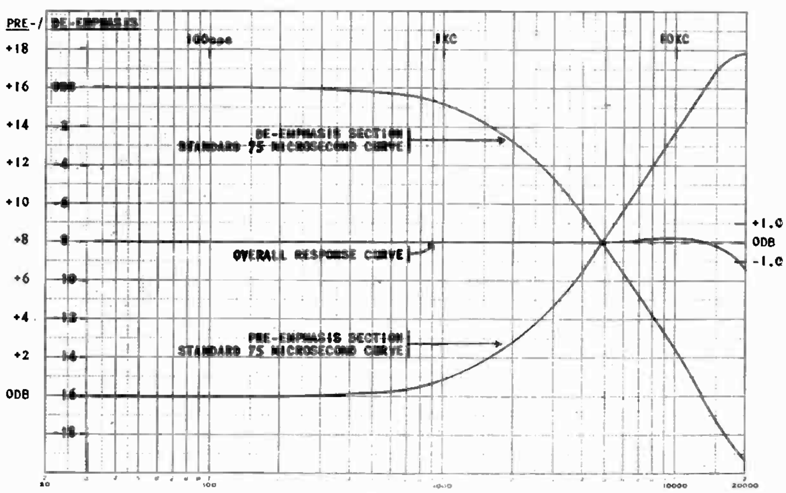


FIGURE 10

Actually, the three curves shown are carefully plotted from the test data on the new FM Top-Level Unit that was developed specifically to eliminate FM overmodulation. The pre-emphasis filter measured within 0.1 db of the standard curve. The overall response measured +0.2 db

@ 10KC and -0.2 db @ 15KC, it was essentially flat below these frequencies. The M6467 FM Top-Level has two identical sections with essentially complete separation. Thus, it may be used for Left and Right stereo processing, main channel and sub channel processing, etc. It may even be used for FM in one channel and TV on the other.

The same problem that has been discussed for FM does exist on the aural portion of TV Stations. It needs the same method of correction.

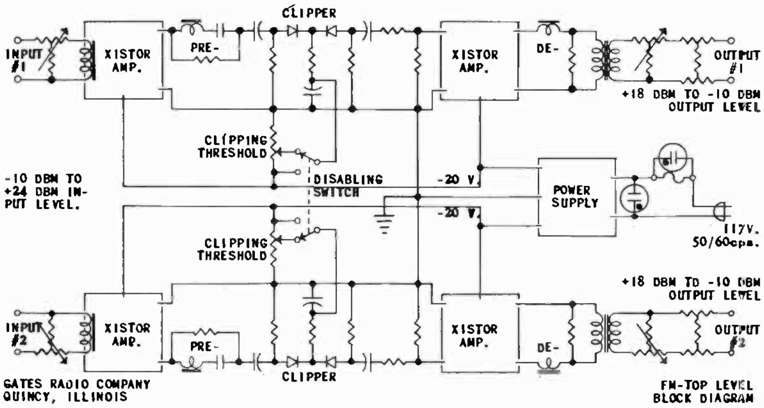


FIGURE 11

Fig. 11 shows the block diagram of the FM Top-Level. After the variable input gain control a transistor amplifier boosts the gain to the proper processing level. This is followed by a precision pre-emphasis filter, a balanced series clipper with its output matching section. This feeds into another transistor amplifier to recover the circuit losses of the preceeding components; then into a precision de-emphasis filter, isolation transformer, variable output gain control, and finally into a 6 db isolation pad.

The unit has 28 db gain, guaranteed ±1 db frequency response, 0.5% maximum distortion (below the clipping point), 75 db or better noise, instantaneous attack and release time, an input level range from -10 dbm to +24 dbm, and an output level range from +18 dbm to -10 dbm after the 6 db line isolation pad.

The unit does not cause deterioration of the programming when properly used because it does not act until the offending program peak tries to exceed 100% modulation. Then it neatly and instantaneously clips the excessive portion of the peak only, without affecting any of the associated signal. The harmonics generated by this clipping are greatly attenuated by the following de-emphasis filter so the action of the unit is extremely difficult to detect by critical listening tests.

IN SUMMARY: Pre-emphasized FM overmodulation presents a very complex problem that requires custom designed equipment to correct. With properly installed and operating corrective equipment, the FM system is actually enhanced since gross overmodulation and associated distortion are completely eliminated.

W. J. Kabrick
Advance Development Engineer
Gates Radio Company

THE USE OF MOBILE RADIO

IN

ON-THE-SPOT NEWS COVERAGE

N.C. Colby

Radio Corporation of America

THE USE OF MOBILE RADIO

IN

ON-THE-SPOT NEWS COVERAGE

The problem to be discussed in this paper is that of communicating between two points by means of mobile radio for, in this instance, the specific purpose of reporting news from unspecified locations remote from a broadcast studio. The problem, which is unique to each individual broadcaster, includes question of eligibility to use mobile radio, frequency allocations, system design and equipment availability. I want to indicate how and where the answers to these questions may be found in order to solve a given user's problem. Mobile radio refers to hand carried transceivers, transceivers installed in vehicles, and temporary fixed equipment installations. The applicable FCC definitions in Sub Part D, Paragraph 74.401, or Part 74 of the FCC rules are:

Remote pickup broadcast base stations are defined as "A base station licensed for communicating with remote pickup broadcast mobile stations", and,

Remote pickup broadcast mobile stations are defined as "A land mobile station licensed for the transmission of program material and related communications from the scene of events, which occur outside a studio, to broadcasting stations and for communicating with other remote pickup broadcast stations and mobile stations. (As used in this part, land mobile stations include hand-carried, pack-carrier, and other portable transmitters.)"

Eligibility to operate equipment in this service is specified by the FCC, in Paragraph 74.432(a) as follows: "A license for a remote pickup broadcast base station or mobile station will be issued only to the licensee of a standard, FM, or television broadcasting station. More than one remote pickup broadcast base and mobile station may be authorized to a single licensee. A separate license is required for each transmitter. An application for a new remote pickup broadcast base or mobile station shall specify the frequency or frequencies desired and the transmitter shall be capable of operating on each frequency requested."

Frequencies available for remote pickup broadcast station operations are shown in Figure 1. Group A carries a footnote to the effect that operation is subject to the condition of non-interference with standard broadcast reception. The band from 1605 Kc to 1715 Kc, in which Group A falls, is shared with six other services; aeronautical fixed, international fixed, industrial, public safety, maritime mobile, and radio-navigation. The long range propagation characteristics of signals in this frequency band increases the user's chances of interference from distant co-channel users. The necessity for large antenna structures makes this band less desirable for mobile use.

Groups D through J carry a footnote identical to the footnote for Group A. The frequencies in Groups D through J fall into two FCC groups that, together, lie between 25.6 Mc and 26.48 Mc. The frequencies from 25.6 Mc to 26.1 Mc are assigned primarily to international broadcasting. The frequencies between 26.1 Mc and 26.48 Mc are assignable to land mobile, principally for remote pickup service. Channel spacing is 20 Kc beginning at 26.11 Mc.

In Group K there are fourteen frequency assignments in the VHF band. Nine of these frequencies between 152.87 Mc and 153.35 Mc are shared by the land mobile industrial service and they are assigned for remote pickup on a non-interference basis. Five frequencies between 161.64 Mc and 161.76 Mc are assigned to the remote pickup service exclusively. There are some historical users in the public safety and land transportation services who are permitted to continue on the basis that no interference is caused to the remote pickup service.

Groups L and M are in a government band and are assigned only on a non-interfering basis and not at all in an area in the southeastern United States defined in the footnote.

Group N contains twenty UHF frequencies assigned exclusively to the remote pickup service. Many recent developments in equipment for this band should make its use highly desirable. More will be said of this new equipment later.

Whether a broadcaster elects to buy his own system or to buy the service from a common carrier depends on a number of circumstances including the number of mobile units planned for the system, the coverage required, the availability of service from a common carrier, and available equipment maintenance service.

Mobile radio telephone service provided by common carriers has several advantages. No investment in equipment is required. A good "system" is provided because the common carrier will have facilities for providing a good base station transmitter site and satellite receivers which extend coverage over a much greater area than is possible with a single receiving site. Equipment maintenance service is provided by the common carrier. The chief disadvantage of the common carrier system is the likelihood of not being able to get a free channel at the exact time it is desired for news coverage. The advent of the new improved mobile telephone service, abbreviated IMTS, has brought a bright ray of hope for the common carrier mobile telephone service. The IMTS concept involves trunking on the eleven channels assigned to this service in the 150 Mc portion of the spectrum. It can be shown that for a 5% probability of blocking, four single channels can serve twenty users while four channels, in which trunking is practiced, will serve 5.9 times as many users. The advantage increases as the number of channels in the system increases. A second feature of the IMTS system is the extent to which privacy of communications is achieved through the use of receivers that seek an idle marked channel the moment the channel to which they are tuned becomes busy. The IMTS system, now referred to in the Bell Laboratories as the MJ system, has many sophisticated operational features that are too numerous to cover in this paper.

Privately owned systems are most economical for systems having several mobile units. The base station installation is the most costly single item in the system; hence, the more mobile units associated with it, the lower is cost per mobile unit. Privately owned systems provide the greatest opportunity for designing a system to meet the owner's particular needs. Private systems can, with proper frequency coordination, provide a reliable service with the freedom from co-channel interference so necessary for broadcast service.

For those engineers who would like to design their own systems, a large body of systems engineering knowledge is now in existance in the technical literature. The goal of a system design is to provide a radio circuit over which a highly intelligible voice message may be transmitted and with adequate margin to allow for equipment and radio propagation deterioration. A circuit that provides a 40 db signal-to-noise ratio under the worst condition of propagation, and in which harmonic distortion does not exceed 10%, will meet the requirements. The required systems engineering knowledge involves knowledge of equipment characteristics and knowledge of electromagnetic wave propagation.

A notable example of the knowledge that exists concerning wave propagation is the published papers of Kenneth Bullington of the Bell Telephone Laboratories; for example, "Propagation at Frequencies Above 30 Mc" published in the PROCEEDINGS OF THE IRE, October, 1947. The RCA Service Company published a very useful system planning guide entitled "Point-to-Point Radio Relay Systems". With the help of the references cited, it is possible to predict, with an error of at most 3 db, the signal level to be expected at a given distance from a transmitter.

Two simple rule-of-thumb equations, relating to signal propagation, that a systems planner should always keep in mind are shown in Figure 2. The first equation gives the power density in watts per square meter at a distance r from an isotropic antenna radiating P watts. The second equation relates the gain and effective area of an antenna. As an example of the use of these equations; assume a transmitter operating at 150 Mc with a power output of 50 watts, a base station antenna gain of 6 db and a receiving dipole of 30 miles away, what is the level of the received signal on a 50 ohm transmission line? The first equation can be used to find the power density in free space at the receiving point. The power density at the receiving antenna is 6855 micro-microwatts per square meter. The second equation shows that the effective area of the receiving resonant dipole is .521 square meters; hence, the power received is .521 times 6855 micro-microwatts or 3571 micro-microwatts. This is approximately 420 microvolts on a 50 ohm transmission line. This is a free space signal and is stronger than would be received were the antennas near the earth, but is an indication of what one can expect.

The presence of the earth and the limitations of finite antenna heights will modify the results of the preceding calculations to give a lower received signal level. The reduced signal level is the result of cancellation of the direct signal by the signal reflected from the earth's surface and by absorption of energy by vegetation in the case of a grazing path. These effects are taken account of in the nomographs in the references cited. By using these nomographs for the example worked out above, and with the additional assumption of a 300 ft. transmitting antenna height and a 7 ft. receiving antenna height, one gets 8 microvolts for the received signal.

Nomographs and slide rules are available from manufacturers of mobile systems components, especially manufacturers of antennas, that are quite useful guides in systems planning. The RCA Service Co. book is very useful for planning paths in which there are intervening obstacles.

The equipment characteristics of most importance to systems planners are:

1. Transmitter power output.
2. Transmitting and receiving antenna gains.
3. Receivers sensitivity.
4. Audio distortion.
5. Primary power requirements.

Detailed equipment specifications are available from the manufacturer. In the next few paragraphs the significance of some of the equipment specifications is explained.

The FCC rules do not specifically limit transmitter power beyond the statement that no more power should be used than is required to establish an acceptable radio circuit. The authorized power will be stated on the station license. The maximum power output capability of the mobile transmitter will usually be needed to compensate for the relatively poor performance of mobile antennas. A mobile transmitter for remote pick-up service should be capable of continuous duty - a capability not normally found in equipment designed for land mobile service. There are two exceptions; equipment designed for use in mobile telephone systems and a new mobile unit developed by RCA and first shown to the public at this NAB convention. The power output of continuous duty mobile transmitters is of the order of 30 watts. Continuous duty rating is necessary because of the long transmissions in the remote pick-up service as compared to the short transmissions (from a few seconds to a minute) typical of press-to-talk simplex operation in private user land mobile systems.

Base station antenna gains of 6 db and 10 db are common for omnidirectional antennas for use in the 150 Mc and the 450 Mc bands respectively. The stated gains are relative to a resonant dipole. The gain of a mobile antenna, which is most commonly a vertical quarter wave radiator, mounted on a conducting-surface (the automobile roof), is, for system planning purposes, taken as zero or minus two db relative to a resonant dipole. Claims of 3 or 4 db gain over a dipole are made by some manufacturers of special mobile antennas.

Receiver sensitivity is, in itself, an involved subject and any statement made about it will need some qualifications. The noise figure is seldom used to specify the performance of a receiver in the land mobile service, except in the designer's laboratory. This is true for two reasons; noise figures are difficult to measure and their significance is not popularly understood. A more common measure of receiver sensitivity is the minimum level of an RF signal, without modulation, required to produce 20 db of quieting at the receiver output. Whereas there is a correspondence between noise quieting and noise figure, it isn't one-to-one. The sensitivity of a receiver intended for land mobile service is the result of a compromise between minimum noise figure and the susceptibility of the receiver to intermodulation interference. Intermodulation interference results from the mixing, in the low level circuits of the receiver front-end, of two or more undesired signals. Intermodulation susceptibility is reduced by the use of narrow band, multi-sectional filters ahead of any active circuits of the receiver. The insertion loss of the filters reduces the overall receiver sensitivity db for db. An insertion loss of 4 db can be tolerated in exchange for better intermodulation performance.

In this discussion of systems engineering and equipment design it is appropriate to say a word about systems performance limitations. The problem is that there are not enough clear channel frequencies available to serve everyone that would like to use mobile radio. There is no limitation on the number of users thay may obtain a license to operate on a given channel. Most user groups practice "frequency co-ordination" to a greater or lesser extent. The best coordination is in the Public Safety service and the least in the Business radio service. Whether or not a person elects to become another co-channel user is decided by whether or not in the judgement of the potential user, the value of the communications outweighs the nuisance caused by other users on the same channel. Co-channel users attempt to gain an advantage for themselves by buying the highest power transmitters available - a power race is the result. The steady increase in the number of users and the increase in the use of high power transmitters has been responsible for the emergence of intermodulation that is now the number one problem in the large metropolitan areas. Receiver designers give more and more of their attention to the intermodulation problem in equipment design and are tending to optimize intermodulation performance at the cost of sensitivity and equipment first cost.

The minimum useable signal level in a system in metropolitan areas may be limited by ambient noise generated by the many gadgets associated with modern civilization - automobile ignition, neon signs, electrical machinery to name a few. On the basis of noise quieting, a sensitivity of 0.3 microvolts at 150 Mc and 0.5 microvolts at 450 Mc is achievable. At 150 Mc, with a signal into the receiver at a level that produces 20 db of quieting a S/N of approximately 16 db will be obtained if the carrier is deviated ±5 Kc with a 1000 cycle tone. Therefore, to obtain a 40 db S/N signal 25 db greater, i. e. 6 microvolts, would be required.

The audio distortion characteristics of equipment built for the land mobile service are adequate for remote pick up of voice signals. Harmonic distortion is less than 10%. The audio pass-band response between 300 and 3000 c/s is a function of the level into the transmitter. The audio signal processing in land mobile equipment is quite complex, the design goal being to raise the average modulation level relative to the peak level as much as possible. In normal operation the audio signal level to the transmitter is kept high enough to produce audio limiting before modulation. Under these circumstances the transmitted carrier is angle modulated in a way that produces frequency modulation rather than phase modulation.

The primary power required by a mobile transceiver should be as low as possible to avoid battery problems in the vehicle in which the equipment is mounted. The use of transistors exclusively in place of tubes, in mobile equipment designs, has reduced the battery drain to a point where mobile receivers may be left "on" all day long with no risk of discharging the automobile battery. RCA's Super Carfone and Super Fleetfone receivers, with an audio output capability of 5 watts, require only 200 milliamps of current from a 12 volt battery in a "ready-to-transmit" mode of operation. When transmitting, with a power output of 30 watts, the Super Fleetfone transmitters draw 10 amperes from a 12 volt battery. This is by far the lowest transmitter drain in the industry and is of real significance in the Remote-Pickup service where long transmissions are common.

At this point I would like to show you pictures of two of RCA's newest products for use in land mobile service, the 150 Mc and the 450 Mc Super Fleetfone. The view in Figure 3 shows the equipment in its case. The external appearance of both units is identical. The rugged construction is apparent. The receiver and transmitter exciter are housed in the compartment on the left and are common to both models. The chassis for the receiver/exciter is a copper plated zinc die casting. All of the printed circuits are on glass filled boards. The transmitter and transmitter power supply are housed in the compartment on the right. The entire compartment, which forms the chassis for the transmitter, is an aluminum die casting. The aluminum casting provides an excellent heat sink for the power transistors. The aluminum construction and the high efficiency of the transmitter power transistors make possible the continuous duty rating of the equipment. Figure 4 shows the unit with the top covers removed. The receiver die cast chassis is visible. The right hand portion of the transmitter enclosure houses the transmitter power supply. The high frequency transmitter transistors are in the enclosure in the upper left. The entire transmitter enclosure shows as an integral aluminum casting; this construction provides an ideal heat sink for all high power transistors. Figure 5 is a bottom view with covers removed. Printed circuits are used throughout. The cylindrical structure at the right, in the upper (transmitter) compartment contains the solid state antenna switching components. There are no electromechanical relays used in this unit.

The two Super Fleetfone equipments that you have just seen are true state-of-the-art products employing the best known methods of assembly and the newest high frequency "overlay" transistors developed by RCA's Semiconductor Division.

The Super Fleetfone equipment is designed to meet the reliability requirements of the Broadcast Service as well as the reliability requirements of the Public Safety and Special Industrial Land Mobile Services. I invite you to inspect the model on display in RCA's NAB exhibit.

FREQUENCY ASSIGNMENTS (MC/S)

GROUP A	GROUP D	GROUP E	GROUP F
[1] 1.606	[2] 25.87	[2] 25.91	[2] 25.95
1.622	26.15	26.17	26.19
1.646	26.25	26.27	26.29
	26.35	26.37	26.39

GROUP G	GROUP H	GROUP I	GROUP J
[3] 25.99	[3] 26.03	[2] 26.07	[2] 26.09
26.21	26.23	26.11	26.13
26.31	26.33	26.45	26.47
26.41	26.43		

GROUP K

[3] 152.87	[3] 153.17	[5] 161.64
[3] 152.93	[3] 153.23	[5] 161.67
[3] 152.99	[3] 153.29	[5] 161.70
[3] 153.05	[3] 153.35	[5] 161.73
[3] 153.11		[5] 161.76

GROUP L	GROUP M
[4] 166.25	[4] 170.15

GROUP N

450.05	450.55	455.05	455.55
450.15	450.65	455.15	455.65
450.25	450.75	455.25	455.75
450.35	450.85	455.35	455.85
450.45	450.95	455.45	455.95

Figure 1

$$P_d = \frac{P_t}{4\pi r^2}$$

P_d = POWER DENSITY AT A POINT DISTANT r FROM THE TRANSMITTER

P_t = POWER TRANSMITTED

$$A = \frac{G\lambda^2}{4\pi}$$

λ = WAVE LENGTH

A = EFFECTIVE AREA

G = GAIN OF THE ANTENNA RELATIVE TO AN ISOTROPIC RADIATOR

= 1.64 FOR A RESONANT DIPOLE

Figure 2

Figure 3

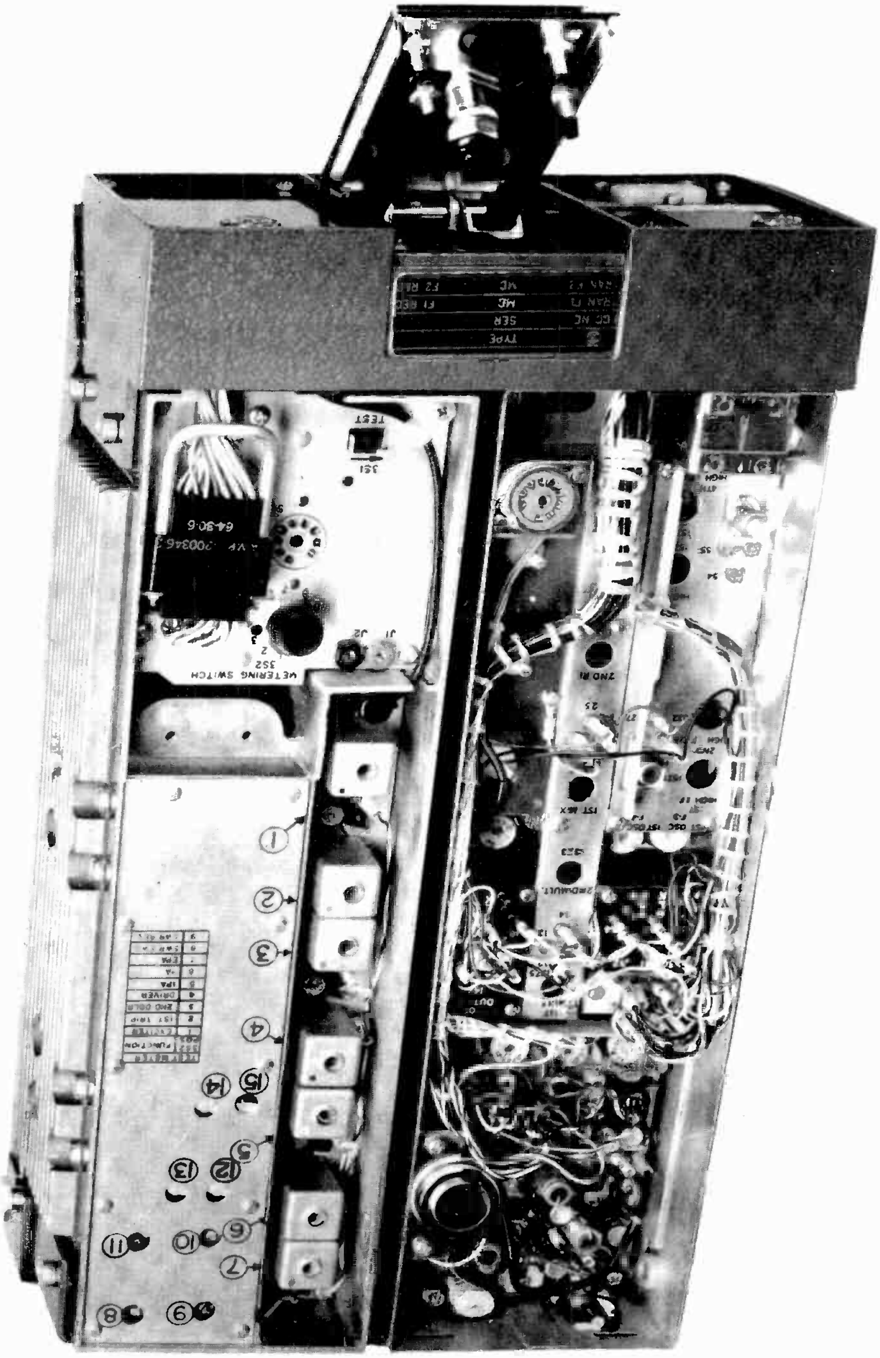


Figure 4

Figure 5

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a technical paper

Keeps You in View

A TECHNICAL PAPER

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ENGINEERING CONFERENCE

OF THE 43RD ANNUAL

NATIONAL ASSOCIATION OF BROADCASTERS CONVENTION

MARCH 23, 1965

SHOREHAM HOTEL, WASHINGTON, D.C.

A SIMPLE, TROUBLE-FREE QUADRUPLEX VTR SYSTEM

by

Steve Allen, President
Allen Electronic Corporation
Palo Alto, California

New quadruplex VTR systems designs provide substantial advantages in simpler, more stable, trouble-free VTR operation with highest performance. The resulting transistorized modular plug-in units comprise a modest cost VTR equipment which routinely achieves the performance specifications for the new high band color operation and provides automatic VTR "sync-lock" comparable to the best sync generator "gen-lock".

These solid state units are so packaged as to allow the complete changeover of existing tube type VTR equipment to eliminate all troublesome tube chassis. These new units make possible re-equipping for the best achievable performance and operational convenience with substantial saving in depreciation of the major capital investment in station VTR equipment.

A SIMPLE, TROUBLE-FREE QUADRUPLEX VTR SYSTEM

New quadruplex VTR Systems accomplish systems design which provide substantial advantages in simplier, more stable, trouble-free VTR operation with highest performance. These VTR Systems are made up of transistorized plug-in modular units which comprise a modest cost VTR equipment that meets or exceeds every performance specification of the most expensive latest "deluxe" models of VTR equipment.

These new VTR System components are packaged to install in a flat tape transport VTR console to provide a self-contained VTR console machine with no associated equipment racks or external system cabling. The overhead bridge provides handy control of monitoring equipment at a convenient eye level height which can be seen across a video tape operating room and which provides for the inclusion of a color monitor in color operating VTR machines.

A program of factory rebuilding of existing VTRs to incorporate these systems by conversion to "like new" units not only lowers cost but under the current IRS Regulations provides substantial profit advantages in the depreciation of VTR capital equipment in re-equipping for the best achievable performance and operational convenience.

The new Allen VTR Systems are simpler, have far fewer adjustments and controls, and have been painstakingly designed for the utmost in stability and reliability. They consist of:

1) A completely new ALL BAND Signal System which accommodates any current or proposed standard of VTR carrier and deviation frequencies including High Band color.

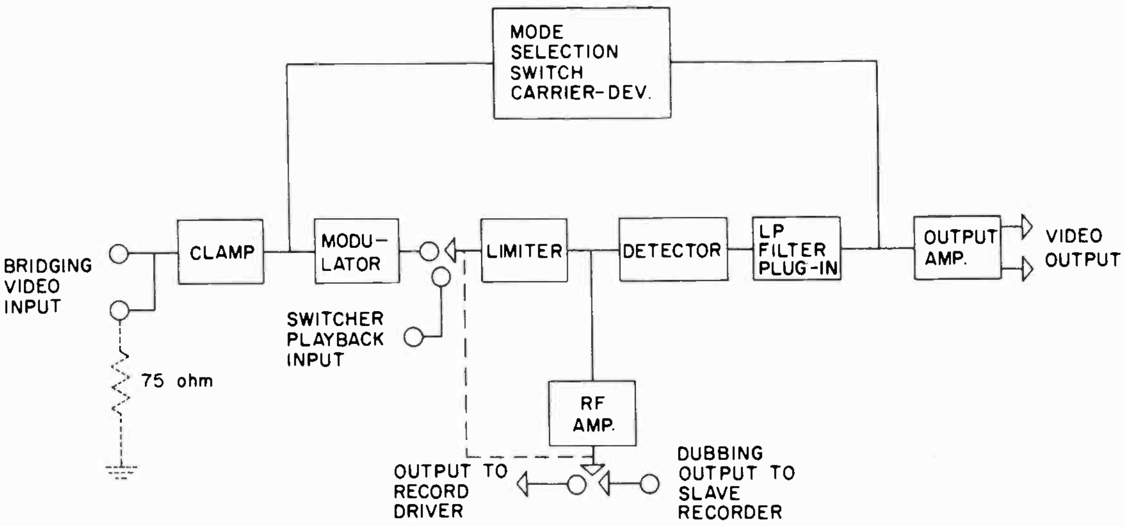
2) A completely new "Sync-lock" Servo System which has a more rapid, more positive automatic lock-up action and which provides a new order of servo stability.

3) A set of transistorized accessories to complete the VTR.

The Allen VTR Signal System consists of an unique VTR frequency modulation system of proven high performance. Units are available to serve any of the current or proposed carrier and deviation frequency standards. The extremely wide range of the detector slope of the demodulator, usable from below 3.4 mc/s up to 10 mc/s, provides many advantages. Tapes which have been recorded slightly off frequency are easily accommodated. The wide dynamic range of the detector slope provides clean sync output from tapes which would otherwise exhibit positional noise distortion on the leading edge of sync – with resultant poor results when time base corrected.

The units are designed to maintain extremely stable carrier frequency and contain a built-in calibrator to enable rapid setting up or checking of deviation and carrier frequency without interruption to the recording process. The unit's stable balanced characteristics provide a minimum of moire and beats for monochrome and color operation.

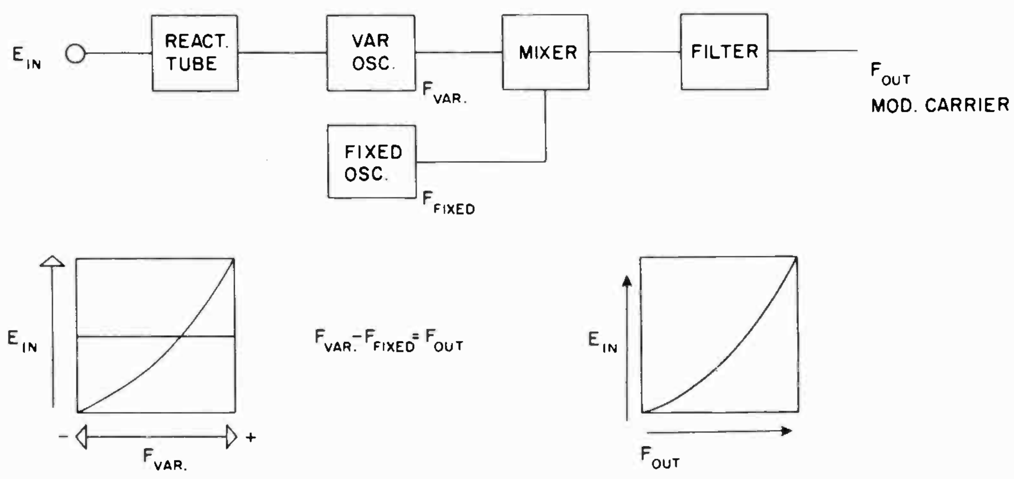
SIMPLIFIED SYSTEM BLOCK DIAGRAM



This is a simplified Block Diagram of the System. The mode selection switch is provided for changing the deviation and carrier frequency to any desired standard.

To consider the difference in the operation of this new unit and to explain the basis for its improved performance, it will be useful to consider the typical formerly used modulation system.

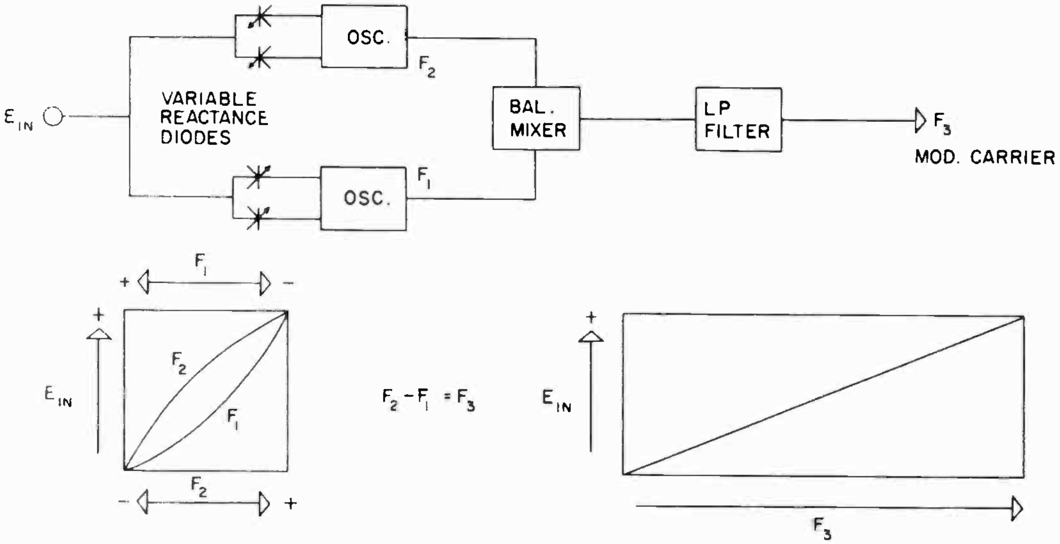
CONVENTION HETERODYNE MODULATOR



The transfer characteristics (input vs. frequency) of the conventional heterodyne modulation approach cannot be any better than that of the reactance control circuit. This places a severe limitation on the differential gain, axis shift, and phase shift characteristics of the system.

The Allen unit achieves improved performance by the utilization of a Differential Oscillator type Heterodyne Modulator.

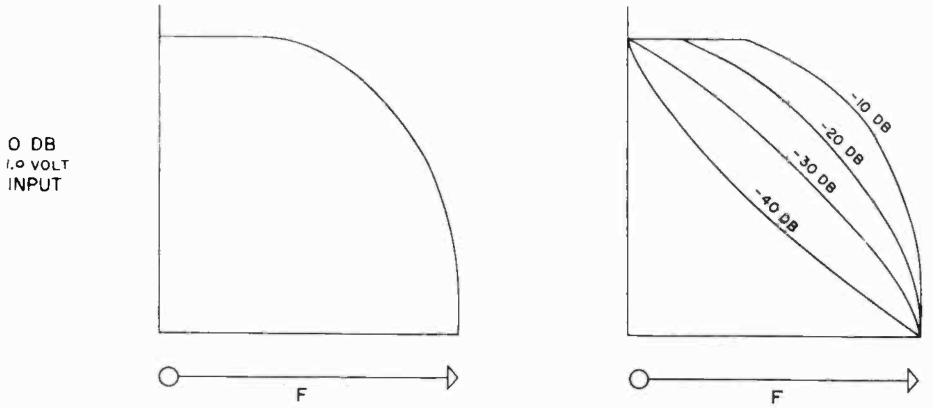
ALLEN DIFFERENTIAL OSCILLATOR TYPE HETERODYNE MODULATOR



In the Allen Differential Heterodyne approach, there is a first order cancellation of the reactance control characteristics, resulting in a 1 to 2 order of magnitude improvement of the modulation transfer characteristics as well as a 2 to 1 increase in its dynamic range. This is accomplished by arranging the variable reactance diodes in a complementary fashion so that the oscillator frequencies (F_1 and F_2) change in opposite directions with respect to the input signal. The substantial advantages of this system first introduced by Allen in 1963 have lead to its adoption by the major VTR manufacturers in their latest model high performance VTR's.

The playback system produces a measure of dropout resistance by a reduction in bandwidth with respect to dynamic changes in playback RF level.

RELATIVE FREQUENCY RESPONSE OF DEMODULATOR SYSTEM VERSUS LIMITER INPUT LEVEL



Individual Head Channel Equalization for RF playback is provided by a manual channel Equalizer for monochrome operation and by the Allen AUTOCHROMA automatic saturation control for color operation. These units with the solid state RF Record/ Playback electronics provide substantial improvements in the quality of color video tape recordings both on the basis of systems performance and in the control of color quality variations.

The system provides 43 to 46 db S/N for monochrome (either Low or High Band) and 43 to 46 db S/N for High Band color operation (38 to 40 db for Low Band color) when used with a good head and good tape.

Its excellent overall transfer characteristic and dynamic range provide in the order of 2% low frequency linearity and 5% differential gain measured at 3.58 MC. Differential phase for color operation is in the order of 5° and a transient response "K" factor substantially better than 2% with a 2T sine squared pulse.

The All Band Head Channel Switcher operates on a new principle to achieve the utmost in simplicity and compatibility as there are no operating controls or maintenance adjustments. This unit is compatible with all current and proposed deviation frequencies with no modifications necessary. This switcher generates its own timing reference and eliminates phasing controls. Individual gain controls in each channel are not required as the Allen Signal System will accept ±10 db variations in RF amplitude without degradation. (An individual Channel Gain Control Panel is available, however, for use with machines equipped for operation with the 3-M Dropout Compensator).

Head switching transients are greatly reduced in duration (0.2 to 0.5 u sec. maximum) and positioning is predictablefrom channel to channel thereby allowing the switching transients to be removed from the picture and placed within the first-half of the front porch of sync avoiding any transient near or at the leading edge of sync which might disturb automatic time base correction. This eliminates the possibility of switching transients in the video breaking up ungated clamps in other pieces of equipment and also removes possible FCC objection to switching transients being transmitted in the picture.

The switching function can also be automatically timed to be placed on the front porch, sync tip, or back porch.

The Allen VTR "Sync-Lock" Servo System consists of a Left Hand Control Panel Assembly with transistorized plug-in units for

1) Full automatic "Sync-Lock" for H & V in playback mode
2) Drum Servo control
3) Capstan servo
4) Tape guide position sensor
5) Tape guide servo
6) Drum motor drive amplifiers
7) Capstan motor drive amplifiers
8) Relay power supply
9) Control track record/playback
10) P.E.C. amplifier

DC, power, and motor amp output stages are located in the rear of the console.

This unique new system provides for line lock, H lock, V lock, or complete automatic "Sync-Lock" to maintain drum motor position in the order of 70 nano seconds with a ball bearing head. It has much faster recovery than other systems and has a stable servo loop which is damped so as not to sustain runaway oscillation.

The entire system is simple. The "Sync-Lock" Servo uses electronic switching for a smooth transition from vertical to horizontal sync reference. Its unique design makes the motor the longest time constant in the servo loop, and, therefore, does not require the usual critical stability controls.

Control of drum motor torque is positive as acceleration and deceleration are instantaneous which is not possible in an amplitude modulated system (deceleration rate in such systems is determined by inertia of motor friction and back EMF loading).

The Allen "Sync-Lock" Servo System utilizes three phase sine wave linear wide band motor amplifiers. Torque correction pulses are applied to the 240 cps drive signals at line scan rate 15,750 cps. This is more than an order of magnitude faster than can be achieved in square wave phase modulated systems which must wait for cross-over to change or in single phase modulation systems with phase shift which introduces delay into the H lock loop.

Recovery after disturbances such as an extremely poor splice or loss of signal is automatic and does not require stopping and restarting the machine. Initial frame and line lock-up is solid in less than two seconds after tape guide snaps in.

Each of the Allen transistorized plug-in modules contains the entire circuit for a complete system function eliminating the necessity of circuit tracing from card to card in case of trouble. The component layout on the module follows exactly the layout of the circuit schematic and block diagram greatly aiding trouble-shooting. All plug-ins are factory jig aligned to be interchangeable from machine to machine with no readjustment.

As the modules are designed to have one complete system function on a single module, inputs and outputs of each module are simple and standard. Any Allen module can be replaced by a replacement module from the factory or from another Allen unit with no readjustments required. Spare modules are modest in cost, can be stocked by the station or can be obtained from the supplier on emergency service basis.

In case of failure of any plug-in module, a phone call to the factory will result in immediate troubleshooting help on the problem by phone or, if needed, in having a replacement module on the way via air express. If the unit is within the one-year warranty policy, the module exchange service is free (unless unit is damaged or components changed). If the unit is out of warranty, the same fast factory service is provided and a loaner is made available while factory repairs are made to the defective module for a nominal service charge.

This assures the customer that his unit will be calibrated and brought within the exact standard specifications using factory procedures and specialized test equipment not otherwise available. In practice these equipments are designed with long mean-to-time-to-failure rates reducing greatly the need for servicing.

The Allen VTR systems are uniquely designed for Simplicity and Performance. Entirely new designs have allowed simpler systems to achieve better performance. The result is improved operation from all standpoints.

Vastly improved performance is obtained with

1) Simpler operation
2) Less adjustment
3) Less maintenance
4) Less complicated equipment and
5) Less cost

"ALLENIZED" VIDEO TAPE RECORDER

FEATURES

- Simpler Operation – far fewer controls and adjustments.
- Best performance – routinely meets or exceeds all performance specs of the latest, most expensive "deluxe" VTR equipment.
- Stable "Sync-Lock" Servo – positive lock comparable to best sync generator "gen-lock", automatic quickest recovery.
- Self-contained Console – all transistorized plug-in modules fit in console eliminating all racks and troublesome tubes.
- High Band Color Operation – at modest cost.
- Available as complete machine to add to your facilities.
- Available as systems components to re-equip your existing VTR.
- Plug-in modules interchangeable with no readjustments.
- Reduced Power – only 2.5 KW from power line.
- Flat Transport for easiest tape handling.
- Stable Signal System – incorporates all current deviation standards and will accommodate all currently proposed standards for high-band operation.
- Head Channel Switcher with no operating controls and no maintenance adjustments.
- Switching transients greatly reduced (less than 0.5 μ S) and removed from the picture with no upset of automatic timing correction.

SPECIFICATIONS

PHYSICAL

Size	75" high by 58" wide by 34½" deep – self contained Note: add 5" to installed depth for bridge	
Weight	Net – 1200 pounds	
Transport	Flat – for less tape handling problems	
Tape Timer	Accumulated time in minutes and seconds	

POWER REQUIREMENTS

Power Input	105 – 125 volts, 60 cycle, single phase 2.5 KW	

SIGNAL REQUIREMENTS

Vide Input	0.5 to 2.0 volts Peak to Peak Composite	
Sync Input	2 to 8 volts Peak to Peak	
Color Subcarrier	1.0 volt Peak to Peak, minimum (when equipped for color)	
Audio Input	-10 to ⁄+8 dbm, balanced bridge for 600 phm line	

OPERATING CHARACTERISTICS

Video Response	Low Band	High Band
	±1 db 50 cps to 3.6 mc/s ±3 db 30 cps to 4.2 mc/s	±1 db to 4.2 mc/s ±3 db to 4.5 mc/s
Audio Response	±3 db 50 to 12,500 cps	
Cue Channel Response	±3 db 300 to 6000 cps	
Video Noise	-44 db for either monochrome or 6.1 – 7.9 mc deviation color -46 db for 7.06 – 10.0 mc deviation color	
Audio Noise	-50 db (referred to 3% distortion at 400 cps)	
Jitter	±0.07 microseconds (disturbance rates greater than 1 cps)	
Drift	±0.07 microseconds (disturbance rates less than 1 cps)	
Video Equalization	Variable each head ±6 db at 4.2 mc/s Variable at demod ±3 db for all frequencies above 2.0 mc/s	

DEVIATION STANDARDS

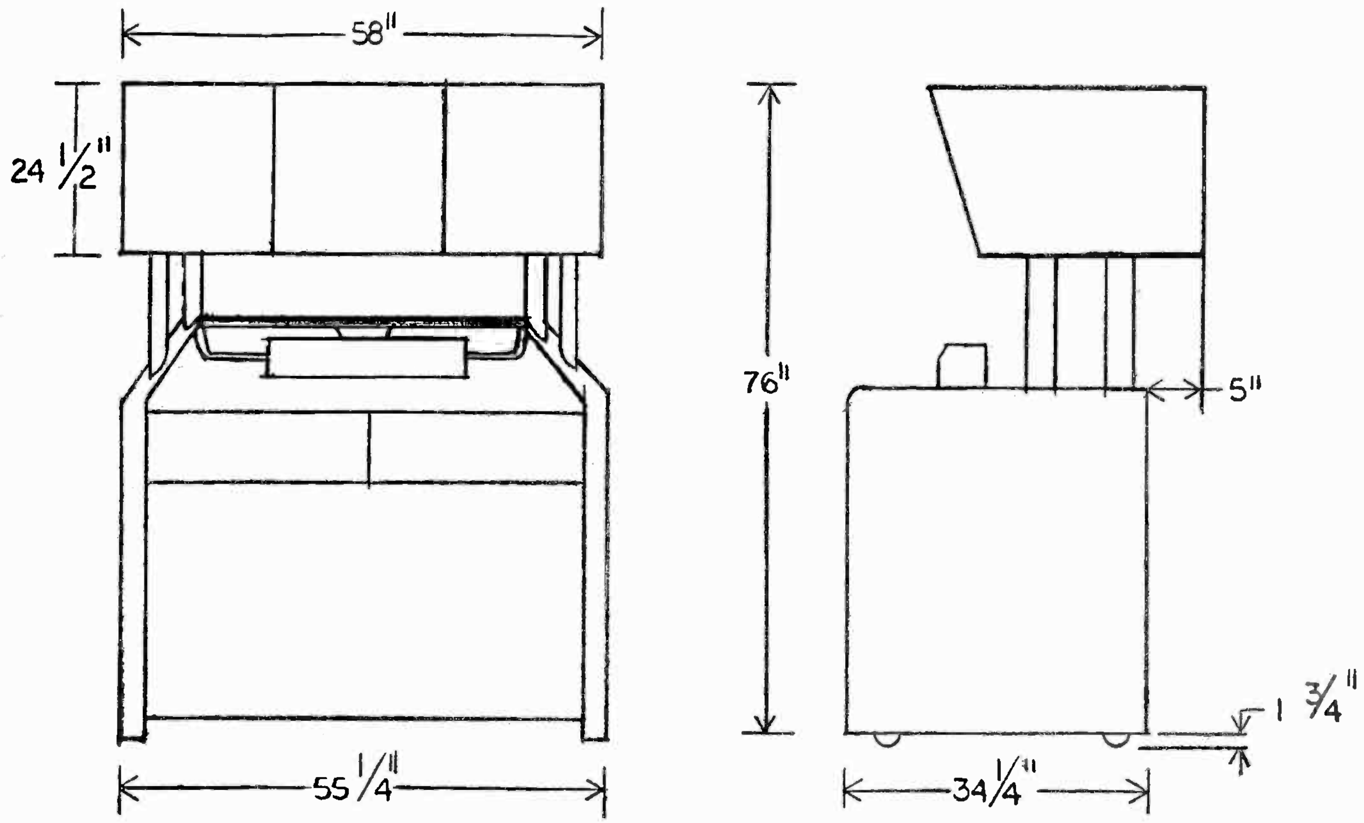
Standards provided	Selected by front panel switch:
4.28 – 6.8 mc/s	SMPTE monochrome record and playback
4.28 – 6.8 mc/s	SMPTE monochrome record with variable playback de-emphasis
5.5 – 6.5 mc/s	SMPTE color pre-emphasis (Low Band)
5.5 – 6.5 mc/s	SMPTE color record with variable playback de-emphasis
6.1 – 7.9 mc/s	"Mid Band" (RCA proposed)
7.06 – 10.0 mc/s	"High Band" (Ampex proposed)

PRE-ROLL REQUIREMENTS

Start Time	Within 4 seconds from stop tape guide pull-in and frame lock
Sync-Lock Mode	Fully synchronous picture (locked both vertically and horizontally) typically in less than ½ second after tape guide pull-in

GENERAL

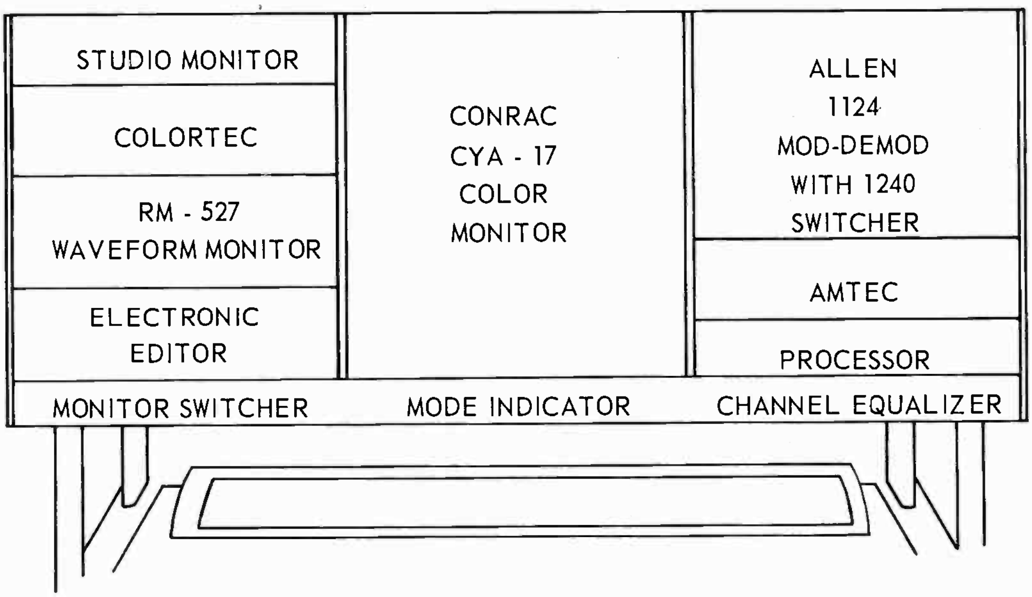
Tape Speed	15 IPS standard. May be provided for operation at 7.5 IPS where required
Rewind Time	4 minutes for 7200 ft. reel
Picture and Sound Separation	18½ frames with sound leading (for 15 IPS speed)
Head Switching	4 by 1 (Alternate heads are not paralleled)
Tape Interchangeability	Will play back all tapes, regardless of machine used for recording, provided they are made to applicable quadruplex standards.



CLEARANCE OF 24" NEEDED
ON 2 SIDES AND REAR
FOR DOORS.

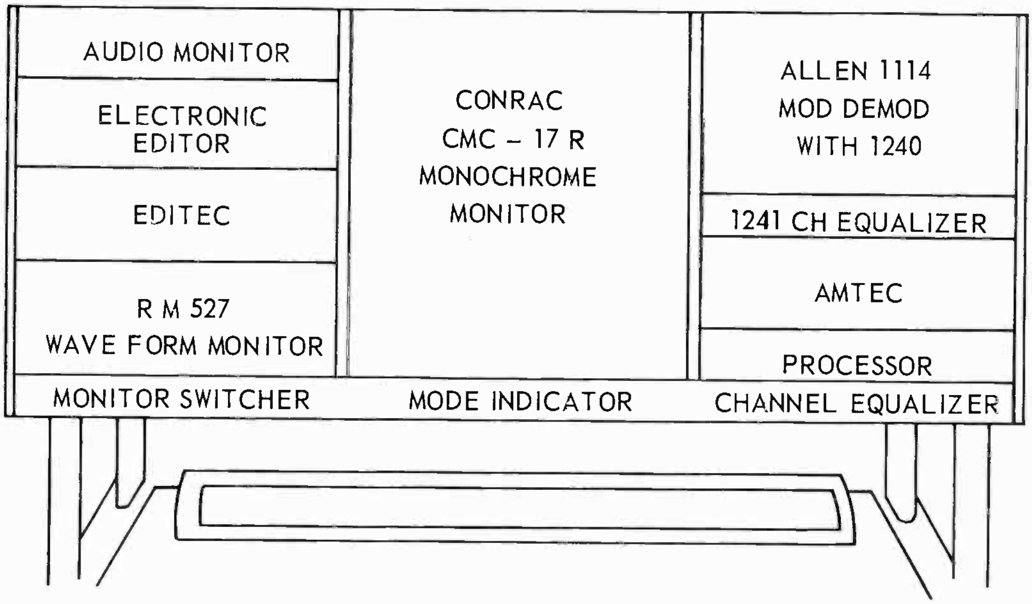
VISUAL ELECTRONICS CORP. ENGINEERING DEPARTMENT NEW YORK, NEW YORK	
"ALLENIZED" CONSOLE BRIDGE OVERALL DIMENSIONS	DATE 1/21/65
BY JM	DWG. H-30-0012-1
REV. / DATE	
REV. / DATE	

COLOR BRIDGE WITH SELF CONTAINED COLOR MONITOR



VISUAL ELECTRONICS CORP. ENGINEERING DEPARTMENT NEW YORK, NEW YORK		
"ALLENIZED" VTR TYPICAL BRIDGE LAYOUT		DATE 1/21/65
BY JM		DWG. H-30-0012-2
REV.	DATE	
REV.	DATE	

MONOCHROME COMPLETE WITH ELECTRONIC EDITING



VISUAL ELECTRONICS CORP. ENGINEERING DEPARTMENT NEW YORK, NEW YORK		
"ALLENIZED" VTR TYPICAL BRIDGE LAYOUT		DATE 1/21/65
BY JM		DWG. H-30-0012-5
REV.	DATE	
REV.	DATE	

Application of Quartz Iodine Lighting and New Electronic Dimmers in Television
by Milton Forman, Executive Director, ColorTran Industries

To be delivered at the NAB Engineering Conference, March 23, 1964

Six months ago MGM, in Hollywood, ran a series of tests to determine whether they could make a complete substitution of Quartz Iodine lights for standard studio lights. They were preparing to shoot a series of one-hour shows in color and the economic pressures required that they cut costs withour jeopardizing their quality.

The objectives of these carefully planned and controlled tests were to determine whether they could use Quartz Iodine lights and still get the quality they desired; whether the color tones and color rendition would be equal to their usual high standards; whether there would be any reduction in power consumption; and whether any major labor savings would result.

Fenton Hamilton, Head of the Electrical Department at MGM, took the assignment of determining whether the large scale use of Quartz Iodine lights was practical in lighting studio sets.

Instead of trying to mechanically substitute each Quartz Iodine light for a standard tungsten studio light, Mr. Hamilton made a careful evaluation of each Quartz light and developed a "feel " for each light. Then, when assigned to light the test set, he utilized the special features of each light to fulfill his requirements. The test footage was evaluated by the heads of the camera and production departments and the results were found to be completely acceptable. The color rendition was excellent, the artistic lighting emphasis required for the dramatic needs were fully met.

As a standard for comparison, the same set was illuminated with standard tungsten studio lights for black and white filming. The results were truly amazing.

Using standard lights, the set was brought to a level of 150 footcandles and almost 900 amperes were used. Using ColorTran Quartz Iodine lights, the same set was brought to a level of 400 footcandles using only 280 amperes. Figure 1 shows the set used for this test. As a result, MGM is now in the middle of a program of setting up each new television film for the complete use of Quartz Iodine lights.

Quartz Iodine lights are now widely used in shooting "Mr. Novak,", "Dr. Kildare", "The Man from Uncle", Gunsmoke" and many others.

The production of low-cost, high quality, color and black and white television programs is decisive for the economic health of the television and motion picture industries. Fortunately, the present revolution in lighting, which utilizes the Quartz Iodine source, placed a new instrument in the hands of the producers to help accomplish this end.

What is there about Quartz Iodine that lends it to this purpose?

1. Quartz Iodine lamps are very small for the wattage that is packed into them. Figure 2 shows the comparison of size of standard tungsten lamps and Quartz Iodine lamps.

2. Quartz Iodine lamps do not darken with age or lose their intensity. Standard tungsten lamps lose in excess of 25% of their initial intensity during their life.

3. Quartz Iodine lamps do not change in color temperature during their life. Standard tungsten lamps lose up to 300° K as they age.

4. For the same color temperature, Quartz Iodine lamps have a longer life. For example, a 2 Kilowatt standard bi-post lamp has a rated life, at 3200° K, of 100 hours. The life of various Quartz Iodine lamps at 3200°K varies from 125 hours to 500 hours.

5. Because of their filament design, standard tungsten lamps have the annoying feature of developing filament noise or "sing" shen used on AC. This "noise" is particularly noticeable in the scoop and the larger bi-post lamps. This filament "singing" is increased when used with electronic dimming. Because of the filament construction of all present Quartz Iodine lamps, none of them develop this filament "noise".

Certainly these advantages make it mandatory for the television and motion picture industries to study these lights very carefully.

Because of these advantages, ColorTran Industries allocated 80% of its research and development facilities to the development of new optical systems to take advantage of this new light source. Today, our engineering staff is larger than the combined staffs of the three largest manufacturers of television and motion picture lighting equipment.

The results from this intensive program over the last 3 years have been quite gratifying.

The first group of lights to be developed were the ColorTran Quartz King lights. They were designed to primarily meet the needs of location filming and outside broadcast. They were designed to be very compact and lightweight. For example, the Quartz King Dual 1000 light weighs only 1 pound and uses a 1000 watt, Quartz Iodine lamp. It produces more light than a 5 Kilowatt standard Fresnel spotlight. These lights were quickly accepted for outside broadcast use. For example, NBC used 50 of them to illuminate the chapel in Boston during the Kennedy Memorial Services. (See Figure 3). 100 units were used by the Canadian Broadcasting Company to cover the Queen of England's visit to Canada.

On 3 hours notice a camera crew was called on to shoot a sequence for the Jack Paar show at the Hollywood night club, "Whiskey A-go-go". A camera crew of two, set up 15 lights in one hour from the various wall outlets and took the necessary footage. Figure 4 shows some of these shots.

A much more difficult problem was the lighting requirements for the Olympic games in Tokyo in 1964. The ceilings in the main gymnasium and swimming pool arena were over 100 feet high and 250 footcandles were needed on the floor level. All existing lighting was of the mercury vapor type which would have made it impossible to shoot color. The level of illumination was much too low for television and film coverage.

Fortunately, ColorTran had previously developed a one Kilowatt light which produces up to 1,500,000 centerbeam candlepower or 160 footcandles at 100 feet. Figure 5 shows this light, the Hi-Spot. 240 of these were installed in the ceiling of the huge main gymnasium and they produced, at the floor, even illumination in excess of 250 footcandles.

100 of these Hi-Spots were installed in the main swimming pool arena with the same excellent results. Figure 6 shows the main gymnasium. Figure 7 shows the swimming pool arena. Figure 8 shows the method of installation of the Hi-Spot.

Particularly wide use is made of these lights in closed circuit and educational television. For example, the University of Illinois has just set up a studio and over 80% of the lighting complement is Quartz Iodine.

The acceptance of Quartz Iodine internationally has been quite rapid. In Australia we are providing a complete complement for a 50' x 70' stage. NHK, the government-owned network in Japan, has already set up a complete stage with Quartz lights. It seems that the initial stage of introduction of Quartz Iodine lights is passed and now serious attention and study must be given for their very wide use in the major studios of the world.

The first wide-spread application and acceptance of Quartz Iodine lights was for the illumination of large cycloramas. Many studios in the United States, Germany, Japan, etc., already use quartz cyc-lights. Figure 9 shows a typical 4-light, strip light, which utilizes a 1000 watt, 3200°K, 500 hour Quartz Iodine lamp. The optical design of the reflector permits very even, high level illumination of cycs up to 30 feet in height. The problem with this strip light is that it is not flexible enough. Since the spacing between the lamps is fixed, the level of illumination is fixed. To solve this problem, we developed a modularized version of this light called the ColorTran "Back Light". (See Figure 10). This light is only 5 inches high and 5 inches wide. It weighs one and one-half pounds and can be mounted on the floor, on pipes and on stands. The major networks in Japan are making excellent, imaginative use of this light and providing themselves with the flexibility required. Figure 11 shows these "cyc" lights mounted in the studio and it is to be noted that they have installed a 1-1/4 inch diameter pipe completely around the stage, close to the cyc to hold the "cyc" or "Back Lights".

Higher intensities at the cyc can be obtained by adding lights on the pipe and permitting a closer spacing of the lights. Figure 12 shows a close-up view of the installation of the lights and how they connect to the battens.

Another light which is extremely useful is the Mini-Light. This was developed at the request of the Walt Disney organization since they required a compact light which could be barndoored in 4 directions. The same fixture houses a 500 watt, 2900°K, Quartz Iodine lamp with a life of 10,000 hours, a 500, 750 or 1000 watt, 3200°K, Quartz Iodine lamp with a life of 500 hours. In addition to covering an area (to 10% of maximum intensity) of 24 feet, when the light is 10' away, it weighs 1-1/2 pounds. Its most important feature is that it can be cut with barndoors to a knife edge. Figure 13 shows the light and Figure 14 shows the remarkable control with a barndoor. Figure 15 shows the wide area it covers.

Another new series of Quartz lights is the newly introduced Shawdowless, Soft-Quartz lights. These are larger and heavier than the regular Quartz lights. They are made in 4 sizes and develop a quality of light far softer than the standard scoop. The smallest light (10" square) is a maximum of 750 watts and is being used by [redacted] NBC, Hollywood, as a camera light. This light is mounted directly on the camera to provide a very soft fill light. The larger models of this light are used to provide wide, shadowless illumination as shown in Figure 16 in the MGM tests. Figure 17 shows the light and it is to be noted that the light is completely reflected from a specially designed reflector.

Another extremely useful development is the Variable Broad which covers extremely large areas. The intensity and coverage of this light can be varied in a ratio of 2:1. At 10', this light covers an area (up to 10% of maximum intensity) up to 48 feet. A simple lever permits the field to be reduced to 25 feet while the intensity is increased two times. No lenses are necessary. Figure 18 shows the Vari-Broad. Note that the 1000W, 3200°K, 5000 hour lamp is used vertically at no sacrifice to life or performance.

Another light widely used is a small variable beam luminaire using either a 2000 hour, 2900°K, 400 watt lamp or a 125 hour, 3200°K, 650 watt lamp. Without the use of a lens, the intensity can be varied 7.7 times and the field changed from 7.5' diameter to 24 feet in diameter at 10 feet. Figure 19 shows the light and Figure 20 shows the output curve at 10'. Note that the intensity is varied from 800 footcandles to 110 footcandles.

The few lights described give a glimpse of a few of the new lights available.

However, there are thousands of Fresnel lights in the studios and we decided to make a study to see whether these could be converted to Quartz and made more efficient and useful. It was soon evident that the straight substitution of Quartz for standard incandescent lamps would not increase the efficiency of these lights. Therefore, we designed a new reflector and adapter. Figure 21 shows the new reflector adapter and Figure 22 shows it installed without modifying the present 2 Kilowatt Fresnel light. The results are quite interesting. You will note from Figure 23 that we compromised the performance in the hard spot. But this compromise is not so much as shown since the intensity of the standard lamp falls off in excess of 25%. However, you will note that we have increased the maximum spread in flood from 12' to 19' with very little loss of intensity.

Figure 24 is even more interesting since it compares the lumens per watt performance of a 2 Kilowatt, 12" Fresnel light. It is to be observed that the standard 2 Kilowatt, 3200°K lamp with 100 hours life, produces 4.7 lumens/watt in spot and a maximum 8.9 at widest flood. The Quartz Iodine conversion, using 2, 1 Kilowatt, 3200°K lamps with a life of 150 hours, produces from 3.9 lumens/watt in spot to 14.9 lumens/watt in widest flood. A maximum increase of 56%. Also remember that the standard lamp will lose about 25% in efficiency as it ages and the Quartz Iodine lamps will maintain their efficiency.

This leads us to one of the important problems facing sections of the television industry. Is it possible to take an existing black and white studio and convert it for color without increasing the power input? The cost of doubling the electrical capacity of existing studios would be enormous and therefore, intensive study to see whether it can be done with existing power is certainly justified. [redacted].

We have already shown that a 2 Kilowatt light can be increased up to 56% by converting it with a ColorTran Quartz Iodine adapter. Figure 25 shows an analysis of various Quartz Iodine lights when the lumens per watt is analyzed.

It must be noted that the total lumens available from any light source varies from 26 lumens per watt to 28.8 lumens per watt. You will note that all of the Quartz Iodine lights perform better than the standard 2Kw.-12" Fresnel lens, and 4 of the Quartz Iodine lights produce more than 20 lumens per watt in their field to 10% of maximum intensity.

One Network

[redacted] asked us to make an analysis of the amount of light available between the 10% and 1% of maximum intensity since this light falls on the set. Our studies show that at least another 3 lumens per watt are available. This is more than 10% of the light available when calculated to the 10% level.

In addition, we made an analysis of the field areas covered by single lights and this data is particularly interesting since it may lead to simpler arrangements of lights on a set. Figure 26 shows these results. This test was made with the light 10' from the surface covered. You will note that the areas covered are truly amazing.

The significance of the tests at MGM is that they used these lights as new instruments with special characteristics. They used them as new tools and their results were beyond what was expected. The television industry must do the same.

One word of caution. The maximum single lamp available now is one Kilowatt. Therefore, the absolute intensities available are limited. So we are limiting our recommendations only to sets that do not require very long throws. The medium size sets can be handled easily.

For the complete conversion to Quartz, we will still have to wait for the development of single, 2 Kilowatt lamps. But we are well on the road to making Quartz lighting an important instrument in reducing the cost of installation and production for film and live television because we can reduce the electrical current requred, we can reduce the cost and weight of hanging and controlling fixtures and we can provide more reliable lumenaires which maintain their intensity and color temperatures.

I wish to make a few comments about some new developments in the design of electronic dimmers. Up to now, electronic dimmers have utilized the Silicon Controlled Rectifier (SCR). The SCR is a silicon device for controlling power and is essentially a DC device. Therefore, in order to control AC, two of them are required back to back. Because its design requires a gate to control the current, it is extremely sensitive to line transients, therefore requiring special circuitry to protect it. In addition, it requires extremely fast fuses to protect it.

A few years ago, we were ready to introduce a line of SCR dimmers. At that time we became familiar with a new 5 layer silicon diode which had some remarkable characteristics. First, one device symmetrically controlled AC current. Being a diode, without a gate, it was easier to manufacture and it was not vulnerable to line transients. Therefore, it required no circuitry to protect it. In addition, the fusing to protect it is much less critical. But, most important, its surge characteristics for tungsten were excellent. We therefore scrapped our SCR dimmers and designed a line of dimmers using this silicon symmetrical diode.

Essentially, these dimmers for in-studio use perform similarly to the SCR dimmers. They can be filtered to any desired values to prevent filament noise and TV interference. The consoles can be designed to fulfill any and all of the most sophisticated requirements of television and stage.

For example, an installation is now going into KOLN-TV. In Tokyo, since May, 1964, a 200 dimmer system has been installed at NET-TV to fulfill the most rigid requirements of this large network. Figure 27 shows the control console and Figure 28 a rack for the dimmers. The government-owned network in Japan, "NHK", after extensive testing, just ordered a system composed of 500, 3 Kilowatt and 6 Kilowatt dimmers using this silicon symmetrical diode. In Australia, a new studio is being built and these dimmers are being installed there.

Yet, the most interesting application of these new silicon dimmers is the design of a complete line of portable dimmer systems which provide amazing flexibility. In concept, this circuitry is extremely simple and rugged. Each dimmer can be used in a system or by itself. The present capacity of these dimmers for 120 volts is 6 Kw., and for 220/240 volts, 10 Kw. Figure 29 shows the design of the dimmers. They are all plug-in and can be conveniently installed in a rack. A small adapter plugs into the back to permit them to be used individually. Figure 30 shows the adapter and Figure 31 shows the adapter installed.

The control consoles of these systems are very small and light. They require no external power and any size dimmer can be attached to any of the channels at any time. The portable console can be operated up to 2000 feet from the dimmers. All of the dimmers are fully filtered to the highest standards. Figure 32 shows 6-module control consoles for remote operation. Figure 33 shows a small console with 6 controllers and 1 master. It is 3" deep, 12" wide and 10" high, weighing 5 pounds. Figure 34 shows a portable console with 12 controllers and two masters. It is possible to control any dimmer independently. Any or all of the controllers and dimmers can be switched to either of the masters. In addition, since very light control cable connects each dimmer individually to each controller, it is possible to patch any of the dimmers at will to arrange them as deisred at the console itself. These consoles are also available with linear controllers. (See Figure 35). Such systems were provided for rental to television and stage work in San Francisco and Toronto, Canada. A simple system composed of 30, 2 Kilowatt dimmers was made for ABC and widely used during the Republican and Democratic Conventions in 1964.

The equipment we have described in this paper represents the sensitivity of Color-Tran to the needs and requests of various sections of the television and motion picture industries. Without the creative suggestions of the industry, these developments would have been impossible. Now, it is necessary to the rest of the industry to study this new equipment, use it creatively and recommend improvements. ColorTran is dedicated to a progressive program of solving the growing needs of the television and motion picture industries.

Figure 1: Test set at MGM: Standard Lights required 850 amperes to illuminate for black and white (150 foot candles.) ColorTran Quartz Lights required 280 amps to illuminate for color (400 foot-candles.)

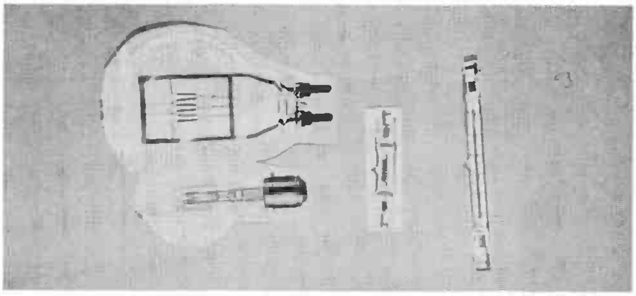


Figure 2: Comparison of size of standard studio lamps and Quartz-Iodine Lamps.

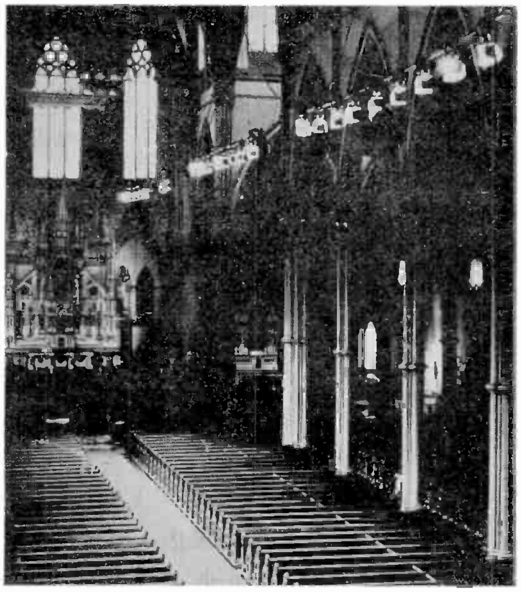


Figure 3: ColorTran Quartz-King Lights used to light Boston Chapel for the late President Kennedy's Memorial Services.

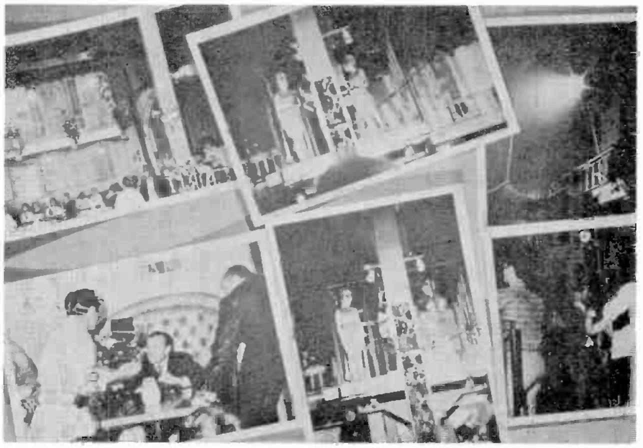


Figure 4: 15 lights consuming 1000 amperes, from wall sockets used to light "Wisk-A-Go-GO" for Jack Paar Show.

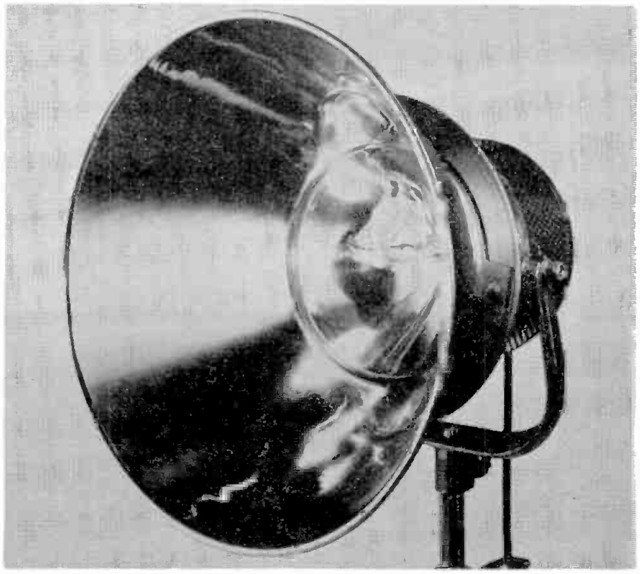


Figure 5: ColorTran Hi-Spot - produces 160 foot-candles at 100 feet used 1-kilowatt Quartz-Iodine Lamp.

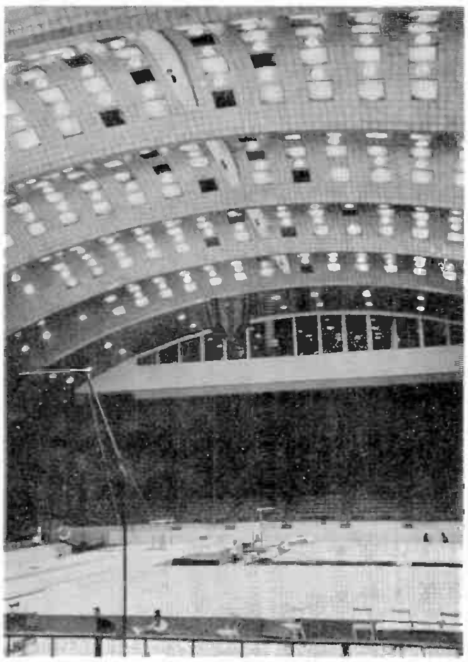


Figure 6: 240 ColorTran Hi-Spots mounted in ceiling of main gymnasium in Tokyo for Olympic games in 1964. (250 foot-candles at floor level.)

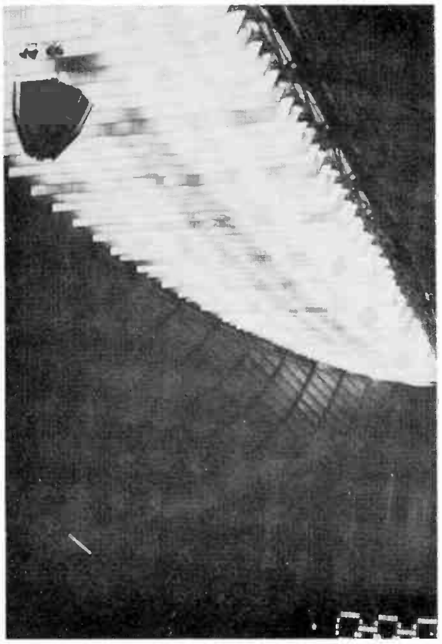


Figure 7: 100 ColorTran Hi-Spots used in main swimming pool arena in Tokyo for Olympic games. (250 foot-candles at floor level.)

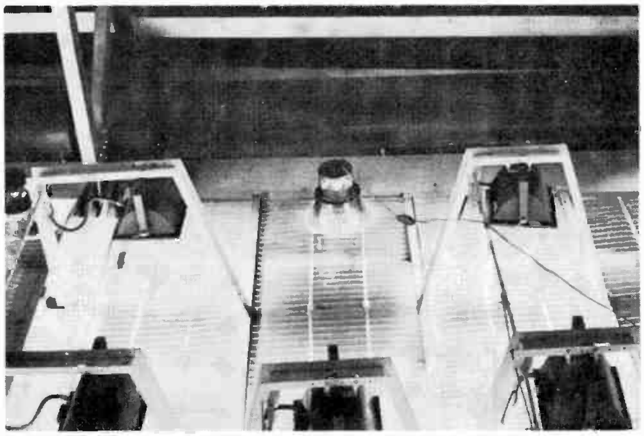


Figure 8: Method of installing ColorTran Hi-Spots for Olympic games.

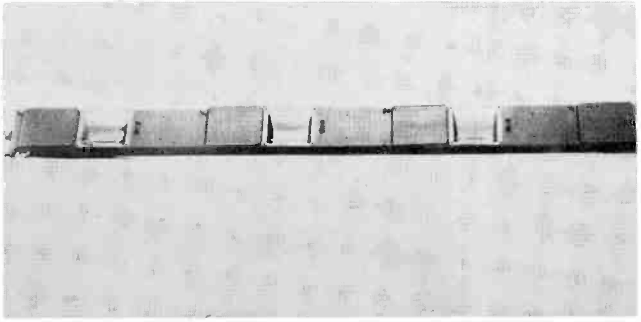


Figure 9: Standard Quartz-Iodine Strip-Cyc Lights.

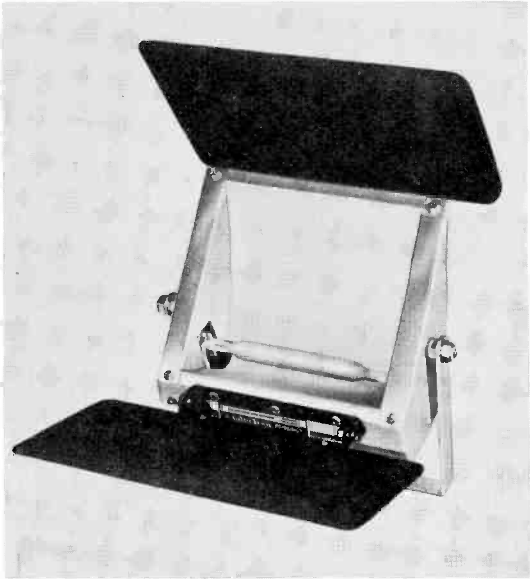


Figure 10: ColorTran Back Light for flexible lighting of cycloramas.

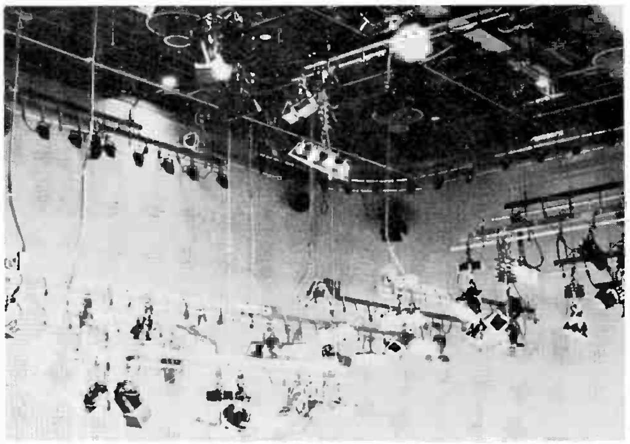


Figure 11: NHK-TV in Tokyo using individual cyc lights for lighting cycloramas.

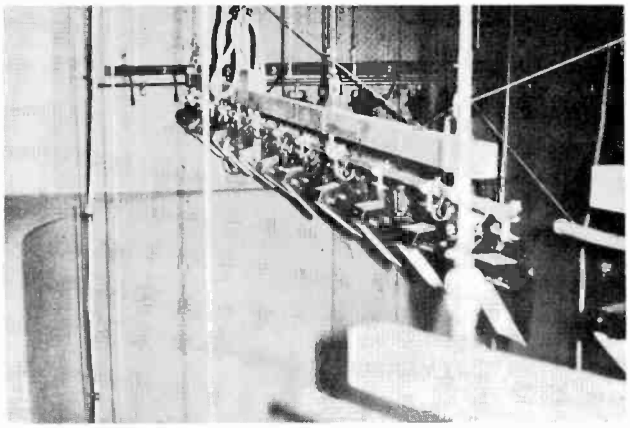


Figure 12: Detail of cyc lights at NHK-TV in Tokyo. Note: pipe used for holding lights permitting variable spacing.

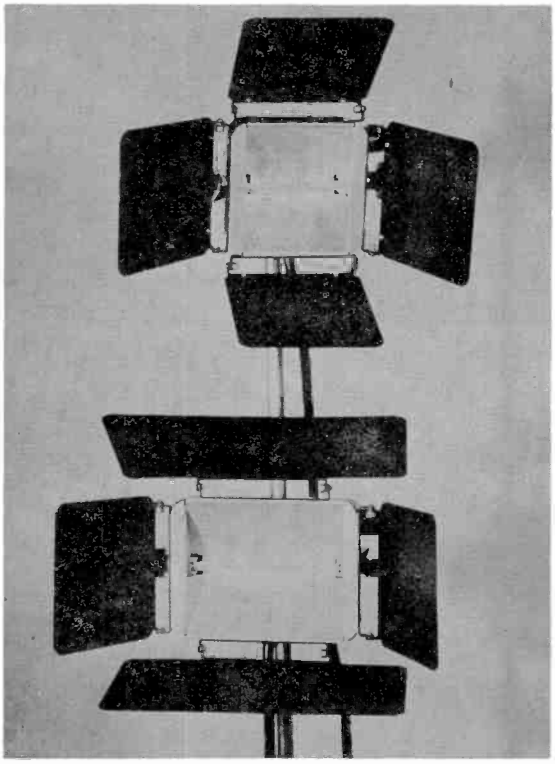
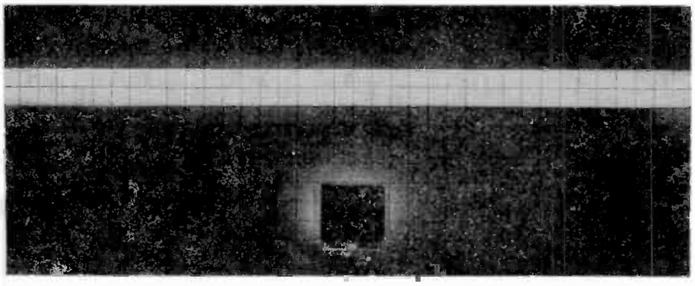
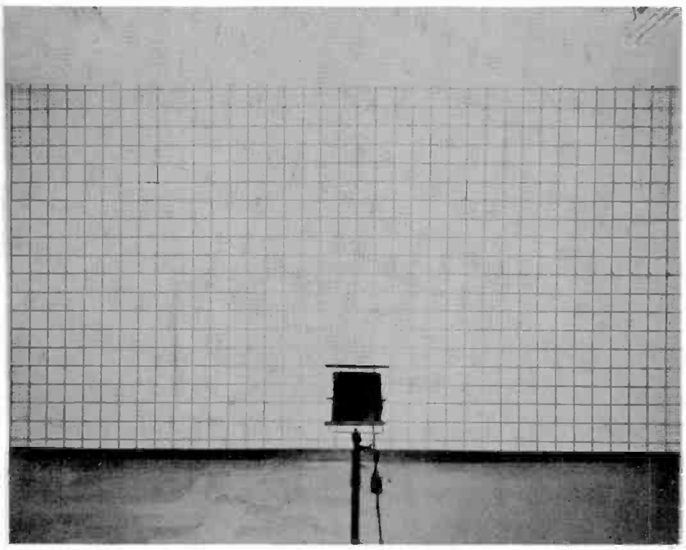


Figure 13: ColorTran Mini-Light uses 1000-watt, 500-hour - 3200K lamp.



igure 14: Knife-edge barn door effect possible with ColorTran ini-Light.



igure 15: Wide coverage with single ini-Light at 10 feet, covers 25-foot rea to 10% of maximum intensity.

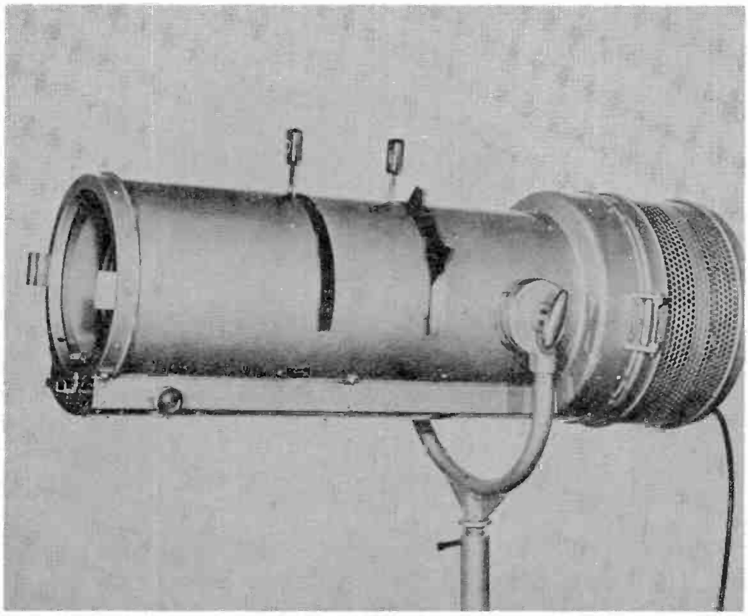


Figure 15A: 1-kilowatt Quartz-Iodine follow spot.

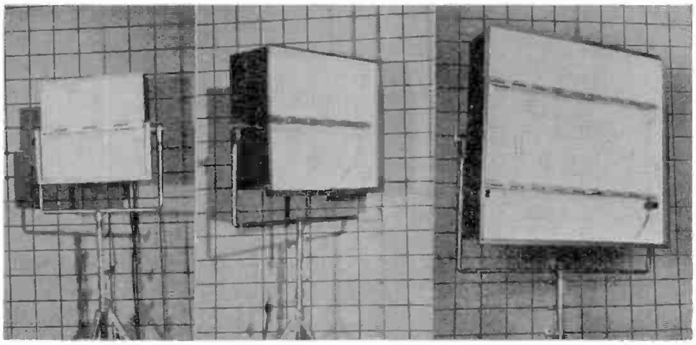


Figure 16: ColorTran Shadowless, Soft-Light, Designed in 1-killowatt, 2-kilowatt and 4-kilowatt capacities.

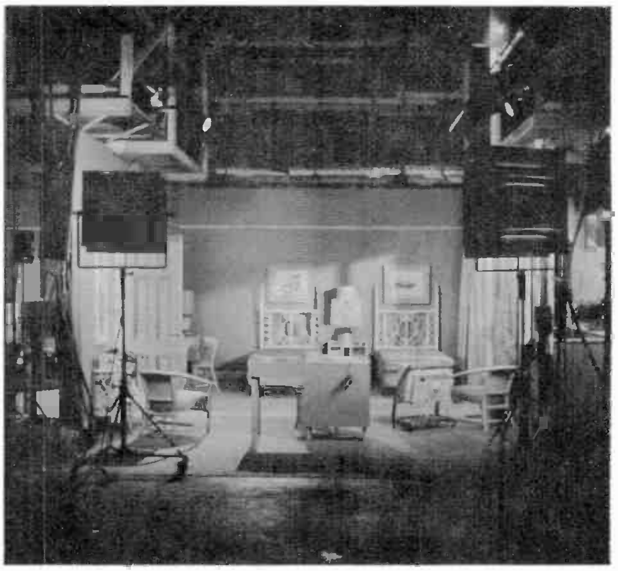


Figure 17: ColorTran Shadowless Light (in foreground) used in MGM tests.

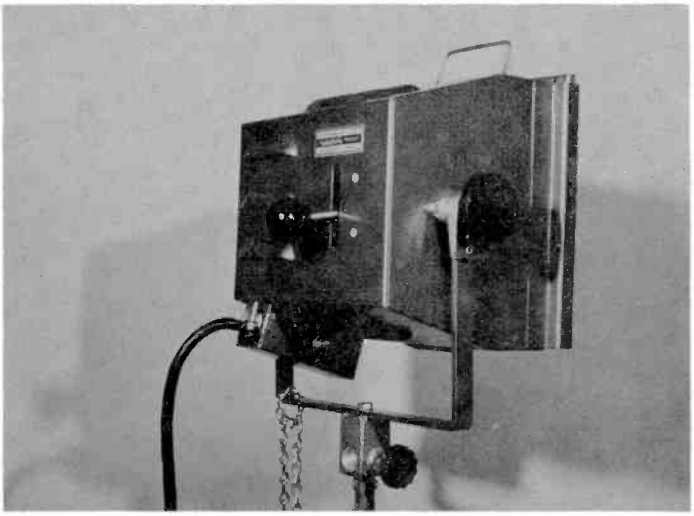


Figure 18: ColorTran Variable Broad. At 10 feet can be infinitely varied to cover an area from 25 feet wide to 48 feet wide.

Figure 19: ColorTran Multi-Beam (code LQF-6): A 650-watt Quartz - Iodine variable beam light which produces up to 800 foot-candles at 10 feet.

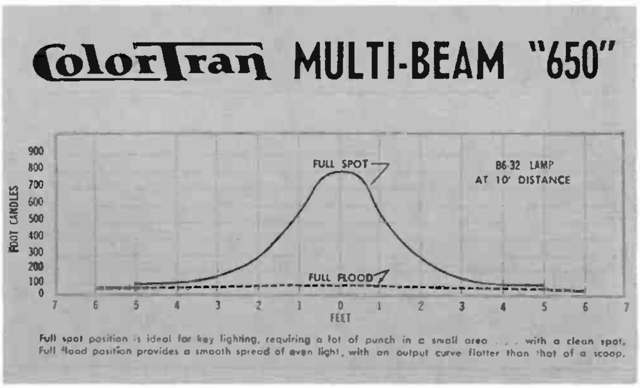


Figure 20: Performance chart showing infinite range of intensity of ColorTran LQF-6 Light.

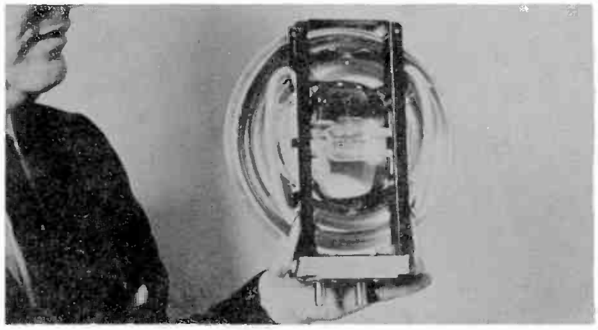


Figure 21: Quartz-Iodine reflector and adapter fits into standard 2-kilowatt Fresnal lights. Uses two 1-kilowatt Quartz-Iodine Lamps.

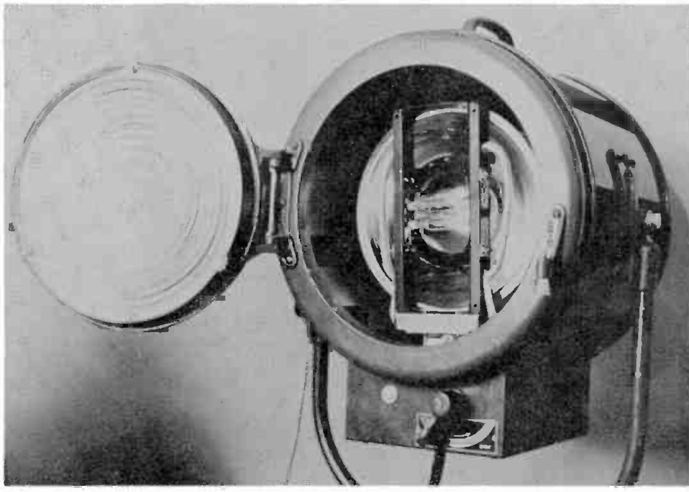


Figure 22: Quartz-Iodine Adapter fits into standard 2-kilowatt light. No modifications required.

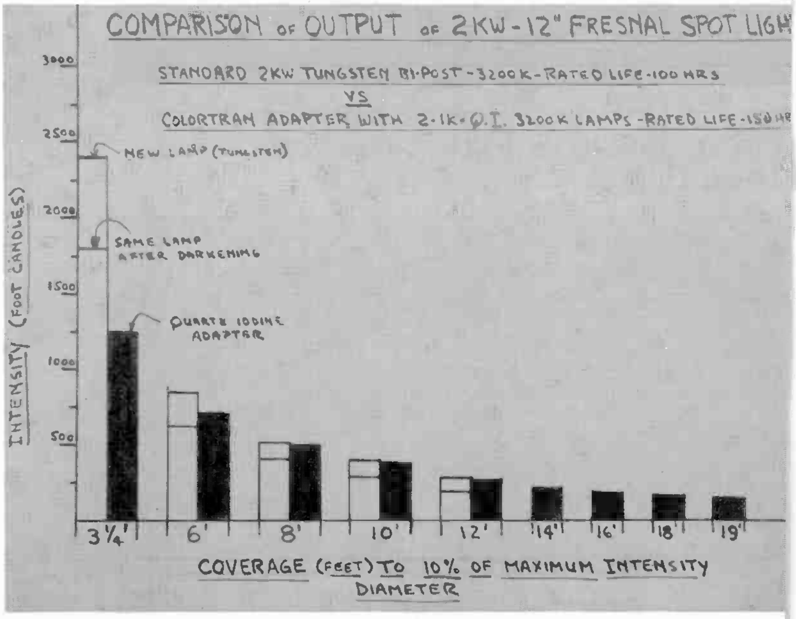


Figure 23: Comparison of output of standard 2-kilowatt, 14-inch Fresnal light and with 2-kilowatt Quartz-Iodine Reflector adapter. Note that intensity of spot is reduced and area covered is increased from 12 feet to 19 feet with very little loss of intensity.

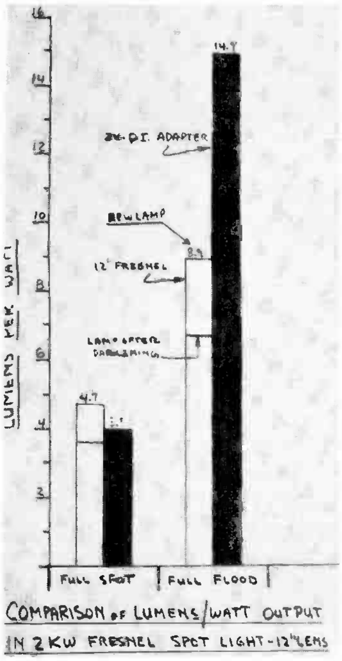


Figure 24: Comparison of lumens-per-watt output of 14-inch 2-kilowatt Fresnal light with standard 2-kilowatt lamp and Quartz-Iodine reflector adapter. Note that lumens-per-watt are increased over 50% when in wide flood.

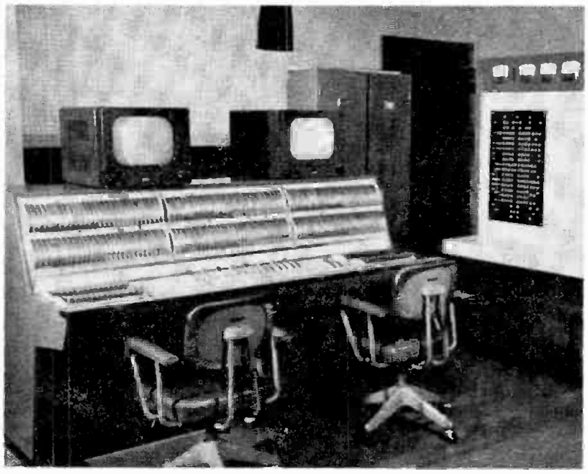


Figure 27: Console controlling 200 - 3-kilowatt electronic dimmers at NET-TV in Tokyo.

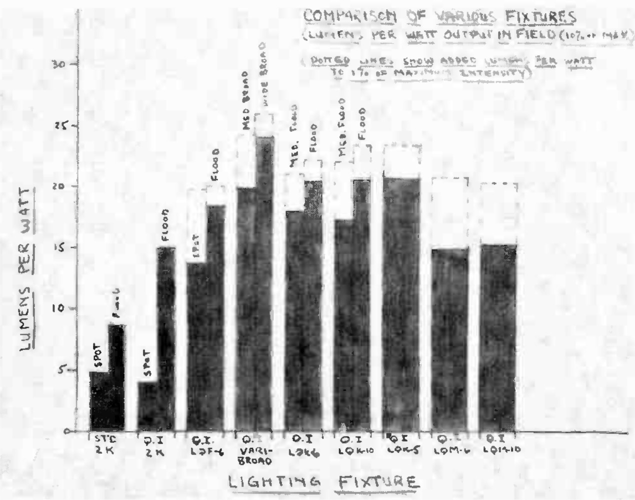


Figure 25: Lumens-per-watt comparison of various ColorTran Quartz-Iodine lights with standard 2-kilowatt, 14-inch Fresnal light.

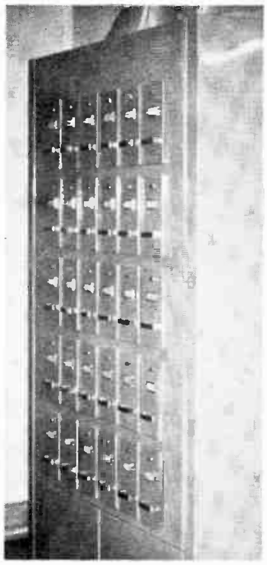


Figure 28: One of the Racks with 3 - kilowatt electronic plug-in dimmers.

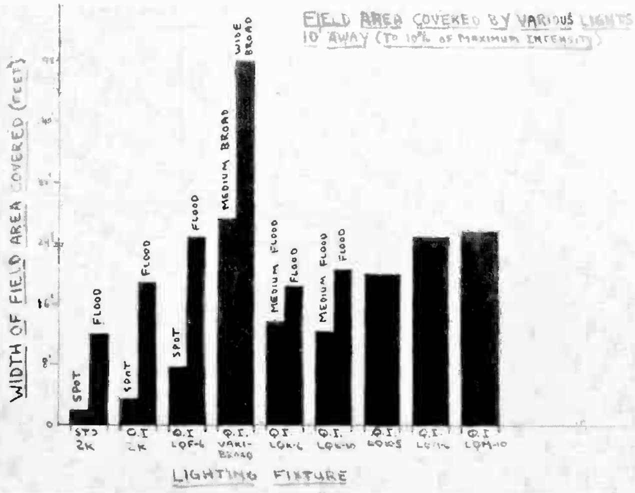


Figure 26: Comparison of width of area covered at 10 feet to 10% of maximum intensity of standard 2 - kilowatt - 14-inch Fresnal light and various ColorTran Quartz lights.

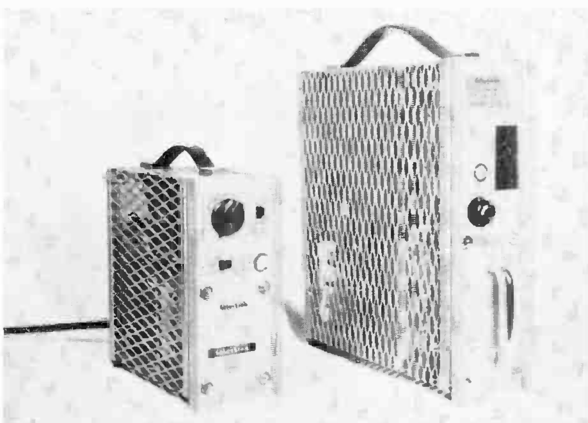


Figure 29: 1-kilowatt and 3-kilowatt portable electronic dimmers.

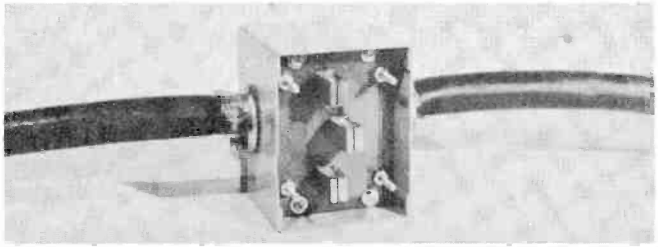


Figure 30: Adapter converting plug-in dimmer to portable dimmer.

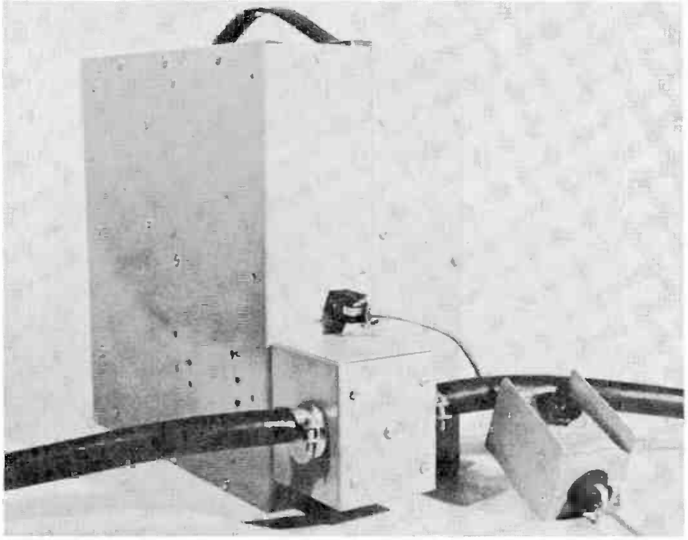


Figure 31: Adapter installed on plug-in dimmer.

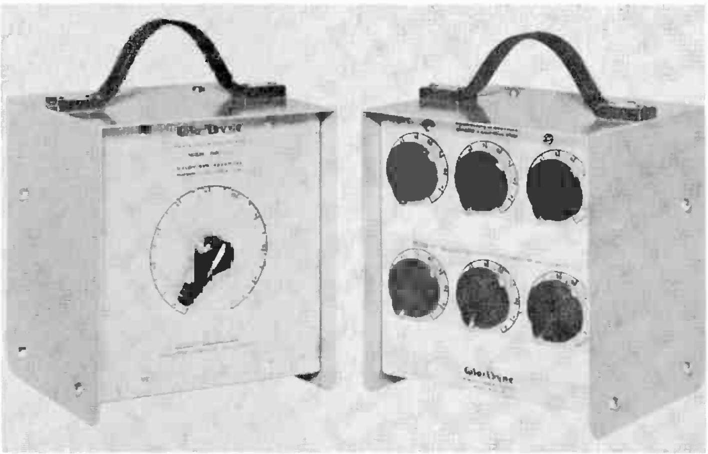


Figure 32: Shows 6" X 6" remote control units.

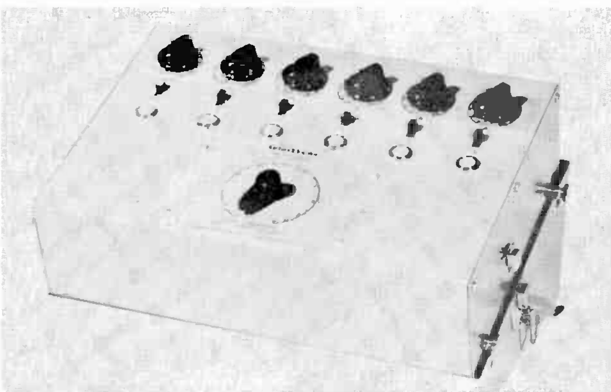


Figure 33: Portable remote console, weighs 6 lbs. and has 6 presets and one master. Controls any size dimmer.

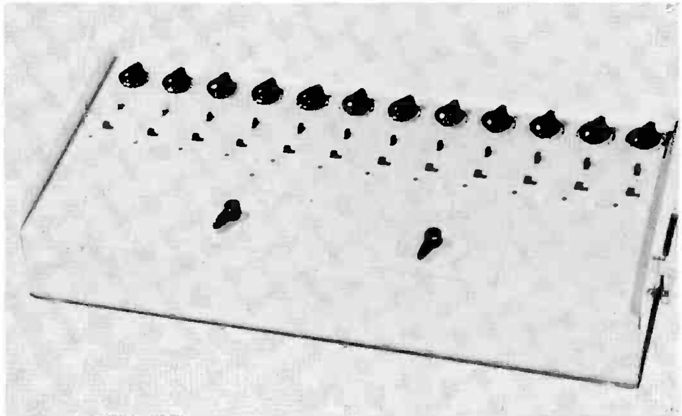


Figure 34: Portable remote console weighs 15 lbs. and controls 12 dimmers of any size. Each controller can operate dimmers independently. Any or all controllers can be switched to either of the two masters. Any size dimmer can be patched to any of the controllers.

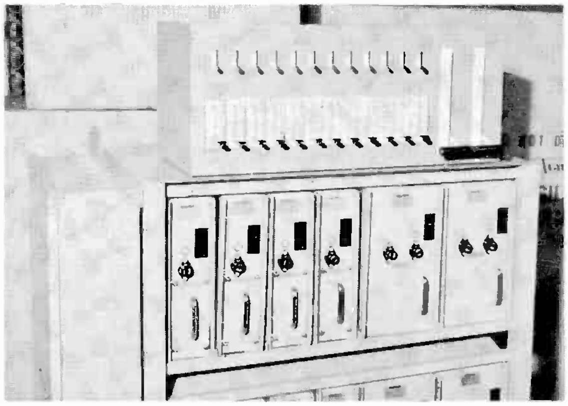


Figure 35: Portable remote console with linear controllers controls 12 dimmers of any size. Each controller can operate dimmers independently. Any size dimmer can be patched to any of the controllers.

Figure 36: Portable rack on casters with 8-3K and 4-6K plug-in dimmers. Each dimmer can be used as an individual unit, away from rack, with adapter shown in figure 31.

THE OPERATION OF TV TRANSMITTERS IN PARALLEL

by

ROBERT E. WINN

RADIO CORPORATION OF AMERICA

TRANSMITTER ANTENNA SYSTEMS

GIBBSBORO, N.J.

NAB CONVENTION
MARCH, 1965
WASHINGTON, D.C.

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The increase in reliability afforded by this type system has been calculated by Mr. G. D. Weinstock of RCA to increase the mean time before failure (MTBF) to 150%. This calculation does not take into account any maintenance or repair and states only that if two identical "units" are paralleled and made to operate together, the output will be available 50% longer when starting with two units instead of one.

With proper care and maintenance of the equipment and with the built in initial 150% MTBF figure, the off-air time should be negligible. This indeed is the case as evidenced by one year of operation at WNAC where virtually no air time was lost due to transmitter failure. At two other stations both outside the United States during three years of operation one lost 42 seconds of time - the other none at all, due to transmitter failure.

The second advantage of parallel operation is that maintenance of the transmitter system is easier. Maintenance cost will also be reduced since this work can now take place during regular working hours by switching the transmitter to be repaired out of the system. In the event of transmitter failure a direct comparison can be made between meter readings, etc., of the working and non-working units, thus speeding the repair time.

Thirdly this system contains fewer tube types than are normally found in main/stand-by operations. Also parts such as capacitors, transformers, chokes, etc., are identical in each transmitter unit; therefore, a less costly spare tube and parts inventory.

The fourth advantage of parallel operation is that with it comes improved performance. With the transmitters operating in this manner the system transfer characteristic is an averaged sum of the two individual transfer characteristics. Therefore, system variables that are controlled by the transfer characteristic - such as frequency response, sawtooth linearity, and overshoots will be improved. As will be shown later, this system also offers "ghost cancelling" due to the combining scheme used.

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The video signal passes thru a stab. amp. used as a common video control point to a distribution amplifier whose two outputs feed the modulators. A variable delay line is inserted in one modulator feed to allow correct video phasing.

Aside from the units to be paralleled, three areas of components form the heart of the system. They are COMBINERS, BALANCE EQUIPMENT, AND MONITORING EQUIPMENT.

Under the heading of COMBINERS there are the exciter power splitters and the combining diplexers. Except for the power levels involved these two units are quite similar. The exciter power splitter is a coaxial ring hybrid and is shown in schematic form in figure 2. The input, port 1, is 3/4 wavelength from port 4 while all other adjacent ports are 1/4 wavelength apart. From this diagram it is seen that signals arriving at port 4 from port 1 are in phase. Likewise signals reaching port 2 will be in phase, while those at port 3 will be 180 degrees out of phase. In this device power fed to port 1 will split equally between ports 2 and 4 when all ports are properly terminated. When ports 2 and 4 are not properly terminated - as is the case when the transmitter input stage is being tuned - the mismatch power is fed to port 3. The isolation offered by this scheme is sufficient to decouple the two transmitter input stages.

Figure 3 shows the diplexer equivalent circuit. Generators G_1 and G_2

correspond to the respective transmitter output signals to be combined. The inductive coupling sections shown are assumed for our purposes to be ideal networks containing no losses. Combined signal output appears across R_2, and R_1 represents the reject load.

If we define diplexer efficiency as the ratio of output power to input power and further, define "a" to be the voltage amplitude ratio and "θ" the phase angle between G_1 and G_2, an equation can be derived giving efficiency as a function of "a" and "θ".

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Since two modulators are used in this system some means of controlling their relative phase is needed. The video line stretcher serves this function. This unit is a lumped constant line providing a total of 50 milli-microseconds delay at 3.58 mc in five 10 milli-microsend steps.

Monitoring equipment includes the means used to varify that RF amplitude and phase at the diplexer input is proper and that the video modulatos are working in phase.

RF phase and amplitude balance is monitored by the combining diplexer reject load power indication. This indication is unique in that this load receives zero power only when the two input signals are in phase and equal in amplitude. During operation, as was shown by the balance curves plotted for the diplexer, the maximum power received by the reject load occurs when one transmitter fails. During this condition the reject power will be one-forth of the normal combined power, or in the case of a 50 KW operation 7.5 KW.

The video phase monitoring in this system is made up of two video detectors, pre-measured video cable, and a two channel differential oscilloscope. By reclaiming the video of each modulated visual transmitter an equal distance from the diplexer input, feeding these signals thru like cables containing equal delay, and then into the differential oscilloscope, continuous means of monitoring the video phase is available.

Correct initial video phasing can be detected using this method by feeding a standard video stair step wave form containing 3.5 mc burst on each step to the system input, and adjusting the video delay line switch for minimum vertical deflection as observed on the oscilloscope. Gain control adjustments on the oscilloscope are used to maintain equal inputs to both channels from the pick up diodes, thus showing a true display of modulator phases.

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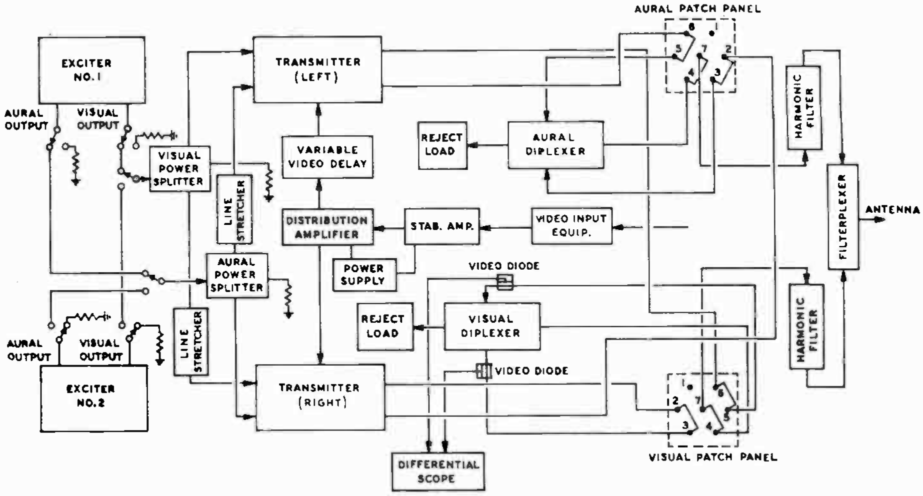

FIG. 1. Simplified block diagram of WNAC-TV parallel transmitter system.

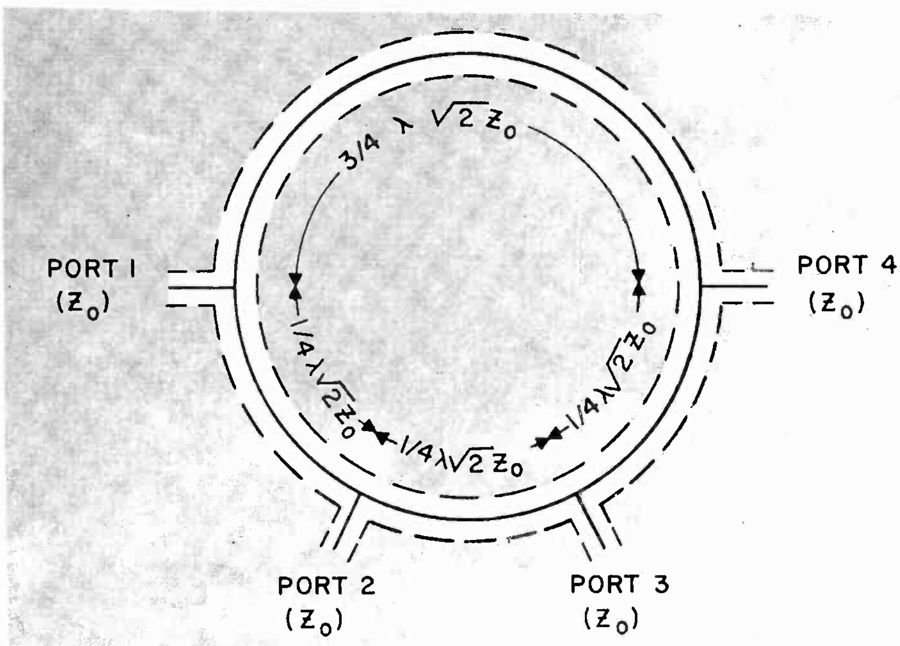

FIG. 2. Schematic diagram of power splitter.

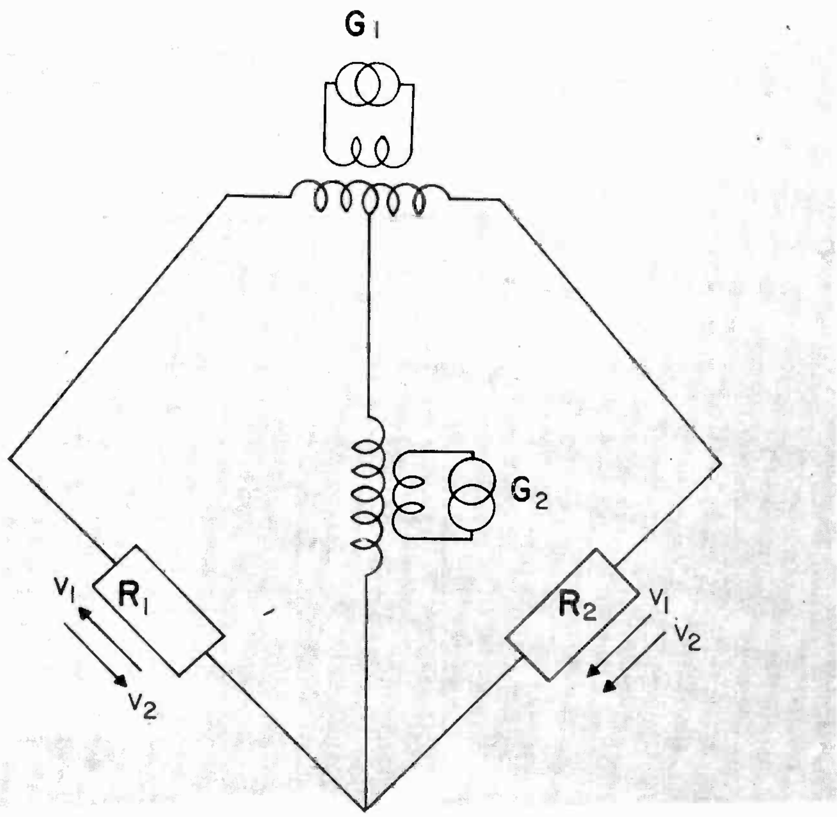

FIG. 3. Simplified schematic diagram of diplexer system.

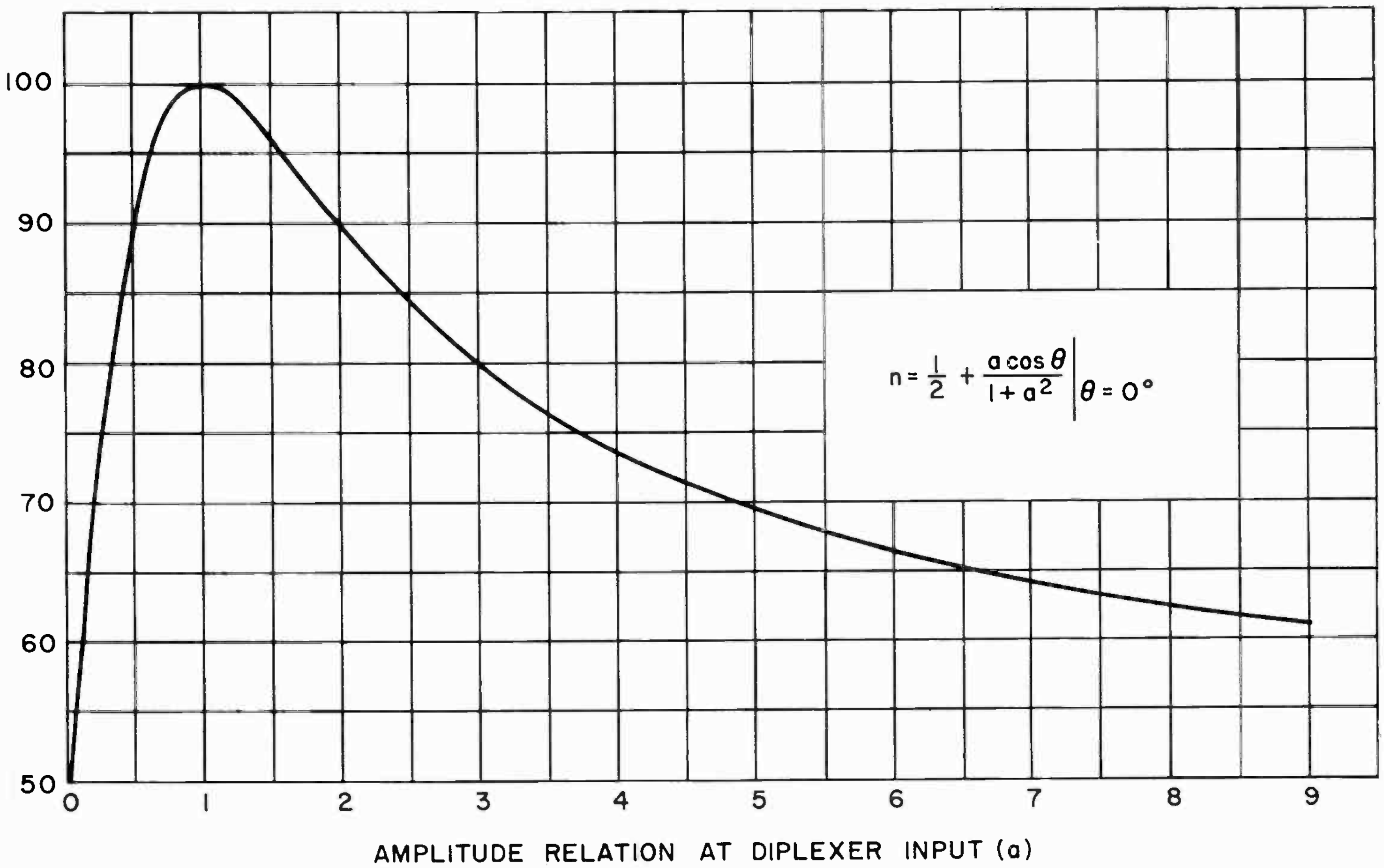

FIG. 4. Curve showing diplexer output for various ratios in amplitudes of input signals.

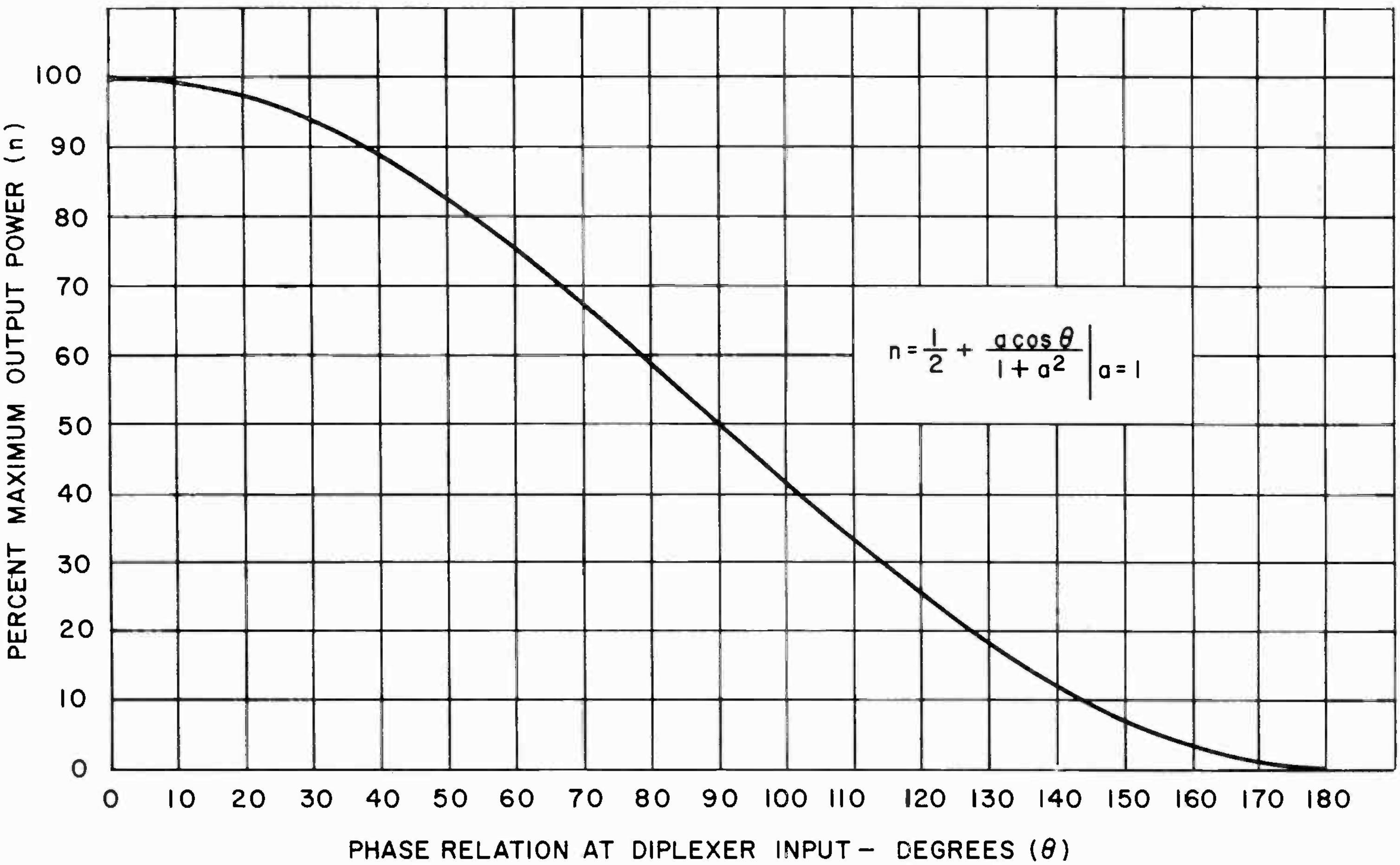

FIG. 5. Curve showing diplexer output for various input signal phase relationships.

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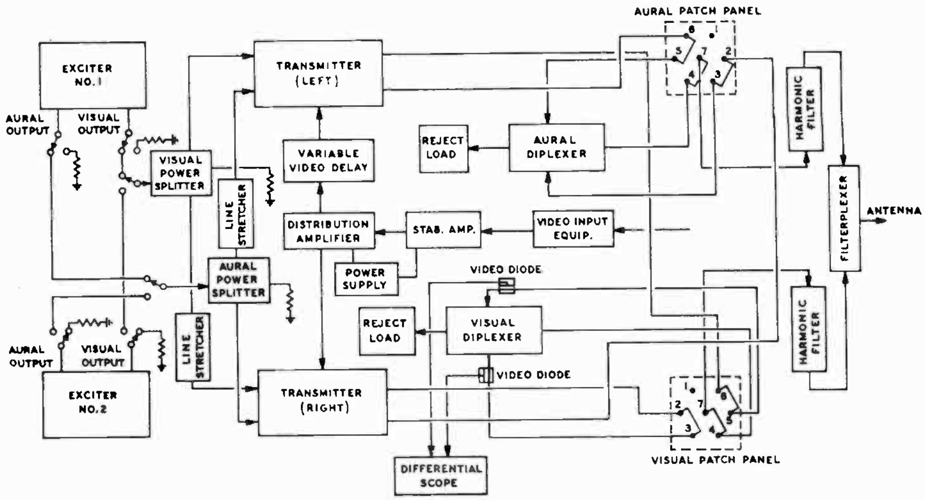

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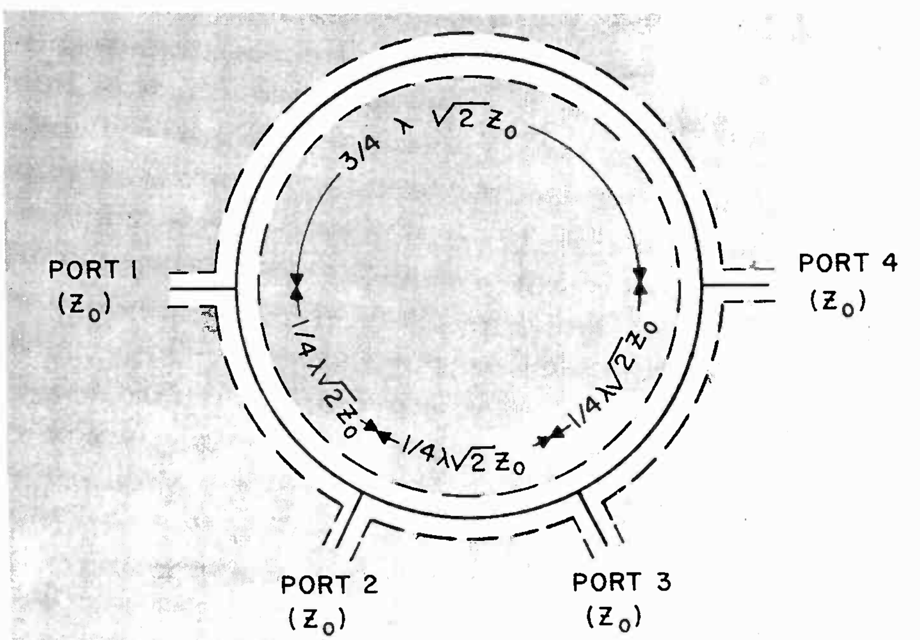

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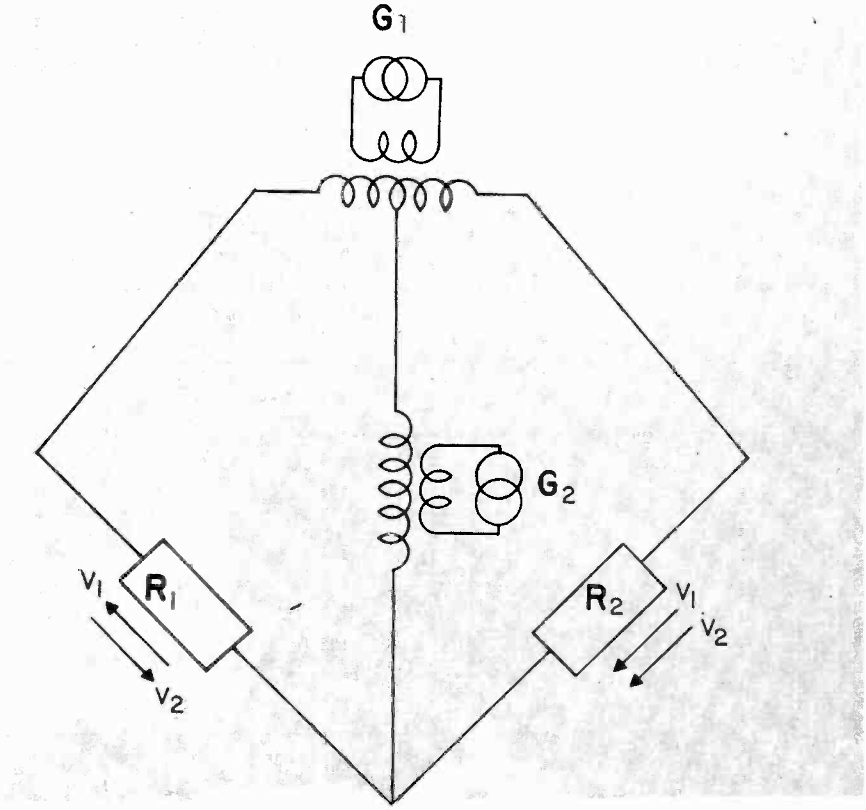

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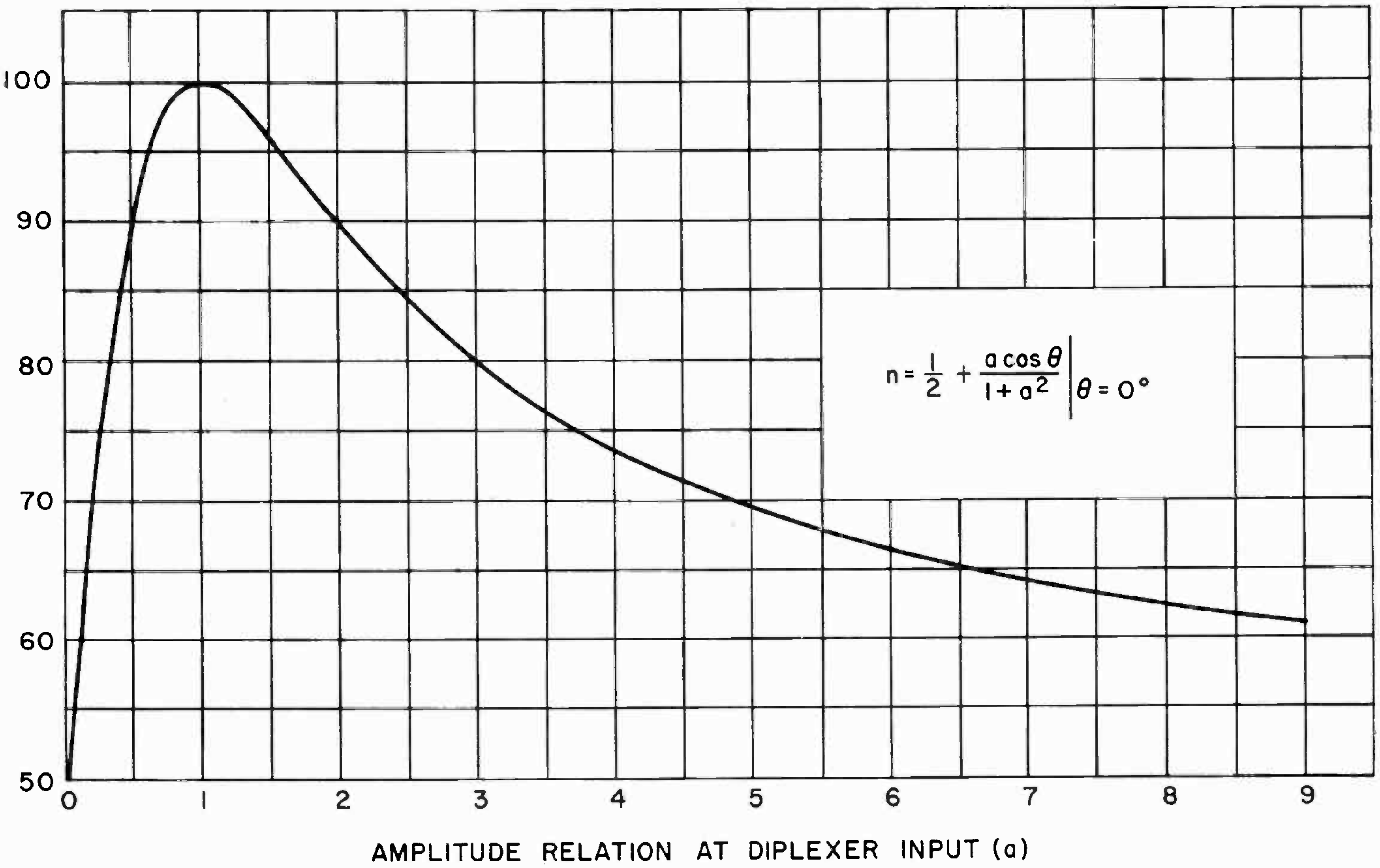

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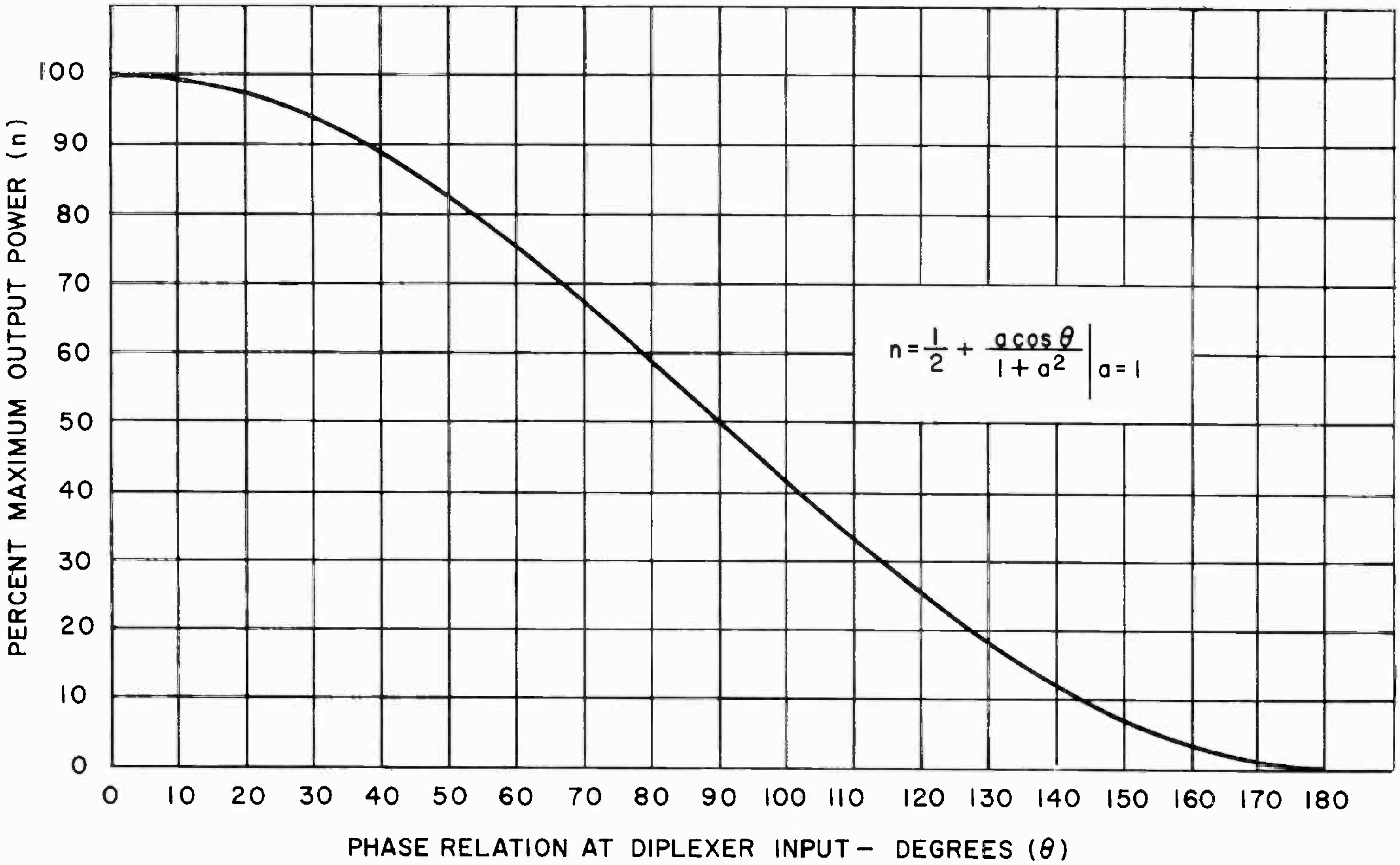

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CHRONO-LOG CORPORATION
2583 WEST CHESTER PIKE
BROOMALL, PENNA. U.S.A.

STATION BREAK AUTOMATION WITH STEP - TEN YEARS OF OPERATING EXPERIENCE

Arthur Freilich, V.P.
Chrono-log Corporation

SUMMARY

Chrono-log STEP Systems for automation of TV station break switching have been in operation in stations in the U.S., Canada and Mexico since 1961, representing a total of ten years of operating experience.

A survey of the stations operating with the STEP System indicates the following:

1) Low-cost station break automation is a profitable investment for stations willing to plan for automation and properly train and educate their personnel.

2) In a properly planned installation, station break automation using the STEP System can pay for itself in one to three years.

3) The STEP Automation System is highly reliable and requires little maintenance.

4) Installation of the STEP System can be simplified through the use of interface options which are presently available in the equipment. These interface options were designed as the result of the experience of stations which are using the equipment.

INTRODUCTION

The large number of switching operations which must be performed at precise intervals during the station break "panic period" has led TV broadcasters and equipment manufacturers to investigate means to perform the switching automatically. Various approaches have been tried ranging from simple pre-set switchers which rely on the operator at each step of the sequence, to digital computers which are theoretically capable of control of all phases of station operation.

Chrono-log Corporation introduced the STEP System for station break automation in 1961. STEP (Sequential Television Equipment Programmer) is a unique, low-cost system with powerful capabilities for automating TV switching. The first installation of STEP was made at WTVR in Richmond, Virginia in September of 1961. Other installations were made in succeeding years in stations in the United States, Canada and Mexico. As of March 1, 1965, STEP had been in operation for approximately 10 station years. Based on the results of this period of operating experience, this paper examines the concept, economic justification, planning, installation and reliability of station break automation with STEP.

THE CONCEPT BEHIND STEP

The Chrono-log STEP System has been described in the literature[1] in detail. A brief summary of the system is given in Appendix I. The design philosophy of the STEP System is based upon relieving the operator of the intensive station break switching activity and, in effect, spreading the station break effort over a longer period of time. The T.D. is available in the control room. Under normal manual operation, he has very little to do for long periods but then is called upon to perform many switching functions rapidly and precisely in a very short period. Unfortunately, this period of intense switching activity is the time interval in a commercial station when the bulk of the revenue producing material is aired; errors in this period are costly. In both commercial and non-commercial stations, switching errors disrupt the smooth on-air presentation.

With the STEP System, the T.D. uses the period between station breaks to set up the next break (in accordance with a STEP programming template prepared in advance for the operator or from the log); loads the sequence into STEP; checks the sequence prior to running it to eliminate errors; and then starts STEP at the beginning of the station break. The actual switching during the break is performed automatically by STEP so that no errors occur.

In other words, the sequence is prepared in advance, the operator gets everything ready at his leisure, without pressure, and checks the sequence to insure that it is correct. Then, STEP controls the high-speed complex switching while the operator monitors the operation.

1 - The "STEP" System, IEE Transactions on Broadcasting, Volume BC-9, No. 1, February, 1963.

ECONOMIC JUSTIFICATION

Much has been written about television automation systems but very little can be found concerning the economic justification for automation. According to the results of a survey of stations operating with the STEP System, the economic justification for automation falls into two broad areas:

1) Reduction or elimination of lost revenue due to switching errors and resultant make-goods.

2) Better utilization of man-power through automation. Stations using STEP found that automation permits the same control room personnel to perform more functions than they can handle without the automation system. By automating the routine station-break switching, control room personnel can be set free to devote their time to tasks which require the skill and creativeness of the human operator, such as control of video taping sessions.

With the exception of one installation which was made without any planning or training, the STEP System has produced the expected economic payout. Typical results of STEP installations are:

1) One station originally justified purchasing the STEP System on the basis that it would increase the flexibility of their operation as well as permitting much more to be done with the same number of personnel. After about one year, this station found that it was possible to perform many more functions with the same control room personnel. Man-power savings at the end of one year were between $10,000. and $15,000. The total cost of the STEP System installation at this station including the STEP System itself, design, material and labor for the interface and the installation of STEP was approximately $13,000.00. Therefore, an economic payout in approximately one year was attained.

2) The savings from reducing make-goods due to switching errors was used by another station as its justification for purchasing the STEP System. After two years of operation, it is estimated that the system will pay for itself before the end of the third year. The total cost of this STEP System installation was $9000.

3) Another station installed STEP simply to take the panic out of the "panic period". After several years of operation, they find that there are about 70-75% fewer make-goods. They are also able to handle more complex breaks without switching errors. According to station management, the STEP System has paid for itself long ago on make-goods alone. The total cost of the STEP installation at this station was $7500.

4) Another station which has not been operating long enough to determine the actual payout from the STEP System, originally installed the equipment for use only during taping sessions. STEP handles the on-air switching while the operators attend to the taping sessions. Without the STEP System, it would have been necessary to increase control room personnel. An interesting fringe benefit which has already been found in this installation is that the station is able to tape material much faster and consequently their advertisers are more satisfied. Before STEP was installed, the station could tape only during network shows.

Many fringe benefits have been found by stations operating with the STEP System. Among these are:

1) Smoother programming.
2) Better advertiser relationships.
3) Reduction of load on the program director.
4) Ability to handle complex breaks.

PLANNING FOR AUTOMATION

When automation is added to a station, it is not simply a matter of installing a piece of equipment to operate in addition to existing equipment. Automation consists not only of hardware but also of procedures. In order to obtain the benefits of automation in TV operation, it is necessary to plan how the station will be automated. Station Management, Engineering, Program, Operating and Traffic staffs should all be involved in planning the overall procedures of automated operation.

In all industries, planning for automation affords management an ideal opportunity to step back and view, objectively, the existing plant operation. This fresh look at operations has provided tremendous advantages. In general, operating procedures tend to grow, become entrenched, and then become almost impossible to alter because any change reflects in some way upon the individuals involved in the operations. Over a period of time, most operations become less efficient than originally planned because of gradual shifts in control. Automation planning provides an opportunity to start anew, utilizing the experience gained during past years of operation and to revamp where necessary, procedures which have gradually become inefficient.

Experience in television, as well as many other industries, has proven that automation, when planned carefully, represents an excellent investment of capital funds with a fast return on this investment. On the other hand, experience in television and many other industries proves that when automation is added without planning, the results are disastrous.

Time after time, a careful analysis during the planning stage for automation reveals facts about operations which were not known previously and which offer opportunities for increased efficiency and reduced cost of operations.

At WTVR, in Richmond, Virginia, an analysis of past station breaks was made during the planning for the installation of the STEP System. It was determined that about 85-90% of station breaks which were run at WTVR utilized a limited number of different switching sequences. It was found that twenty (20) standard station break sequences would handle about 90% of the station break requirements. This analysis resulted in a highly efficient and extremely simple programming procedure with automation. Standard station break sequences were set up permanently so that the operator need only select the proper sequence for each break without actually preparing the individual steps within the sequence. The log sheet was revised to include the station break sequence number to be used for each break. The few special station breaks each day which do not fit into one of the standard sequences are set up in advance by the program director. Figure One shows the STEP System installed in WTVR. The pinboard plugged into the system contains standard break sequences 9, 10 and 11.

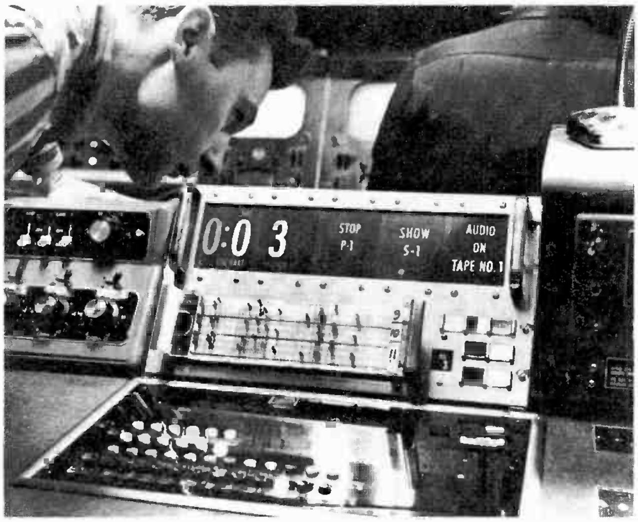

FIGURE ONE

This concept of standardized breaks has been found to be valuable by several other stations using STEP. Obviously, this type of approach requires a careful analysis of past operations but the benefits in terms of operational simplicity are considerable.

It should be borne in mind that any system of automation will impose certain limitations on the procedures of various departments involved in station operation. Automation is the automatic operation of a system. Although every effort is made in the STEP System to provide for operator intervention when necessary, nevertheless, as in any automation system, operations and procedures must be more rigorous than with manual operation. The margin for error is much less with an automatic system than with an operator involved in the control. In TV operations, this restriction manifests itself primarily in considerations of timing.

Although the STEP System can operate on a manual basis (in which case operation is similar to that of a preset switcher with the operator initiating each step at a specific instant based on his observation of the program material) the maximum benefits of automation are obtained when the system is permitted to operate on an elapsed time basis. In this case, each switching function occurs at a predetermined time following the previous function and in this way, highly complex switching can be done on a routine basis.

However, if an eight second spot is programmed, it is important that the material actually be eight seconds in length and that there be no audio content extending past the eight second limit. With the operator controlling switching, an over-time spot will be allowed to finish before switching to the next item. This results in a smooth flow of program material but it also results in added exposure by the advertiser at no extra cost. With an automated system, at the end of an eight second time interval, the material being shown will be switched off and new material will be shown. Clipping will result if an eight second spot actually has nine or ten seconds of audio material. Although it is true that this is the responsibility of the advertiser, nevertheless, in the interest of smooth programming, it is extremely important that all program material be timed prior to being shown on-air.

Responsibility for timing of material generally rests with the Traffic Department. Traffic should routinely time all station break material being fed into the automated system. This may sound like a great deal of work. However, it represents a tighter control on the product which the commercial station is selling, namely on-air time. In addition, with tight control of timing, it is possible for station breaks to be performed much more smoothly, with less clipping or stretching out at the end of the break than with manual operation.

Several stations which installed STEP instituted control on timing in the Traffic Department at the same time the automation system was put into operation. In these cases, generally speaking, operation has been very successful. Several other stations started timing of spots in the Traffic Department after the STEP System was installed because the need for it became apparent. In these cases, there was a period during which operation was not completely satisfactory because of timing problems.

In planning for automation, this problem of timing is probably the critical issue. If the Traffic Department will time all spots, then the station is well on the way to a highly successful automation installation. Because of this timing consideration, it is important that the Traffic Department be involved in the planning stages for automation.

Another important consideration in planning is to define exactly who has the responsibility for the programming and operation of the STEP System. Either the Traffic Department, the Program Director or the operator should be responsible for actual programming of the station breaks. This involves not only the pre-determination of the switching sequence but also the selection of the equipment to be used during the break. This responsibility can be split between different individuals or departments, depending upon the final operating procedure which evolves from the planning study. However, the responsibility should be fixed so that it is clearly understood by all concerned and so that those individuals who will have the responsibility will also have the authority, the training, and the understanding to properly carry out the functions which they must perform.

INSTALLATION

It is necessary to integrate the automation hardware with the existing station equipment. In many cases, this task is quite readily done. In other situations, particularly with older equipment, integration of the automation system may involve changes in existing equipment or the addition of some interface equipment between the STEP System and the station equipment. The Engineering Department is the prime factor in the installation of the automation system.

All the STEP Systems which have been installed to date have involved a certain amount of interface design and construction by the stations. Based on our experience with these installations, Chrono-log Corporation now offers interface options which greatly reduce the amount of design and construction work which is required by the individual station. Nevertheless, it is interesting to analyze the costs at the various stations utilizing STEP in order to get some idea of the complexity of the problem.

Although at first glance the interface between the STEP System and the existing station equipment would appear to be rather costly, experience has indicated that even with the station doing all the design, construction and installation on the interface, the cost is quite moderate and the problem well within the capabilities of typical station engineering staffs. The average cost for the interface between STEP and the station equipment, including parts and material for construction of the interface, engineering time and installation labor and associated costs was $2,100. for the stations surveyed. The smallest station, which had only a few video and audio inputs, estimated this cost at $500.00. The most complex installation, which involved the construction of various special interface circuits for use with video taping as well as on-air switching was estimated at $3500. Installation time varied from 100 man-hours to 480 man-hours.

These figures include, in many cases, the construction of rather elaborate audio switching systems in addition to the normal interface and installation.

The interface between the STEP System and the station equipment normally is divided into three general areas:

1) Video switching - the STEP System does not perform video switching itself, but controls the operation of a video switcher. Where solid-state, crossbar or relay video switchers are being used, the interface between the STEP System and the switcher consists simply of an interconnecting cable. The greater problem in the video interface arises where a station is using a direct switcher which operates from maintained contact pushbuttons. In these cases, the video interface requires the addition of video switching contacts in parallel with the direct switcher. For this function, it is best to construct a crossbar switcher utilizing the Cunningham type P crossbar switch. Installations in several stations utilizing STEP have included the crossbar switcher in the interface and these costs are included in the installation costs.

2) Audio switching - as with video, where solid-state or relay switchers are being used for audio, the interface between the STEP System and the switcher reduces to an interconnecting cable. Generally speaking, the interface required for audio switching, even where a direct switcher had previously been used, is simpler than for video. An audio switcher can be readily constructed from either relays or a crossbar switch. Where a crossbar switcher is being constructed for video, the same switch can also be used for switching audio. The smallest crossbar switch available is a 2 X 10 which can be operated as a 1 X 20 switch. For small stations, this is adequate for handling all the video and audio switching in a single crossbar switch. Figure Two shows the STEP relay chassis installed at XETV, Tijuana, Mexico. Above the STEP chassis is the crossbar switcher constructed by XETV for switching audio and video under the control of the STEP System.

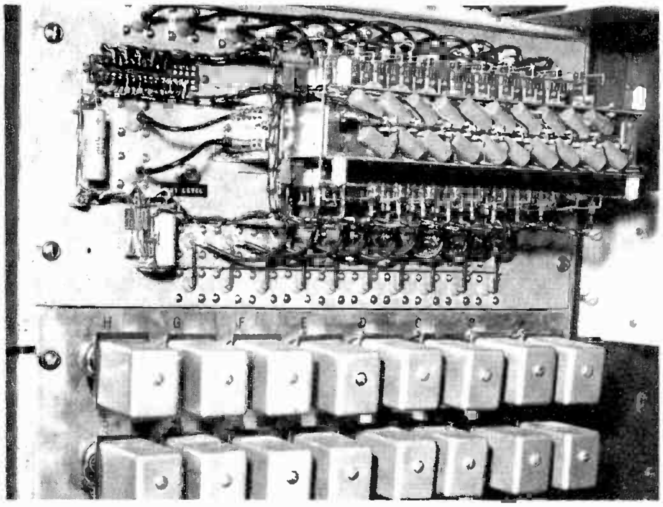

FIGURE TWO

The use of the crossbar switch for video and audio switching is the least expensive method for installing automated station break switching when the existing switcher is of the direct pushbutton type. The complete video and audio crossbar switcher system constructed at XETV, including distribution amplifiers, audio amplifiers, the crossbar switch, relays and other accessories, a video mixer, power supply and miscellaneous items cost $3,400. including design, all material and labor for constructing the switching system and installing STEP.

Based on our experience with these station equipment complements, Chrono-log now offers the STEP System with optional crossbar switches for video and audio. This crossbar switch option is not designed as an all-purpose video or audio switcher but is designed to permit operation of the STEP System in installations which are using direct pushbutton switchers.

The STEP System is also in operation with relay switchers, as well as solid-state switchers such as the RCA TS-40 and the Sarkes Tarzian switcher. Riker Industries currently offers the STEP System with their solid-state switchers as a complete, factory checked-out package. In this case, there is no interface work required by the customer.

3) The third portion of the interface is concerned with connecting the STEP System to film projectors, slide projectors, multiplexers, and VTR's in order to control the mechanical operation of these devices.

The STEP System starts and stops the film projectors and VTR's prior to switching the video. The STEP System can also operate multiplexers, dowsers, and slide advance mechanisms. In all the installations to date, the interface has been worked out by the customer, primarily through the use of relays to isolate the STEP control contacts and permit a variety of voltages to be used to control the station equipment. As a result of this experience, Chronolog now offers an interface option as part of the STEP System which provides, within the STEP System, the necessary isolation of the output contacts.

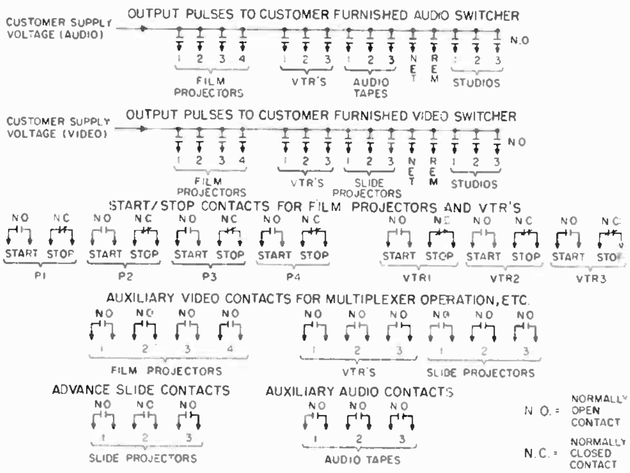

FIGURE THREE

Figure Three shows this interface option for a typical installation. A variety of isolated contact closures are available for starting and stopping film projectors and VTR's, advancing slides, and operating dowsers and multiplexers. Contacts are also available for instant starting of audio tape units. With this interface option, the STEP System is compatible with most station equipment without need for external relays or other special control circuits. In essence, the STEP System operates in the same manner as a remote control panel. Note that the start contacts in STEP are normally open but the STOP contacts are normally closed, which is in accordance with the usual film projectors and VTR circuits.

Because of the interface options now available on the STEP System, it is expected that the installation costs which were mentioned previously will become practically negligible in future installations.

Actual installation of STEP in the control console is relatively easy. The pinboard, pushbuttons and message displays can be located together as in Figure Four which shows the installation at WAGA (Storer Broadcasting) in Atlanta, or the display can be mounted separately as in the console at CBXT in Edmonton, Canada, shown in Figure Five.

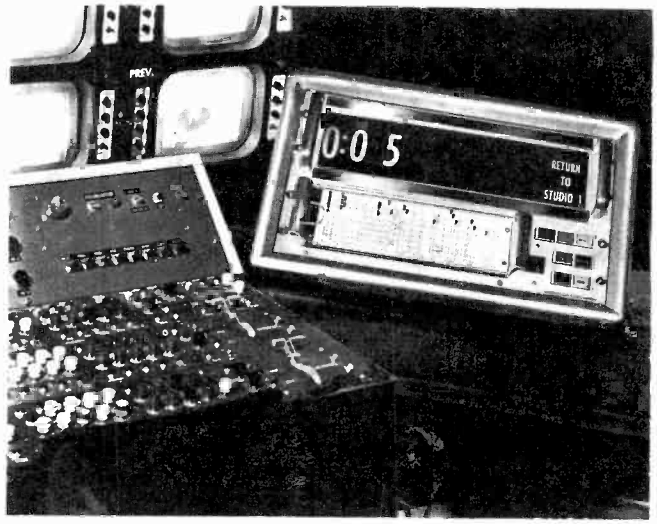

FIGURE FOUR

FIGURE FIVE

EDUCATION AND TRAINING

One very important consideration is the education and training of the station personnel who will be operating the automation system. The operators must be given a basic understanding of how the equipment operates so that they have confidence in the system. When automation is introduced with an accompanying training program, the transition to automated operation is generally smooth and satisfactory. Where it is dumped in the operator's lap, without training or education, the situation can become extremely difficult. It is far better to train the operators so that they realize that there are benefits to them as individuals from the automation system rather than to start with a lack of enthusiasm or even hostility on the part of the operator, which must then be eliminated.

One installation of STEP has not been satisfactory. We would like to quote the comments of the station manager in discussing some of the reasons for the unsuccessful installation:

"The only preparation and training prior to using STEP consisted of studying the Installation and In -

struction Book. The personnel problems which should have been overcome in introducing the STEP machine was that of selling the machine to the individuals so that they would understand the use and possibility of the STEP machine. However, this was not done and the individuals involved were told to use the machine without any prior training or belief in the machine itself. I have seen STEP function properly in other stations and have asked myself, 'Why can't ours?' There is a possibility that this machine could be of help providing, of course, that the individuals involved were properly sold on the implementation of the machine."

These comments, of a completely negative character, point out more strongly than the positive results of our survey, that education, training and planning are vital considerations. To turn to the other side of the coin, at WTVR in Richmond, Va., the following training procedure was followed before installing the STEP System; these quotations are from Mr. Jim Kyle, Vice President of Engineering at WTVR:

"Complete plans were made as to how STEP was to be used and what it was to control. A complete operation was set up on a display board in the shop to prove every operation. This same display board was used in training the men before STEP was finally set-up in the control room. STEP was wired in parallel with the existing manual switches and as soon as this wiring was completed it was put into operation on full scale with trained personnel. STEP was used in full-scale operation from the beginning. This was possible because it was so easy to go back to manual at any time during the station break cycle."

According to Mr. Felipe Fernandez of XETV, "For the first two weeks, the video operators programmed STEP in automatic mode but without applying power to the output control relays. In this way, they could run parallel operations with the normal switcher which was actually controlling all the equipment."

Mr. Bob Latham, Chief Engineer of KNTV in San Jose, California commented, "Most of the personnel became familiar with STEP during the course of installation of our new control room. Since we were remodeling our entire control room, there was time to become familiar with its requirements. Some skull sessions were used as well as a limited number of dry runs with the program department. STEP was used full-time from the start. We made a number of mistakes because of lack of coordination with other departments but I still feel this was the best approach. Most personnel both in and outside the station felt automation was impractical and because of this, they were reluctant to change their method of work to conform better to smooth STEP operation. This is no longer the case now that they have seen what it can do and will do for them."

There is nothing mysterious about automation. The fear of automation which exists in the minds of many people is the fear of the unkown. This fear can be overcome by education. The negative attitude towards automation can be dispelled by pointing out the positive aspects. A moderate amount of training in the preliminary stages of equipment installation can make the difference between a successful and unsuccessful installation.

MAINTENANCE

The reliability of the STEP System has been extremely high. The equipment is designed so that active parts are plug-in wherever possible and a complete spare parts kit is provided with the equipment. There have been no reports of failures which have caused a loss of on-air time by the STEP System. One reason for this is that in the STEP System, diagnostic maintenance personnel can detect intermittent or faulty operation before it actually causes an on-air failure. This preventive or diagnostic maintenance can be performed in about 15 minutes. Stations were asked how often preventive maintenance or routine checking was performed. Answers ranged from less than 1 hour per week to whenever personnel have some time. In most stations, a routine weekly checkout is performed by senior technicians.

The advantage of plug-in spares is that the faulty component can be removed, the spare plugged in and the system returned to operation immediately. The faulty component can then be repaired on the bench at leisure.

At WTVR in Richmond, the STEP System has been on-air since September 1961 and there have been only three or four minor failures, all of which were repaired by use of plug-in spares. Similar experiences at other stations indicate that the basic design of the STEP System is reliable. Several stations reported no failures. Only one station reported a problem which occurred several times and as a result of which, station personnel modified the equipment to eliminate the particular components which were causing the problem. Operation since then has been completely satisfactory. There is a possibility that this problem was due to improper handling of the equipment during installation.

The failure rate of equipment is a function of the basic design, the reliability of the individual components and the number of components in the system. Consider the latter point; no component which has been eliminated by careful design has ever been known to fail in the field. This seemingly facetious statement is very important. The STEP System contains a minimum of components. Wherever possible, the same basic components are used over and over again. In this way, by selecting inherently reliable components in the first place, and using the minimum number of such components, the basic reliability of the STEP System should be quite high. This was the goal during the design of the STEP System. The field results have shown that the design goal has been more than achieved.

ACKNOWLEDGEMENTS

The author wishes to express his thanks to the following individuals and stations who aided in the preparation of this paper:

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Mr. Felipe Fernandez, Chief Engineer, XETV
Mr. Hugo Bondy, Chief Engineer, WAGA

APPENDIX I

STEP System Description

The Chrono-log STEP System handles complex station and commercial breaks by automatically sequencing TV station equipment in accordance with a predetermined but readily variable sequence.

The overall design criteria for STEP were:

1) It was to have the capability of controlling all necessary audio and video switching for the break.

2) It was to start the break upon signal from the operator but thereafter, the entire break was to be automatic, if desired, on an incremental time basis.

3) If desired, the operator was to be able to override manually the automatic functions of STEP.

4) The STEP System must provide for programming an entire day's breaks in advance.

5) The operator should have a means to check out the entire break sequence in advance of actually running the break.

6) The operator must be able to read the entire program sequence that is stored in the system and must be able to make last second corrections to any event of a sequence at any time.

7) STEP must always display what the next event is to be, i.e. the switching which will be performed on the next event, and the time remaining until that event.

8) The equipment must be low in cost, so as to make automation economically justified for small and medium stations as well as large stations.

9) STEP must be reliable and easily maintainable.

A complete sixteen event sequence is set up by inserting pins in a 3" by 15" pinboard insert and template. After STEP has completed one sequence, the pinboard insert may be removed and a second pinboard insert on which the next sequence has already been set up may be inserted. It takes less than 10 seconds to change pinboard inserts. Templates can be marked in advance to set up the entire day's breaks. Figure 6 shows the pinboard insert and template.

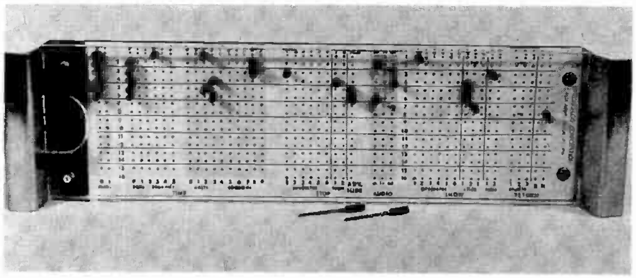

FIGURE SIX

The Chrono-log STEP System automatically controls the starting and stopping of film projectors and video tape units; controls video and audio switchers; sends ADVANCE SLIDE pulses as required for slide projectors; and at the end of the sequence returns the video and audio to a remote crew, network or one of several studios.

As STEP runs through the sequence, it displays - in words - what the next event will be and how much time remains - in minutes and seconds - before the next event.

Modes of Operation

These are two general modes of operation for STEP:

1) Automatic - in the AUTO mode, the time increment between events is pinned into the pinboard program. STEP then initiates each event at the proper time. Time increments for each event range from one second to 1 minute, 59 seconds.

2) Manual - in the MANUAL mode, each event is initiated manually by pressing the TAKE button. In this mode, STEP resembles a preset switcher. The system can be returned to the AUTO mode at any time by pressing the AUTO button.

3) Preview - the PREVIEW mode allows the operator to check out the entire break, prior to running the sequence. In this mode, the operator advances event-by-event, using the TAKE button. All pinboard settings are shown on the message display screen but no control pulses are sent to the station equipment. Changes or corrections can be made by simply changing the pins in the pinboard.

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(213) HO 2-1133

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777 Warden Avenue
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ILLINOIS, Park Ridge
Webster Engineering Co.
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(312) 823-8206

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(614) 885-0743

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COLOR CAMERA PANEL

QUESTIONS AND ANSWERS

Moderator: Frank L. Marx, President, ABC Engineers,
American Broadcasting Company

Panelists:

R. T. Cavanagh, General Manager of Studio Equipment,
North American Philips Company

H. N. Kozanowski, Manager, TV Advance Development,
Radio Corporation of America

Albert W. Malang, Chief Engineer, Whittaker Corporation

R. E. Putman, Manager, Audio/Video Development Engineering
General Electric Company

(Taken from the official transcript)
19th NAB BROADCAST ENGINEERING CONFERENCE
Washington, D.C.
Tuesday, March 23, 1965

COLOR CAMERA PANEL

NAB Broadcast Engineering Conference
Washington, D.C.
Tuesday, March 23, 1965

MR. MARX: Good morning! We certainly hope that out of this panel will come some solution to the color television Tower of Babel, particularly as it relates to color cameras.

We have been extremely fortunate to get four of the leading world experts in this field, and I know in the audience there are probably several others. I hope that those who are in the audience who can contribute will feel free to do so.

During the question and answer period, which we feel will be most important to all of us, we will not ask you to identify yourselves unless you wish to do so. We feel that it might speed up things a little bit, and also perhaps make each of us feel free to ask questions.

We do have a problem insofar as how the panelists will be presented. There being four of them at the head table, the order in which they are presented may be open to some discussion among you. We want to keep this as family-like as we possibly can. So you may consider the hat that I'm holding here as a bowl of mashed potatoes being presented at a family dinner. I'm going to put this bowl in front of the four panelists. There are four numbers in here. Each will select a number and that will be the order in which they will present their particular philosophy insofar as color cameras are concerned. They may take as much time as they wish, within reason, not exceeding, we hope, 15 or 20 minutes.

(Mr. Cavanagh drew #1; Mr. Malang, #2; Mr. Putman, #3; and Mr. Kozanowski, #4)

MR. CAVANAGH: To begin with, I'll only speak about two hours. The problem is when I start talking about Plumbicon tubes and Plumbicon cameras I get intensely interested personally. Before we start in terms of Philips' considerations of color cameras, we really should start with a consideration of the pickup tubes as such.

All of you are very familiar with Image Orthicons over the last number of years, and Vidicons. The Plumbicon is really the new production tube that's on the scene now. This particular tube is not just an infant, it is a tube that started in research and development approximately ten years ago.

The research and development effort was all aimed toward a specific end result which was an optimization of resolution, sensitivity, lag, spectral characteristics required for broadcast operations.

If we think of the tube and where it stands right now, future improvements can be expected in areas of sensitivity, resolution, spectral characteristics, all within the existing configuration.

Now, the existing configuration is quite interesting. It is a one-and-a-quarter-inch diameter tube and it's eight inches long. So in terms of operating advantages of a Plumbicon tube, we think in terms of size, we think in terms of very low dark current...and by very low dark current, it's of the order of a few nanoamperes.

This is all related to the fundamental physics of the surface itself and how it is made.

As a result of this, there is no shading coming out of this tube. There is no shading compensation anywhere in the color camera system. It is a linear transfer characteristic, or as close to linear as we can hold it. It is of the order of a gamma, 0.9.

The lag was purposely held down, and again it is related to the fundamental physics of the surface. The lag is extremely short, and bears no relationship to the past knowledge of lag in the Vidicon tube.

The construction is very simple. In terms of construction, it looks somewhat like the Vidicon tube.

The operation is extremely simple.

Sensitivity....we think in terms of average, around 400 microamperes per lumen, as the sensitivity.

In terms of resolution of the tube, the production tubes are yielding 40 per cent depth of modulation at 400 lines or five megacycles.

Now, if we think of this and say "Well, what does it mean for color cameras?" the most significant thing is the fact that the gamma is a fixed gamma and holds independent of light level. Obviously, knowing that the gamma is of the order of 0.9 in the tube, this means that the camera must be compensated with an additional gamma exponent of approximately 0.5.

If we talk of a typical camera operation for an RGB color camera, we think in terms of operating at 150 foot candles and scene lumination F/4.0. Now, when we talk F/4.0, the depth of the field associated with that, because the image format is roughly one-half the diagonal of an Image Orthicon image format, the depth of the field is related to F/8 for an Image Orthicon comparison.

The wide channel in the camera you set for a 40 db signal-noise ratio out of the encoder.

The cameras themselves we set for 80 per cent depth of modulation at 400 lines in the center of the image again wide channel.

Now, getting to this particular camera, I might just talk a little bit in general about the policies of our camera as such.

Because of the size, which is very, let's say, fortuitous and very good for a three-tube color camera, weight and the color fidelity advantages, the Philips Plumbicon RGB Color Camera will be continued in production in Holland and in the U.S.

As the Philips research and development activities on the Plumbicon four-channel, which is the YRGB Camera, progresses, the future availability will be determined.

Based on present knowledge, our own and joint knowledge, not just ourselves, but broadly in the industry, any four-tube Plumbicon camera obviously must be larger, it must be heavier, and it will require linear matrix correction for the luminance errors related to chromaticity errors in the reproduction of the NTSC system. Linear taking characteristics of the Plumbicon allow very clean-cut, easy solutions, however, to the luminance errors that exist.

Because of really intense interest in the demonstrations of the Philips RGB color cameras, I thought it would be worthwhile just to digress for a couple of moments and give you the operating characteristics of the set we have down here, since some of you are intimately familiar with set lighting and have responsibilities for that as well.

What we call the indoor scene is illuminated at 200 foot candle incident illumination. The so-called outdoor scene we have there is set for 140 foot candles. The color temperature was set at approximately 3000 degrees Kelvin. The cameras, as they are set up down there, are set for a contrast ratio of approximately 100 to one.

Just for the sport of it, as we are set up there, we have done experiments of this kind before both for the remote pickups and for indoor operation of the Plumbicon camera.

Periodically we take the camera and swing it down into the area illuminated by fluorescent lights in the aisle, down in the hotel there. The color temperature is very different, obviously. We purposely don't do anything when we swing into that area. The area is illuminated at a level of approximately 11 to 13 foot candles.

We open the lens iris to F/2 and adjust the master Black level, and we have what we feel is a very fine picture under even that reduced scene illumination.

Now, obviously you would like to touch up skin tones under the difference in color temperature of the fluorescent lights. But we purposely leave it the way it is, just so you can all have a look at what this means. What it shows is something which we feel is quite significant. It is a tolerance to color temperature changes that starts to approximate what your human eye does. It is very interesting and the skin tones look very realistic under the fluorescent lights. As I say, however, you probably would like to just touch up the skin tones a little bit.

Again, just for your information, because of the interest in them, the cameras we have down there are registered around eight-thirty in the morning, and we purposely do not re-register them throughout the day.

So that any time you would like to just drop around and have a look, please feel completely welcome. This morning I happened to drop in. They had done the re-registering of the cameras in five minutes this morning.

As I said when I was starting here, I could go on for a very long time, because personally I am very pleased with the way this tube works and the flexibility that this tube is giving us, both in the monochrome and the color cameras.

It is all related, really, to the fact that the gamma characteristics in these tubes are purposely controlled in the fundamentals of the surface, and they hold constant independent of illumination level. This gives a capability of color fidelity that is very difficult to realize in any other way.

The other point you might be interested in, just in conclusion here, before we pass on and allow some good time for some questions from the floor..... We have found a very interesting response from groups who have been viewing these demonstrations. The response goes along the following lines, that even advertising groups who have dropped around to have a look at it have been able to appreciate a significant difference in color fidelity. We expect engineers and operations people, management people to do this. We don't always expect advertising people to be that knowledgeable in terms of an acceptance of an - let's say an improved level of color fidelity.

So I think that covers my brief little discourse here, and I would like to leave time for the other members here to go on.

MR. MARX: Thank you, Bob, very much. Al (Malang), I believe you are number two.

MR. MALANG: I'm afraid my position or the position of my company won't be so clearly pointed out as was Bob's. The best way to express our position is probably to say that we're about as confused as you are.

The discussion should really be divided up into two principal facets, since in any operation there are the studio cameras and there are the film cameras. I don't think anyone could really generate much confusion in the film area.

The recent experience has convinced us at least, and I believe most of the members of the trade, that a separate luminance channel is a very desirable feature for a film chain, particularly since many of you must deal with a hybrid operation, partial color, partial monochrome.

I think we are fairly well convinced that the probably best pickup tube for a film chain is the vidicon, although I must confess to you that the conviction is not absolute yet. There are a family of new pickup devices beginning to be available, principal among them our old friend from years back, the dissector. It could conceivably turn out in the very near future that the dissector may take over a part of the film work, the obvious problem being that you need transports of a more continuous light application nature. However, continuous motion transports are commercially available and, of course, the slide doesn't have this problem. But, for the main, it would appear in today's state of the art that the four-V chain is the principal workhorse and the best choice under any given set of circumstances for film use in a station.

When we get to the studio application, the situation is not quite so clear-cut.

The conclusion about four-tube, I believe, is now a legitimate position for us to take. We have convinced ourselves that the four-tube camera is the desirable approach. Principally because it eases the problem of going from monochrome to color operation and back again, which is something that everybody in the room has to face up to for a while. The problem is....which four-tube combination? At the present moment there hasn't been enough work done in the lighting techniques and the lighting equipment availability to be able to easily choose among the many tubes available for the chromo channel. One can talk in terms of vidicons, small Image Orthicons. I think the choice is very varied. Plumbicons obviously. For the luminance channel, I think our opinion is beginning to settle on an Image Orthicon. But for the chrominance channel, we just cannot make up our mind, in the face of what we consider to be the inadequate state of the art in stage lighting fixtures and techniques, inadequate state of the art in terms of efficient and effective color-splitting dichroics, the elements that have to divide the light entering the camera into the three channels necessary - the three colors necessary for the three chromo channels.

So, in essence, we do not have a camera nor are we in a position to rigidly say, if we had to build a camera tomorrow, what we would build. We intend to spend a great deal more time surveying the situation to determine what is the most desirable combination of characteristics. Or, if you will, to approach this honestly, what is the least burdensome set of compromises necessary to do an effective job in a live studio.

Again, we hope to induce people to do something more effective in the lighting area. It is difficult to envision color live production continuing and growing in a situation where dimming and mood lighting is as difficult as it is today. Maintaining color balance from a tungsten incandescent-type fixture will make a person gray very fast. The four-tube camera, of course, does offer a slight advantage in that respect in that as the color temperature of the incident illumination changes, there is the fond hope on some part that the presence of the three chromo channels will permit a kind of color masking, if you will, to be evolved for live operation.

But it would certainly be a great deal more desirable to be able to eliminate the problem in the first place and establish as completely as possible total stable camera operation.

To sum it up, we don't know how to yet, but we intend to find out.

MR. PUTMAN: I think we have lived with color cameras since the middle 50's, and I think we are all familiar with the three-IO color camera and the advantages of selections of tubes to satisfy various lighting conditions and conditions that you get into.

But I think we are at the point of changing to a camera where we have some operational ease and maybe simplicity. I believe - and I'm going to talk to the future more than to the present - that cameras in the future are going to have a separate luminance channel.

Now, you can take your own choice as to how you want to take care of the chrominance channel. This probably is the biggest bag of worms that there is today.

The Japanese have standardized in NHK, the Japanese network, on a two-tube color camera, where they are using two IO's and deriving the color information from a striped filter. That's probably about as simple as you can get.

I think we have all thrown out the thoughts of a single striped tube that many of us played with in the 50's. It always brings up an interesting question, though. We did a lot of playing around in the 50's and separate luminance was not unknown. As a matter of fact, it was a laboratory novelty, and it took five, six, seven years before anything was ever done on it.

But in any of these subjects, there are a lot of pro's and con's. I would just like to cover some of the pro's and some of the con's.

Starting off on the negative side, the argument for separate luminance is that there is in fact a color error. I don't think anybody will deny this. I will say, though, that you can run AB tests and it is very difficult to find any group of people that you can get any pattern to indicate that one is better than the other.

People have proposed to use separate luminance and then put in a correction signal back into the luminance so that you make it absolutely correct. I think the main problem with the correction is how do you derive the correction signal.

There is no doubt that a four-tube camera or anything greater than three is a more complex camera. It has more in it. I think though with present-day technology and the design of cameras, that this is not a problem.

From an engineering standpoint, there were days that if anybody whispered transistors to me I wished I had never heard the word. I had gone through this rigamarole, transistors are the thing of the future, they are long, they are reliable. But from a design point of view there were two things that were very obvious in the early days. They cost too much and took too much time. There is a very gratifying thing, though, that transistorized equipment has proven to be extremely reliable; but more important to you, I believe, it is extremely stable. I do not believe that added complexity in a camera is a detriment from an operational point of view. Physical size, obviously the more you put in a camera, the bigger it gets.

The other point is signal-to-noise.

Now, noise in the chrominance channel is not a problem. But noise in the luminance channel is a major problem. I think that this is one of the keys in a camera of the future. You can use the argument that you would like a three-tube camera to pick up about four db advantage in signal-to-noise.

A single-tube camera, the noise is a function of the tube that's in the luminance channel, and there is nothing that you can do about it. Talking on the positive side, I see operational ease as one of the real pluses. And by ease, I mean more in how do you set the camera up and how long will it stay?

The advantage of the separate luminance system is basically that absolute registration is not going to affect either signal-to-noise or resolution. We will probably end up with a little better black and white picture if we look at it over-all.

There is no doubt that a three-tube camera correctly set up puts out a beautiful picture, and there is no doubt that it is difficult to tell which is which. I think I will sum up, as far as the pro's are concerned, that in general this type of camera is less sensitive to knob twisters. I think we have a little of that in all of us.

DR. KOZANOWSKI: First, I feel that the four-tube approach with a separate luminance channel gives you high resolution, good signal-noise, with the restrictions that Mr. Putman has mentioned.

You have a picture which is completely independent of registry. And, a very, very important thing, it's your bread and butter for a long time while you're getting warmed up on color. So I don't think you want to fool around with that premise.

Then the other thing is that when you get into the chromo picture, you get chromo from tubes of a vidicon type, and I would say at the moment I would try to exclude Image Orth's from the chromo channel because in a sense they are a little bit too complex for the job.

When you get an Image Orth that looks like a vidicon, again, I'll be awfully interested. But in that case, again, the requirements are flat field, because this is the basis of making good chromo pictures. Low dark current, because you don't want to fool around with problems of that general nature. Good color sensitivity which is adequate for a good basis of colorimetry. High sensitivity, because this sets where the threshhold is going to be ultimately for this camera. And adequately controlled lag.

This, again, depends on how you are handling the problem. In a luminance channel, you can put up with a great deal of what looks like lag in the fundamental chromo components and never miss a trick in the luminance. In which, I think, Nature is awfully kind.

Now, I think Dick has already covered this thing, and I think Al Malang has mentioned it too. That you don't deliberately say color registry can be poor and color pictures can be good, because that's a meaningless statement. Color registry should be as good as you can do, but the practical tolerances are such that you do not suffer if things are a little bit upset, as far as the luminance channel picture is concerned. The eye on few channels, after all, needs something on the order of 120 lines resolution or less to perform their function. So its a great deal of engineering satisfaction to get something out to five megacycles and whop it off and have lots of fun.

Then my own personal prejudices on the use of a tube for the luminance channel are very definitely in the direction of Image Orth. Not because we have used it for so many years, but because of the fact that it has a very beautiful built-in knee for taking care of highlights and glint and things that the technical man doesn't see why they have to be in the picture and the production man will argue the point with him. And as long as we can solve our difficulties with the built-in characteristic, I'm awfully happy.

Then, the other thing is a point that has already been mentioned and that is tolerance in technical operation. I think you can get an awfully exciting reaction to a camera under ideal conditions. The idea of how much tolerance can you build in for everything going wrong, and you come out with a good picture, is the whole point.

And I think what Dick has said is very, very definitely true. This camera has a built-in cushion for doing things wrong and not really bleeding from the effect. And I think this is desirable on a long haul basis and particularly in the warmup period when color is starting to roll and people will get more and more excited about possibility.

Another thing we have tried is a rather interesting problem because it is the old outdoor pickup. The thing I'm trying to bring up is this, that outdoor broadcasts have a habit of fooling you, because you look at that thing and say "Ain't Nature beautiful?" Well you look outside and there's very little color there and somebody says "What's all the fuss about?" Especially with a sky up here very very bright and the color information down here almost vanishing. You put that on a system and say, "Well, that's color there, you just have to have faith."

So my own approach to this thing is one that we have tried with Freddy Himelfarb, as a matter of fact, and that is that you can stand a lot of gamma correction and squash the sky down to where it's of reasonable value and pick up your information, then your chromo picture, and this gets us back to Bill Wintringham of Bell Labs a great many years ago, about 1950.

He says - He wrote this up in the IRE - and he says it's the point of view.

If you are running an entertainment service as compared to a colormetric measurement thing, you're making pleasing pictures, he says you really don't want to know from here to here how much is it. What is the impact on the guy that's going to look at it and say I like or I don't like it?

So from that point of view I think there is a great deal of flexibility in - let's be honest about it for the moment - painting a picture, because there's no law against it.

If you have freedom of choice between luminance and chrominance components you can distort, if you will, or compress the white highlights and raise the chromo and the general effects are very, very favorable as compared to the present rule.

Thank you very much.

MR. MARX: I think one of the most important things that may come out of this panel is the redundancy which certainly I haven't heard although I heard it suggested up here at the head table. And I think redundancy of questions may be very important, because I would suspect that if we had three identical questions, we may get three separate answers. So I see no problem in that regard.

I did notice while certain of the panelists were speaking that others were making notes. So perhaps we might ask the panelists if they would like to make any comment on their fellow panelists.

MR. CAVANAGH: I find the comments of my associates here very interesting and very much to the point in certain respects. However, there is one point that really was not emphasized at all.

For those of us who for many years have been working with color systems there is a very difficult thing associated with trying to match transfer characteristics. Now, if you take the position that color fidelity is not important, then that shakes it up very easily. If you take the position that color broadcasting is going to become more and more important as time goes on, then it requires a little more caution in looking at the over-all system and choice of transfer characteristics in the pickup tubes. You can make any kind of a color picture. There are lots of knobs there. You can push them any way you like.

But for the proper color fidelity it is much easier if the transfer characteristics of either the three or the four tubes match.

If we go into the registration, again the comments, if I interpret them correctly, were very valid and related to the present situation where there are not too many color receivers, and it is very important to consider the number of monochrome receivers and the reception on those monochrome receivers.

Based on our own evaluations and other evaluations I must say, though, that the registration requirement for a four-tube color camera for color reception is not significantly different than a three-tube camera for color reception.

Again perhaps I'm a little too cautious, but what we see developing is a very strong position for color for the future, and in the long run our feeling is that we must strive for the best color fidelity we can achieve and the best monochrome fidelity that we can achieve. But neither one should be downgraded in favor of the other.

My comment, again related to lag, would be exactly the same thing. Lag is no problem for monochrome reception, when you have lag in the chrominance channels but excessive lag is very serious for color reception in that particular case.

I think that covers my comments, Mr. Chairman.

DR. KOZANOWSKI: Speaking as an individual - not for any corporation - If I were allowed to write the ticket for an ideal tube, I would be very tempted to write a ticket for a tube which has zero dark current, zero lag, and a gamma .5 that you wouldn't have to tamper with worth a damn. And then I would have an ideal.

But the unfortunate part is that Nature is a little bit cautious. Both the Plumbicon and the Selenicon to get the characteristic that they have, unfortunately came out with a gamma of 9/10ths or thereabout. I would like to warp it into shape but it doesn't warp. So that, I agree in principle, you have to correct because a gamma of 9/10ths gives you a very harsh picture. But I don't think it's a necessary requirement. In other words, this is the best anybody knows how to do right now, and I think it's a very great complement to the success that we have. But I wouldn't shut the door completely saying this is ideal.

MR. MARX: Gentlemen, ladies, the session is now open for questions.

QUESTION FROM THE FLOOR: Mr. Chairman, could we have some comment from the panel on operating cost of the three systems?

MR. CAVANAGH: The costs of the basic equipments are relatively the same order of cost. I don't think you can look at major differences there. In terms of tube life the differences are not that much. The Plumbicons, we feel, have a little longer life, but when you relate it back to operating costs, then you're looking at, let's say, minor differences until you relate it to the actual operating time associated with getting the cameras into broadcast performance, daily. Which, of course, is unknown until enough of, say, the four-tube cameras and the second generation three-tube cameras are in actual operation.

DR. KOZANOWSKI: We had at one time a feeling that an Image Orth had a very limited life. But other things are coming to pass saying Image Orthicons need not necessarily have limited life on the basis of Elcon developments, which eliminate or minimize the possibility of burn and sticking.

So when we used to say the operating costs of a camera would be thus and so, that may not necessarily be true any more in the long haul. The fond hope would be that you could get tubes of the Vidicon type that would have lives comparable to the TK 26, 27.

MR. MARX: I'm sure there are present in the audience representatives of companies outside of the operating broadcast field. Please feel perfectly free to speak if you wish to make any comments on what any of the panelists have said.

QUESTION: Mr. Chairman, to digress from the characteristics of the Vidicon as against the Image Orthicon tube, I make note that in a recent article in Broadcasting Magazine, the figures were posted that 79% of all the stations in the country are capable of transmitting color.

Those 79% can handle network color....28% of all the stations in the United States can handle film transmission in color. And of the total percentage, or 100%, only 14% of the stations in the United States can transmit or originate live.

Now, in considering these figures, of course, there is an expenditure to be considered before a station goes to color. Most of the stations, I presume, would be primarily interested in converting or adapting their present facilities to handle film on a local basis other than a network feed.

Is there a camera on the market comparable to a Vidicon, or an Image Orthicon that could handle a conversion job with present facilities as they are at the stations? Not all stations would be willing to undertake the purchase of new multiplexers or new facilities just to go in for color film. Now, if your panel could give me some indication as to what might be available, regardless of the manufacturer, credit, or what have you, just to the point of...Is there a camera that could be adapted to a present multiplexer for color transmission?

MR. MARX: Before the panel answers that, just to be sure of one point. You are suggesting that the present monochrome black and white camera be eliminated. You want a combination color and black and white?

QUESTIONER: Well, if that's what's on the market, fine.

MR. MARX: Gentlemen, you have heard the question. I hope you understand it.

DR. KOZANOWSKI: In the early days when we weren't ready to talk about film trans and color film and we hadn't made up our minds whether it was going to be flying spot or Vidicons and we still had to put on film, then we used live cameras and put the projection on a screen and took it off from there.

But that doesn't save you money. That spends it for you, because you have to buy a live camera and use it for film, and that's a horrible thought, because basically you do not improve film doing that. As soon as you put it on the screen you lose contrast ratio and put-in flare and other things. So this is an observation. I would say I don't know of any device that we could use, for that.

MR. MALANG: Just a bit of curiosity. I thought I understood the question to be a new film color/black-and-white camera to replace an existing film camera, not a combo film/live.

Could the question asker please clarify that?

QUESTIONER: The question was directed to a film chain only. Studio-wise for live action there are plenty of cameras available. It's adaptability to a film chain setup on a permanent multiplexer.

MR. MALANG: That being the case, frankly, I'm a little bit puzzled, in that to the best of my knowledge any of the available four-tube cameras can be warped up to any of the multiplexers that I am aware of.

Yes, I will admit that there are optical changes necessary since there has been a tendency toward a reduction in the image size of the field lens in order to obtain improved optical characteristics on the multiplexer. But I am personally aware of, oh, perhaps 50 or 100 such conversions.

MR. MARX: I agree. It seems to me that the major problem is if there is enough room to put the color chain. I don't know of any color film chain that can be rolled into the same cubic area, simply because you need more pickup devices.

MR. PUTMAN: I think everything we have said is correct, other than using a multiplexer with prisms in it. Prisms that we are used to today are not only poor in certain cases, but they do not have flat transmission across the visible range that we are using for light. In other words, the receive characteristics or reflect characteristics are a little different than the transmit characteristics. So there would be a problem of color balance. And the way it happens to break out is not an easy one.

MR. MARX: I wonder if there are any station engineers in the room who have made conversions of the type asked in the question. Are there any who have just replaced a monochrome film chain with a color film chain?

MR. MAYER (Marconi Company of England): There is no doubt at all that the film and live color camera which the broadcaster needs is a four-tube camera.

There is also no doubt that in the present state-of-the-art, the fourth tube, the luminance tube, must be an Image Orthicon. However, it does have problems which have already been mentioned by Mr. Cavanaugh. These are problems of registration of the dissimilar tubes of the Image Orthicon to whatever the three other tubes are.

And there is no doubt that for good color pictures the same order of registration is wanted between the three chrominance channel tubes, and secondly between these three tubes and the fourth luminance tube.

However, the Image Orthicon has this very nice attraction of the knee which Mr. Kozanowski has already mentioned. The answer, no doubt, is the tube that Mr. Kozanowski is going to develop privately, this .5 gamma tube. I very much look forward to the day when we are able to use four of his tubes in a color camera..... Because the tube which is available at the moment, the Plumbicon tube, certainly has a number of disadvantages which make me believe that it is not the - perhaps not the final tube to be used for this application. I don't think I need go into these disadvantages, because they have been mentioned already.

QUESTION: I think I heard you use a word which makes my hair stand on end. I think I heard you use the word "painting." Are you still advocating seriously the non-objective adjustment and operation of color chain?

DR. KOZANOWSKI: There is only one word that everybody else hates worse, and that's the word "irregardless". But I say "irregardless" it's one of the facts of life, that you would not like to paint. But it's the old, old story that if you have to paint - You don't have to, your competitor will. And if he can do a better job by using poetic license and you lose the business, why it may want to have somebody look into it.

Just for clarifying the record, I think what is being referred to is a very, very good point, because we are both on the same Committee for Standardization of good color for color film. And there I am very very much with him, to the point where the movie industry is going to put us both on the block. And that is if you set a system up so that white is white, you should be able to put the film into the projector and come out with glorious color.

And this is, I think, what Bob wants to do about painting. I have not really talked to him about the matter of live cameras.

QUESTION: I would like Mr. Cavanaugh to comment regarding the unfeasibility of the four-Plumbicon camera.

MR. CAVANAGH: Well, so far as I'm concerned, there is no unfeasibility associated with it.

I don't know if any of you gentlemen have had a chance to look at the monochrome Plumbicon cameras which are running here. We are quite happy to put these up against a four-and-a-half inch Image Orthicon under any conditions in studios.

Now, again, you get into difference of philosophy here. And the philosophy - all of us are humans - all of us feel personally quite strongly about certain things. It's quite normal and it's quite to be expected. In the final analysis, you gentlemen are the judges of how well we make the choices and the compromises in all of the camera designs.

We believe that the Plumbicon tube itself is a major step forward in terms of an image pickup tube. The image quality associated with it is very demonstrable. There are some things about four-tube cameras which have not really been brought out here this morning which might be worthwhile just making a couple of comments about.

At this stage, it is not exactly easy to make the proper optical split for four-tube cameras. By that I mean it is nice to talk about the wide channel being identical to an Image Orthicon camera. However, you must sacrifice some light in doing this. The choice then can be made for lowered resolution or lowered signal-noise ratios. This, again, is something that is a choice of the designers, but really in all of these matters our feeling is that once you get to the point of operating cameras, the judgement really rests in the hands of the broadcasters as to how well the job is being done and how well cameras stand up in the future.

MR. MARX: In the comments of our panel, there was a passing mention of the new Japanese camera. Perhaps for many of us here who are not as familiar with this device, I would hope that the panel would comment a little further on it and tell us - What is the future potential of that two-tube camera?

MR. PUTMAN: Basically what NHK has done is to take and split the light between an Image Orthicon for the luminance signal and then through a relay system at the relay point where you have a real image again insert a striped filter.

Now, you can get into many types of striped filters, but just for simplicity let's say that it is a red-blue-green striped filter at that point. If you put enough stripes there, you will scan across and then sample. In other words, you have a time relation, you know when you're going across the red, the blue and the green. Sample the information at that point and put it through a filter. This, as long as the filter is half the scanning frequency, will restore a normal picture.

In an encoder or to comply with NTSC regulations - or FCC regulations - you need a half megacycle of Q and about 1.4 megacycles of I. Now, in essence, practically all receiver manufacturers only use a half megacycle for our -Y or B-Y. I believe the Japanese use 80 sets of stripes which, when it comes out to the realistic point, is about a half megacycle of information. It is also a pretty optimum choice in the number of stripes because they also come out with a pretty good signal-to-noise measurement that appears to be right at the crossover point. And speaking about signal-to-noise, in a four-tube system where you're using separate luminance, noise is not an important factor.

There is very little luminance information in the chrominance signal. And you can have noise that gets down almost to two to one, peak to peak, and not really object to it in the color picture.

I realize I have jumped around a little, but I have tried to cover the points that the Japanese have used in their argument. In other words, you can by filters separate out the various colors. You have two tubes. You have only one registration problem. It is the problem of registering the chrominance information to the luminance information. And theoretically, you then have a simpler camera.

Now there are many problems. Two basic ones are the moirè problems that you would have when you cross a filter. The other one is a signal-to-noise problem as to how much noise you can stand.

DR. KOZANOWSKI: Two other pieces of information - one is hearsay and one is authentic.

I have been told within the last few days that there was a four-tube camera built for NVT, which is the independent Japanese station, which was placed in operation in October, and there was quite a bit of publicity for it. This was an Image Orth Vidicon type of camera.

Now, firsthand information on this two-tube camera, we had access to some of the tapes that were made at the Olympic games using the two-tube camera.

Maybe I'm a prejudiced witness in this case, but I would say that the monochrome picture was superb from the standpoint of gray scale, signal-to-noise, and general character. And the color, I would say, was mildly interesting. They did beautiful solid field things, but - well, in the one case that we had, possibly because of the limitations in the striped filters - if you look at the ladies with red hats, you didn't have to look for them. They just stood out. In other words, here's red, we can find it.

I think it meant that they were playing quite a bit too close on what they needed for resolution and what they were actually able to get.

And that's why I'm very much disappointed that we did not have access to this camera at the NAB Convention. I thought that it was going to be demonstrated here.

QUESTION: Mr. Chairman, I would like the disadvantages of the Plumbicon tube discussed at this time.

MR. CAVANAGH: If I could just make a comment, and again, I'll just state a personal feeling.

At this stage of the game, the more we work with this tube, the more we are pleased with it, because we find that it has more and more capability associated with it. Again in a personal sense, to my friends and associates here, I would like to see them do just what Hank suggested and do it very carefully.

QUESTION: I would like to get a short comparison of the trimming techniques for the 3B versus 4B, and the adjustment to varying color compositions of studio light.

MR. MARX: This relates to live cameras, the techniques of trimming, the three versus four-tube. I think it probably relates specifically to the time it might take between one versus the other.

QUESTION: In setting up the 3B camera and adjusting to the color sensitivity or the balancing sensitivity of the three tubes, as to whether or not that can be done without physically going into the camera when you go to the four-tube variety. Can it be adjusted photoelectrically in the chrominance?

MR. MALANG: I'm not quite sure I understand the exact point, but if it relates itself to the initial setup, what used to be called the calibration of the chain for film service, there is a rather rigid set of techniques that evolved in the American Broadcasting Company, and to the best of my knowledge, done equally - in equal direction or with equal fervor at the other major networks. I don't know what has been done at the local level.

One can trim to a lesser extent in the four-tube camera and still see a much more pleasing picture in the output of the channel. But it's not a very desirable way to do things. The principal effect in the 3B is that in the 3B if you do not trim carefully for tracking over at least a plus or minus 3 db range in light level to it, you will get rather serious color shading in the dark areas, the characteristic of going green or magenta as the scene goes low light.

In the 4B you can get equal effects if you do not trim the three chromo channels just as carefully for sensitivity match, for shading match and for tracking over the plus or minus 3 db range.

So I don't believe for good picture quality, one can relax the amount of effort applied to the camera. Again you must bear in mind that a four-tube camera does give greater latitude in registration, greater latitude in most of the color errors and still give you a clean black and white picture.

Also, one has to face up the reality of the fact that very few display devices are in fact luminous when they go to the monochrome signal.

And very few receivers are in fact properly color balanced and properly set up.

The variety of errors in the display from a small error in the channel would astound you.

But, to answer the specific question, it would be unrealistic to say that you can relax the procedures for a 4B.

QUESTION: I think most of us are familiar with the reasons for the failure of Image Orthicons and Vidicons. What is the usual reason for failure in a Plumbicon?

MR. CAVANAGH: It's just the filament primarily. And filaments manage to last a pretty long time. Our experience so far in terms of life indicates that the surface holds up longer than the electron optics. You do not see with this tube with long life the - let's say a noise deterioration starting at around 100 hours and getting worse and worse and worse. The signal-to-noise ratio holds up very nicely and the gamma holds constant to sensitivity. So that in terms of life I would think more in terms of just the life of the filament.

QUESTION: In the area of lighting studio productions for color has there been a significant breakthrough in reduction of light level and, if so, what light levels are we talking about, not for simple productions, just a man in front of a desk, but where you need a reasonable depth of field, multicamera and mobile cameras? What kind of light levels are we talking about? How much base, how much key light?

MR. CAVANAGH: If I could just make a comment about Plumbicon cameras for a moment... We have noticed that the lighting for Plumbicon cameras can be handled differently. By that I mean that the normal fill-in associated with Image Orthicon cameras, which is, let's say, a flat lighting, is not really that necessary.

You can go more to a - let's say - a selective type of lighting. You do not have to build your lighting on a complete base that way, unless, of course, you go back to the point you made where you have a large set, multiple cameras and you need the depth of field.

MR. MARX: Gentlemen - I think we have just about run out of time.

This closes the first technical panel session that NAB Engineering has attempted. Certainly we want to thank the panelists, and I hope you enjoyed this first attempt.

Thank you very much.

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AMPEX

Technical Paper

for

NATIONAL ASSOCIATION of BROADCASTERS CONVENTION

SHERATON—PARK HOTEL, WASHINGTON, D.C.

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THE "HIGH BAND" APPROACH TO TELEPRODUCTION

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PAUL WELCOME

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REDWOOD CITY, CALIFORNIA

INTRODUCTION

In 1956 the recording of television programs on magnetic tape gained immediate acceptance as a means of providing time-delay. Today, almost ten years later, recent developments enable the magnetic medium to be used for teleproduction. The word teleproduction in this context will mean the ability to duplicate and expand upon the well known film techniques of splicing, editing, single frame animation, and synchronous matching of sound to picture or picture to sound, all with the unique advantages which only magnetic tape can provide. Teleproduction is now a useful operational tool because the present "state-of-the-art" makes possible the attainment of hitherto impossible performance in the video recorder. These extended performance characteristics can be logically grouped as electronic, electromechanical and operational. In each of these major parameters of operation, extensions have come about through the refinement of the signal system, the servo system and the flexibility of utilization.

SIGNAL SYSTEM

One of the major limitations to multiple regeneration of video tape program material has been the marginal signal-to-noise ratio and poor transient response in the video system, both record and playback. Each subsequent copy from an original tape would introduce about a 3db loss in signal to noise. The final distribution copy, which was assembled from a number of pre-recorded segments, usually turned out to be at least a third generation tape. The noise would then be in the order of 36 to 37 db and not acceptable by many quality conscious broadcasters. Even the most technically naive viewer notices the reduction in quality of some multiple generation programming, even though he may not know why.

Even more noticeable was the effect of limited transient response, which would introduce visible ringing at each sharp amplitude transition in the image. Trailing effects became very objectionable when several consecutive dubs were made. In the recording of color signals especially, even a second generation was in the objectionable region because of Moire and inter-modulation distortion in saturated areas.

Since these problems are inherent in the signal system, which was established in 1956, (Fig. 1), it is necessary to re-examine the parameters of operation and to determine which ones are significant. Two things become apparent. The signal-to-noise ratio may be improved by wider deviation, BUT the price is inter-modulation which produces unwanted spurious signals, that result in a visible interference in the picture. This generation of unwanted spurious signals is due to the proximity of the carrier and deviation signals to the higher video frequencies (Fig. 2). The obvious remedy here is to move the carrier and deviation frequencies, since the video frequencies are fixed. We have arrived at the point of moving the carrier frequency up, but how far up -- and why choose any particular point? If the carrier frequency is increased, there is not a linear or direct proportional reduction in spurious output. Instead, the reduction of spurious output occurs in discrete steps on which second, third and fourth order harmonics exist. (Fig. 3). At this point, the solution to the problem of signal-to-noise and transient response in the signal system is to operate on the highest shelf of operation which is consistent wich present "state-of-the-art" (Fig. 4). One of the first stumbling blocks to operating at these higher frequencies is the resonant frequency of commonly used head assemblies. This limitation is now overcome by the use of modified head assemblies, which include the intergral pre-amplifiers and rotating transformers that not only raise the head resonance to the desired level but also effect a signi-

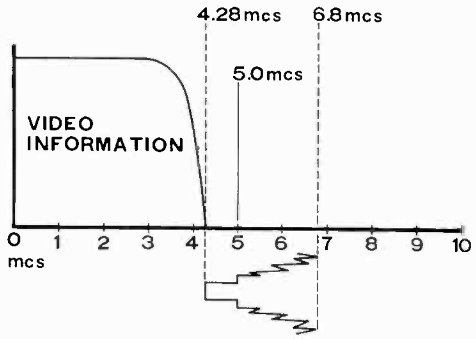


Figure 1

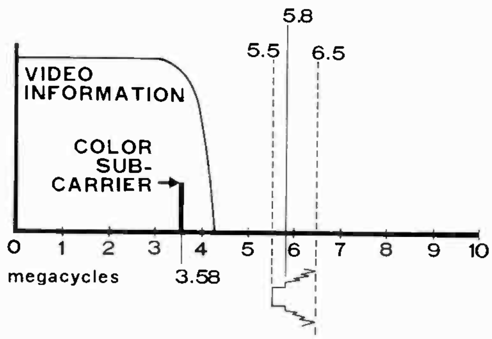


Figure 2

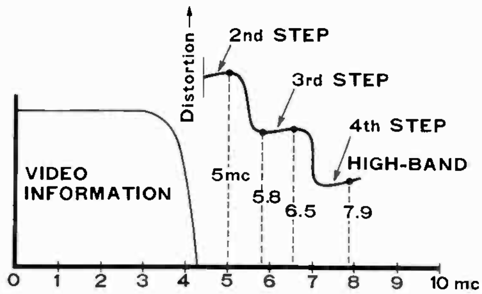
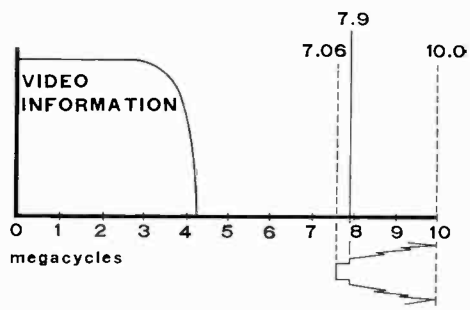


Figure 3



10 MEGACYCLE HIGH BAND

Figure 4

ficant decrease in the crosstalk between heads (Fig. 5). We are now able to operate on the fourth order shelf and this provides a basis for a level of performance that meets tele-production requirements.

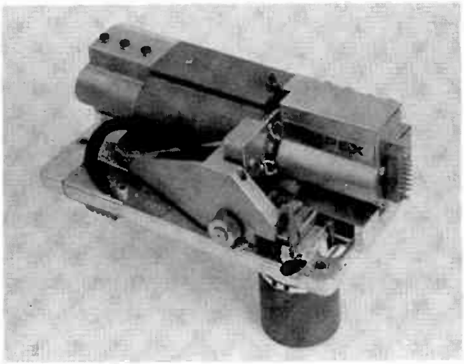


Figure 5

The design of the system must also assure that maximum linearity is maintained from input to output, in order that differential effects are reduced to an insignificant amount. The modulation system which has developed and proven, utilizes a modulator that eliminates the characteristic non-linearity of a single-ended modulator. This is accomplished by utilizing dual-driven oscillators that are operated in anti-phase (Fig. 6). The oscillators are controlled by varactors, and operate at 100 and 108 megacycles respectively, their outputs being mixed and applied through a low-pass filter to the record equalizer and record amplifier. The varactors (variable silicon diodes) change their capacity in direct proportion to the cube root of the applied voltage. Since the frequency to voltage ratio follows the sixth power, only a few percent deviation is needed. The end result is that better than one percent linearity is achieved over a 5 megacycle range AND even order non-linearities cancel out due to the opposite phase modulation. Only video pre-emphasis is used, and the signals are applied to the head through low impedance circuitry, which effectively damps out head resonance (Fig. 7). Under these conditions, even with 100% multi-burst test signals applied, the RF envelope of the FM signal contains very little AM component and is symmetrical.

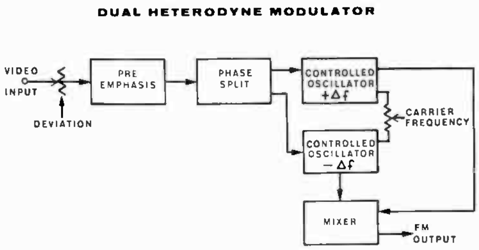


Figure 6

In the playback mode, head resonance cannot be damped out without amplitude loss from the transducer. Special circuitry is included to permit conjugate equalization of this resonant peak. The frequency of the resonance and the Q of the equalizing circuit are altered by C and R components, resulting in a flat amplitude, versus frequency response for each head channel. It should be noted here that the frequency compensating circuitry is located externally from the head assembly and enables the interchange of heads on different machines without additional adjustment satisfying even the engineer with a penchant for splitting hairs. This provides a signal to the demodulator which is free of differential phase effect. Push-pull limiting and detection, through a pair of delay lines, is followed by a linear-phase low-pass filter. The over-all signal system is capable of a better that 2% K factor response, with the 2 T sine-squared pulse. The differential gain and phase is less than 5% and 5° respectively. The signal to noise ratio with a 4.5 mcs reproduced video signal is 46 db, and it is 43 db when a six megacycle video signal is reproduced.

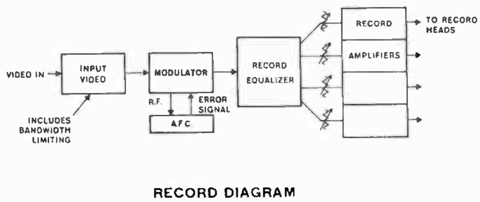


Figure 7

SERVO SYSTEMS

Synchronous operation with studio reference signals is one of the established methods of operating video tape recorders today. One of the major limitations in present servo systems is the band-limiting effect of the power transformers in the final motor power amplifiers which drive the head drum motor. Even when head velocity errors are sensed and corrected rapidly, the large inductive elements of power amlifiers limit the response rate of the feed-back loop to the motor itself.

There has been a considerable improvement in the reliability, stability, and incremental control in servo systems now coming into use (Fig. 8). An entirely new technique is used in the operation of the head drum motor. A solid state 130 volt dc supply acts as the source of motor power. The three phase square wave drive is supplied by switching transistors, controlled by digital circuitry, which gates on the dc supply at the appropriate times. This method inherently provides a high phase-to-phase balance, since each phase is derived by a switch between two fixed voltages and all phases receive an identical voltage. Binary counting circuits provide the three phase signal, insuring 120° phase displacement, which is precise and stable. The elimination of the bulky transformers and other components reduces the over-all size, weight, and heat dissipation yet improves the efficiency of the system. A three phase staircase waveform produces torque with no third harmonic component. This, coupled with accurate phase-to-phase balance, eliminates all even order components and significantly reduces "once around" errors common to previous video recorders. The improved action of the servo loop and the use of an air-lubricated head assembly increases the pull-in range and reduces high frequency jitter to an unbelievably low level.

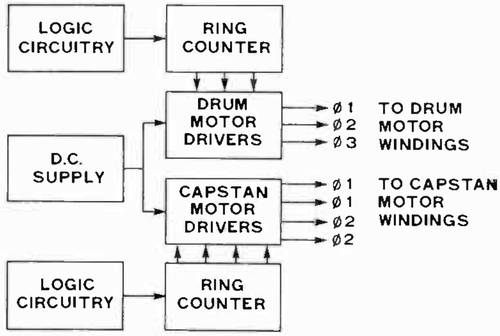


Figure 8

It is possible to reproduce 525-line NTSC color images without the use of a color-corrective device, since high frequency time-base displacement in the head drum is extremely small. The capstan servo system incorporates a change from direct drive to a transmission system which uses a dual field capstan motor and a considerably thicker capstan. The flutter and wow figure for this new combination at 7-1/2 ips is equal to the previous 15 ips specification and is significantly better at 15 ips.

EDITING AND ANIMATION

A comparison of video tape recording with the methods used in the film industry for teleproduction has, until recently, revealed the superiority of film editing techniques. Several problems plagued the magnetic tape process when in direct competition with film. The first was precise control of the onset and termination of recording to a degree which would permit frame-by-frame control. The second problem was an extension of the first, similar control of longer segments in assembling actual productions. The last problem, with no film equivalent, was the wear of the tape with repeated passage across the video head assembly. It would be pointless to produce an animated sequence which required over 100 re-scans of the same segment of tape, only to find that the entire recording was useless because the tape had been worn out.

The first development which has helped to overcome these problems is the use of electronic editing (Fig. 9). This method of editing compensates for the time-displacement between the erase head and the video recording head, permitting consecutive, non-consecutive, or insert recordings to be made.

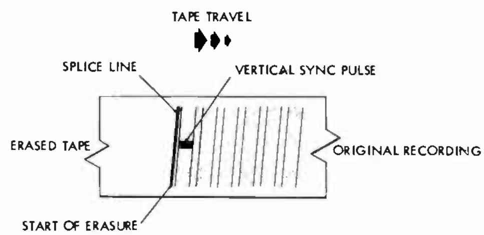


Figure 9

At this point it was necessary to assess what operational features were still lacking in order to have a flexibility equivalent to that possible in film editing. It was apparent that the electronic editing was essentially limited by the reaction time and skill of the operator. This deficiency has been overcome by the use of cueing pulses which provide the single frame accuracy required (Fig. 10).

These cueing pulses are located in the auxiliary audio channel (cue channel for the video recorder) and are of two varieties. Two different frequencies are used and are labeled "remote" and "edit" cues. The edit cues perform the switching functions previously mentioned, while the remote cues are used to actuate external equipment such as other recorders, film or slide projectors, or live camera tally lights.

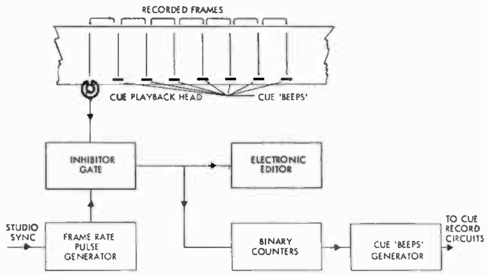


Figure 10

Simultaneous editing of both the video and audio tracks or editing of the video only, leaving a pre-recorded sound track to which a picture can be sychronized, are now a reality. After cues have peen placed on the tape, a picture monitor preview of the inserted or added scene can be viewed without committing the material to the tape, or erasing what is already there. If the preview indicated that the switching point is inaccurate, it may be shifted forward or backward in single frame increments or may be changed in amounts up to eighteen frames. When the precise cueing point has been established, the old cue mark us automatically erased and re-recorded at the new location.

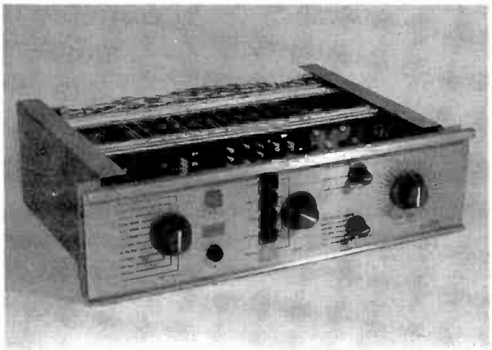


Figure 11

In the animation mode, the recorder can be operated in "automatic" which will allow the recorder to insert the frame increments selected, (from one to 37), to stop, to start, and to recue itself without an operator (Fig. 11). That sounds a little complicated and hard to believe. When the animation mode is operated in "automatic" the initial start is actuated by the operator, and then the recorder is synchronized to the external reference, provides a record cue (tally light), records the scene, rewinds itself, holds for a pre-set period, provides a cue, and if a scene requires changing later starts up automatically and repeats the process over and over until it is manually stopped or runs out of tape. In the event a longer segment of material is required within the established frame intervals, a record over-ride feature permits manual insertion of this segment. Upon completion of the manually inserted segment, the recorder will return to full automatic operation.

REPEATED RECORDINGS

The animation procedure requires a great number of passes on any given segment of the tape. If frame-by-frame animation were attempted on an older recorder, it would cycle approximately 120 times. Several changes have been made in the transport system to minimize wear effect and to reduce the duty cycle of the head on tape. The installation of a retractable full width erase head, which does not contact the video tape except during the actual recording, lowers the tape wear by eliminating redundant contact between erase head and tape. The elimination of this element in the tape path during shuttle and play modes greatly minimizes scratching and tape wear. Search and lock-up period has also been reduced by programming the female guide so that its pull-in period is delayed and the tape is only brought in contact with the video head for a period of thirty frames, rather that the normal 240. In this way, any given segment in the tape is contacted by the head only 12 times even in the maximum animation mode. The audio and control track monitoring is done from the back (or Mylar) side of the tape. The finished tape is adequately polished without suffering any deterioration.

CONCLUSION

New circuitry and new techniques, which include the improved signal system, more precise servo systems, and frame-by-frame control, combined with high band operation, now give video tape an edge over film as a production tool.

Recent improvements in the inherent signal to noise of the video recording tape itself, combined with the improved signal to noise of the recorder, with interference-free recordings, make a third generation copy which rivals the "original" recording of yesterday. The magnetic tape medium has the further advantage of immediacy (no time lag for processing) and the ability to rehearse and to preview edits and animation sequencies ON THE SPOT. By the utilization of the teleproduction advantages and by including the ability to have third generation elements, as a result of transfer editing, the "end result" picture quality is now completely acceptable. The flexibility offered by the new editing and animation techniques (Fig. 12) has opened the door to greater utilization of television techniques and equipment in the production of commercials and in syndicated programming, not only for use by the broadcaster, but also for "screen" use.

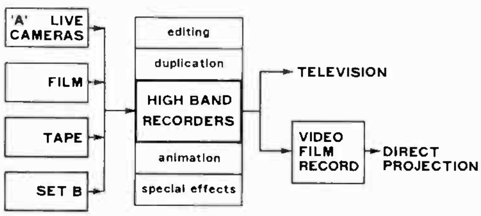


Figure 12

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A PROPOSED METHOD FOR STANDARDIZING SCA CROSS-TALK MEASUREMENTS

by

John A. Moseley*

SCA cross talk is most commonly defined as those undesirable modulation products appearing in the output of the multiplex detector. The source of the unwanted signal is usually the main channel modulation, but adjacent subcarrier activity on the same FM carrier can also contribute to the cross-talk level. Cross talk can be introduced into the multiplex subchannel by the FM transmitter, transmitter power amplifiers, antenna system, the presence of multipathing, and the receiver. When the complete multiplex system, including both the transmission and reception equipment, has objectionable cross talk, it is often quite difficult to locate that precise point responsible for the majority of the cross talk. Usually the lack of adequate test instruments or monitors and the physical separation of the various parts of the system are the cause of this situation. Since the beginning of FM broadcast multiplexing, the causes and cures of SCA cross talk have been the subject of many discussions and articles. Because of this publicity, some broadcasters without a thorough technical understanding of the matter have been misled, and therefore, their efforts to reduce cross talk have often been in vain. Certainly the presence of cross talk can not be denied. This matter is compounded by the fact that cross-talk measurements made by various manufacturers do not always agree because the methods used for making the measurements are difficult and are chosen, perhaps, to give the highest possible cross-talk figure for their product. These procedures unfortunately have little value to the multiplex operator when a number of irate subscribers complain of excessive cross talk.

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It is the purpose of this paper to propose a standard method for the measurement of SCA cross talk. Obviously, defining a standard measurement procedure alone will not reduce cross talk. Rather, it will permit stations to duplicate cross-talk measurements with a minimum of effort using standard equipment. Besides serving as a common test procedure, the proposed method has the advantage of providing a means to adjust all of the multiplex equipment for its optimum cross-talk performance.

In regulating the technical requirements for the SCA multiplex subcarrier, the Rules and Regulations of the Federal Communications Commission are limited to those characteristics of the subchannel that have a bearing on the performance of the main channel modulation. These are covered in paragraph 73.319 of the Rules and relate to the use of frequency modulation on the subcarrier, the amount that the subcarrier(s) can deviate the main FM carrier, the instantaneous frequency of the SCA subcarrier, and the limit to which the main channel can be modulated by the SCA subcarrier operation. The specifications on the frequency range in which the subcarriers may operate, the amount of injection on the main FM carrier, and the main channel band protection from SCA penetration are different for monophonic and stereophonic broadcasting. The broadcaster is most fortunate indeed that the Commission has not made an attempt to regulate the technical quality of the program transmitted over the multiplex subcarrier. Some broadcasters are interested in producing a high quality music service while others are primarily interested in voice relay or, perhaps, telemetering information associated with remote control operations. Thus, frequency response, distortion, and hum components can be determined by the broadcaster for his particular needs and can be readily measured by methods used since the early days of radio. To the FM broadcaster and to the subscriber of the subcarrier service, cross talk is the most objectionable characteristic of multiplex operation. It is an elusive quality that is often hard to accurately describe and is measured in a number of different ways. The method selected to measure it often is chosen to benefit the party making the test. Further, cross talk is introduced in both the transmission and receiving equipment. I am sure that a number of FM broadcasters have found themselves an unwilling part of a serious cross-talk situation where the transmitter manufacturer, the receiver manufacturer, the antenna manufacturer, the broadcaster himself, the subchannel operator, the technician, and even the radio path have all been accused as the prime contributor to cross talk. The unfortunate part of this picture is that all of these can contribute to the cross-talk problem. There is no such thing as a perfect transmitter for the receiver or monitor design engineer to use in checking out his product; likewise, there is no perfect monitor for the transmitter manufacturer to use in his work. While this can be troublesome to the equipment designer, it often represents a major dilemma to the broadcaster trying to operate a clean subchannel. Just where does he look for the most offensive source of cross talk? Pointing fingers has never solved a problem. The answer lies in establishing a common procedure for all parties to use in measuring SCA cross talk. This would provide a positive means to communicate between the broadcaster and the design engineer, as well as serve as a guide for the broadcaster and the user of the subchannel, such as a background music operator, in establishing the minimum operating performance for the subchannel. The NAB, IEEE, and EIA have not established standards in this area. It is time that this be done.

Before considering the proposed method for standardizing cross-talk measurements, it will be wise to briefly outline the procedure often used by the broadcaster to measure cross talk and some of the drawbacks associated with these procedures. First, the procedure. A subcarrier modulation reference is established by applying a mid-range tone, usually 400 cps, to the program input of the subcarrier generator. This reference, incidentally, varies from station to station, but it is usually between 7-1/2% and 10% deviation of the center frequency of the subcarrier. This figure should not be confused with the deviation of the main FM caused by the subcarrier, commonly referred to as the injection level. It should be noted in passing that this limit should be reduced when broadcasting a stereophonic main channel signal; otherwise, the lower order sidebands of the SCA channel that fall below 53 kc/s will modulate the main channel in excess of the 60 db limit established by the Commission. A 53 kc/s high-pass filter will eliminate these out-of-tolerance sidebands caused by excessive subcarrier deviation, but its use will increase the distortion products appearing in the subchannel modulation. Once the reference is established, the subcarrier modulation is removed, and the unmodulated subcarrier is applied to the main FM carrier at its desired deviation level. The main channel is now modulated with a 400 cycle tone so that the total deviation of the main carrier caused by the modulating tone and the unmodulated subcarrier equals ±75 kilocycles, or 100% modulation. Under these conditions the amplitude of the main channel 400 cycle signal appearing in the output of the subcarrier detector is measured in decibels below the subcarrier modulation reference established earlier. There is nothing really unsound with this procedure as long all parties concerned with the operation of the subchannel understand what is being done. There are some drawbacks, however, that are not readily apparent to a non-technical person actively engaged in multiplex operation. Let me illustrate this with a simple example. If the 400 cycle tone modulating the main channel is shifted to approximately 3,000 cycles, and its amplitude reduced to correct for the pre-emphasis network in the exciter, the cross talk will, in all likelihood, increase about 8 db to 12 db. This increase may be due to tuning characteristics of the frequency multiplier stages in the exciter or perhaps to phase nonlinearities in the IF amplifier of the multiplex receiver. Herein lies the crux of the problem: what modulation frequency should be used on the main channel to make the cross-talk measurement? The manufacturer might prefer to make his measurements at 100 cycles and obtain a very respectable cross-talk figure on a given monitor or receiver. The non-technical subscriber to the subchannel might be convinced that this is very acceptable...at least until a loud brass selection is played on the main channel causing objectionable cross talk. At this point he quickly forgets about the attractive 100 cycle measurements and demands that the cross talk be reduced. On the other hand, the lessee of the subchannel might specify a frequency higher in the spectrum which produces very obvious cross talk into the subcarrier in hopes that this procedure will assure satisfactory performance. If it were merely a matter of establishing a standard frequency, certainly a compromise could be reached by the industry. However, if we carefully consider the use of a single test tone, we will appreciate some of the factors that make its use undesirable. First, some FM transmitters and receivers exhibit a characteristic whereby the cross-talk component can be minimized at one frequency but be excessive at others. Secondly, and perhaps more important, a steady tone is not truly representative of program material. Concentrating all of the main channel energy at one discrete audio frequency is not equivalent to the complex waveforms of music and speech that are distributed over the entire audio spectrum. It, therefore, would seem wise to duplicate the energy distribution of the average program and to use this as the main channel modulation test signal in making cross-talk measurements in the SCA channel. We could use one of the top forty records as an average program, but who can guarantee that this selection would last more than a few weeks, and what portion of the record should be used? It seems to me that we as engineers should develop a more sophisticated program test source. This source should have the following characteristics:

a) It should be easily reproducible in the laboratory or in the field and should require a minimum of test equipment.

b) Its use should be easily understood.

c) It should be continuous and representative of the average energy distribution of program material.

d) It should be such as to enable the complete multiplex system to be adjusted to its optimum cross-talk capability.

To meet these requirements, it is proposed that a shaped wideband noise source be used as the standard main channel signal for making cross-talk measurements into the SCA multiplex subchannel. This noise source would be used for monophonic or stereophonic main channel programming.

A broad-band noise source would be a good starting point. Should the noise energy be equally distributed out to 15 kilocycles? This is neither realistic nor representative of the average program.

Rather than introduce a new parameter into our thinking, it seems logical to employ the well-known 75 microsecond de-emphasis characteristic so familiar to all FM broadcast engineers as one correcting factor for the noise source. The fact that this time constant was chosen originally as a broadcast standard indicates some basis for its use to shape the noise source. The low end of the noise spectrum also deserves some attention in determining the over-all response of the noise source. Fortunately, the low frequency main channel components are not the major contributors to SCA cross talk. However, too much energy in the low register will tend to slightly reduce the amount of noise available to modulate the carrier in the mid-audio range. While very little has been published on the distribution of energy for the average musical selection, tests have been made which show that the effective cross talk is not materially changed by rolling off the low frequency response much above 50 cps. Specifically, a noise diode with a constant energy output from 1 to 20,000 cycles was used to generate a broad-band noise source to make laboratory tests. When passing the noise output of this diode through an amplifier with a base and treble control, it was found that the cross talk did not materially change when the roll-off was varied between 30 cycles and 200 cycles. However, when the high frequency response was adjusted to equal the 75 microsecond de-emphasis curve, the resultant cross talk was quite similar to that of a typical program.

In lieu of a special noise diode, a standard FM receiver that is properly aligned can be used to generate the noise source with almost the same degree of uniformity as the noise diode. Also, the receiver conveniently contains the 75 microsecond de-emphasis network. The natural roll-off of the low frequency end of the receiver will tend to reduce the effects of excessive low frequency energy. A standard de-emphasis network is usually a simple RC low-pass filter and exhibits the normal 6 db per octave slope. However, there is nothing to restrict its passing noise energy above 15 kilocycles. As the energy content of program material declines rapidly above 15 kilocycles, it is desirable to also use a 15 kc/s low-pass filter in the output of the noise source to eliminate those frequencies not sufficiently attenuated by the de-emphasis network. The use of this filter is mandatory when applying the test tone to either the LEFT or RIGHT inputs of the stereophonic generator. Without it, noise in the upper sidebands of the L-R stereophonic subcarrier falls directly into the SCA channel and creates excessive cross talk. A four-section M-derived filter has been found satisfactory for this purpose. Such a filter, for example, can be constructed to attenuate the noise near the 19 kilocycle pilot frequency by 50 db or more, and all energies in the 23 kilocycle to 75 kilocycle band by more than 45 db with reference to the passband of the filter. The response of the filter below the 15 kilocycle cutoff frequency should be flat to within 0.5 db. Figure 1 shows the over-all spectrum of the proposed noise source. The gentle slope beginning at 2 kilocycles is introduced by the de-emphasis network of the receiver, and the very sharp drop off at 15 kilocycles is the result of M-derived low-pass filter.

To perform the measurements, the RF input of the FM receiver should first be properly terminated into a noninductive resistance to minimize outside noises. The receiver should be tuned to an unused portion of the spectrum, and its noise output, after having been passed through the 75 microsecond de-emphasis network and the 15 kilocycle low-pass filter, should be applied to either the monophonic input of the FM exciter or to one channel only of the stereophonic generator. For stereophonic operation, this procedure will result in an equal distribution of the noise energy in the L+R and L-R channels. The amplitude of the noise should be adjusted so that the peak deviation of the modulation monitor will indicate 100% with the unmodulated subcarrier present. As some monitors do not possess a satisfactory high frequency response, it may be desirable to use an oscilloscope to detect the 100% modulation level. With such a noise test signal applied to the main channel, the cross talk can be measured below the reference established for the particular multiplex service. With 100% noise and subcarrier modulation, it is interesting to observe that the peak flasher behaves much the same as with normal program modulation. Figure 2 shows the results of typical cross-talk measurements in a 67 kilocycle subchannel using various forms of modulation on the main channel. The subcarrier injection level on the main FM carrier is 10%, and measurements for both monophonic and stereophonic operations are shown. In the case of monophonic operation the 100% subcarrier deviation reference is ±7.5 kilocycles, and in the case of stereophonic operation a ±4.3 kilocycle deviation of the 67 kilocycle subcarrier was used. Note that the cross talk due to the shaped noise source is quite similar to the cross talk obtained with a program source which has been applied through a 15 kilocycle low-pass filter. The cross-talk results obtained without the use of the low-pass filter in the program line are also shown. These results, in themselves, are quite interesting. Further, Figure 2 lists the cross talk obtained with discrete tone modulation on the main carrier. It is interesting to note the spread in the results of the cross-talk measurements for monophonic and stereophonic operations with tone modulation.

It is the purpose of this paper to present a shaped noise source as a useful and practical method for the measurement of cross-talk products appearing in the SCA channel. Its use would permit an equipment manufacturer to specify the cross-talk performance of his equipment, and this could be equated in meaningful terms by the broadcaster in the field. The adoption of a shaped noise source as a standard test signal would reduce the tendency to engage in the art of "cross-talkmanship," but most of all, it would permit the subchannel operator to optimize the adjustments on the transmitter and receivers in his multiplex installation for minimum SCA cross talk.

Figure 1.

TEST SOURCE NOISE DISTRIBUTION

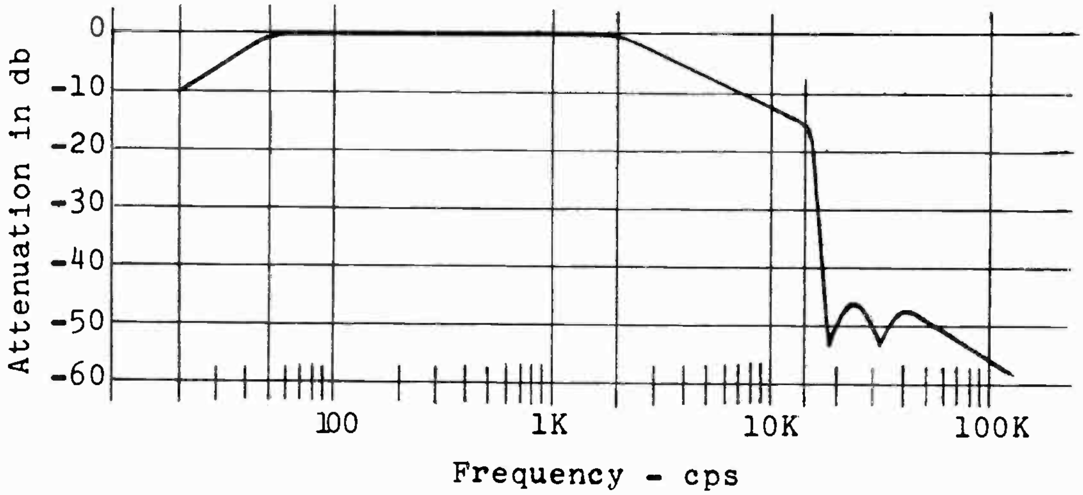

Figure 2.

SCA CROSS-TALK MEASUREMENTS

LPE-10 EXCITER & TBM-4000 MONITOR
(67 kc/s Subcarrier - 10% injection)

	Mono	Stereo
SNR of Unmodulated Subcarrier	65 db	57 db*
Shaped Noise Cross Talk	58 db	50 db
Program (with 15 kc/s low-pass filter)	60 db	52 db
Program (without low-pass filter)	55 db	42 db
100 cps	61 db	50 db
400 cps	60 db	49 db
1 kc/s	58 db	46 db
2 kc/s	54 db	44 db
4 kc/s	52 db	42 db
6 kc/s	52 db	41 db
10 kc/s	58 db	43 db

*38 kc/s suppressed 50 db

ENGINEERING
DEPARTMENT
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CBS TELEVISION NETWORK

A Gyro-Stabilized Lens System

K. BLAIR BENSON
JOHN R. WHITTAKER

(Presented at the 19th NAB Broadcasting Engineering Conference and the 17th SMPTE Technical Conference)

E4121-A

A GYRO-STABILIZED LENS SYSTEM

A major problem in television and motion-picture photography is the picture jump and wobble caused by unsteadiness of the camera mount or from vibration of the camera. In order to reduce these annoying and objectionable degradations to an acceptable level, producers frequently must resort to the use of sturdy, but cumbersome and expensive camera mounts for fixed shots, or tracks for dollying. Where location, time or budget considerations do not permit such extreme precautions, restrictions must be placed on the maximum focal length lens and type of scene coverage that can be employed.

The CBS Television Network has introduced a new, relatively inexpensive gyro-stabilized means to eliminate the effect of unwanted spurious angular movements of television and film cameras which otherwise would result in seriously degraded or even unusable picture quality. The system, called Dynalens was developed by Dynasciences Corp. of Fort Washington, Pennsylvania. The design approach is unique in that rather than attempting to stabilize or isolate the camera from movement of the mounting or supporting vehicle, the required correction is introduced in the optical path by refraction of the light. The degree, and rate of tilt or rotation, of the camera is detected and an appropriate corrective refraction of the light rays is produced by a variable optical element.

The principle of operation is shown graphically in Figure 1. An optical element consisting of a clear fluid contained between two normally parallel glass plates is located in front of the camera lens.

Since the plates are mounted on a flexible bellows, the angle of one plate relative to the other can be changed and a bending of the light rays produced by the resultant prism action. Two pairs of torque motors provide the driving force to move the plates. One pair causes a rotation of the front plate about a horizontal axis and the other a rotation of the rear plate about a vertical axis. In the upper half of Figure 1 the plates are shown parallel and, consequently, no refraction takes place. In the lower half of the illustration the camera is shown tilted up in a manner which would result in a lowering of the scene in the camera aperture. Here the front plate of the optical assembly is tilted to produce a refraction of the light rays. Thus, because of the prism action, the rays of light from the scene enter the camera lens at the same angle relative to the camera optical axis as when the camera was in a horizontal position.

Control of the degree of refraction introduced by the variable prism obviously must be performed with a high degree of precision and stability. This is accomplished by two gyroscope rate-sensing systems and accompanying servo control circuits which, in turn, drive the torque motors coupled to the movable glass plates. Two duplicate systems are provided, one for correction of vertical movement or tilt, the other for horizontal movement. A simplified block diagram of one of the two correction systems is shown in Figure 2. A gyro, positioned in the stabilizer assembly so as to oppose movement in one of the planes of control, is driven by an 800 cps a-c power supply. A pickup coil in the gyro provides an 800 cps output. Movement of the camera and the lens assembly against the stabilizing force of the gyro causes an error signal to be produced as a modulation of the 800 cps gyro output signal. This signal is detected and amplified to produce the power required to drive the torque motors. A rate-transducer on one of each pair of torque motors produces a signal which is fed back to the output of the demodulator at a level appropriate for damping of the torque motor action. By proper adjustment of the phase and amplitude of the control signals, angular movement up to 6^{o} is reduced to an object movement in the reproduced picture of under 2% of frame height. Correction is effective for a period of movement up to 20 cps.

The rate-gyro and servo control systems, along with the variable optical element, are contained in a completely enclosed housing which is attached by simple fasteners to the front of the lens and camera assembly. Figure 3 shows the stabilizer mounted with a 10:1 variable focal length lens on a 3-inch image orthicon camera. A single cable connects the assembly to small d-c power supply and control box. The control box is mounted on the camera pan handle, readily accessible to the cameraman so that the horizontal and vertical correction can be turned on or off, as required, during operation. Usually, where panning of the camera is to be employed, it is advisable to turn off the horizontal correction so as to avoid a lag and overshoot introduced as the servo attempts to correct for the intentionally introduced panning action.

Effectiveness of the stabilization can be reduced materially by motion of the lens elements relative to the camera. Any movement among the optical elements will result in a distortion of the optical path which cannot be sensed by the rate-gyros and, thus, cannot be corrected.

Consequently, it is imperative that all of the components are an integral part of a single, rigid mount. The necessary stability can be achieved by assembling the Dynalens, camera objective lens, and the camera rigidly on a heavy bedplate as shown in Figure 3. The various components dismantled are shown in Figure 4.

Pictures taken from the monitor of a television camera channel shown in Figures 5 and 6 indicate the correction of camera movement that can be obtained*. For both photographs the television camera was being panned at a rate of 25^{o} per second which resulted in a movement of 0.5-degree during the 1/50 second exposure of the still film camera. This is equal to a horizontal movement of about 2-inches on a foot wide test pattern. In Figure 5, wherein no stabilization was employed, pattern is badly burred. In Figure 6, with stabilization in use, full resolution is achieved.

The performance of the system has exceeded our initial expectations. The first equipment was used during the Inauguration of President Johnson on January 20, 1965 for coverage of the parade from a moving vehicle and of the Inaugural Address from a "fixed" platform. The CBS camera used for a closeup of the President during the Inaugural Address was equipped with an 80-inch lens. Further magnification was obtained by a 2:1 electrical expansion between the image orthicon photocathode and target. The combination of the electrical magnification and the 80-inch lens provided an overall equivalent of

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* In the oral presentation of the paper more graphic illustrations of how the Dynalens can reduce or eliminate the effect of uncontrolled camera movement upon the picture under conditions of fixed mounting and mobile use were shown in a television motion-picture film recording.

a 160-inch lens. No special precautions were taken to stabilize the camera platform. Nevertheless, with the Dynalens in operation, spurious movements of the picture image because of platform vibrations were reduced from 10 percent or more of the picture height to an imperceptible value.

Thanks are due Dr. Leonard Goland of Dynasciences and his staff for their cooperation and design achievement on this project, to Mr. Paul Wittlig of CBS Television Network Operations Department who produced the demonstration film shown at the oral presentation, and to Mr. O'Brien, Director of Engineering, CBS Television Network for his encouragement throughout the project.

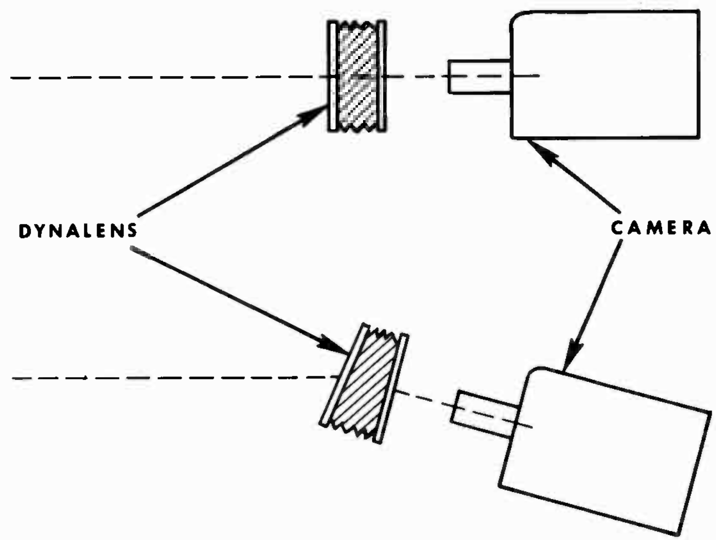

FIGURE 1.
Principal of Operation

Upper - has no correction.
Lower - Dynalens front plate is tilted to provide corrective refraction of light rays for tilt of camera.

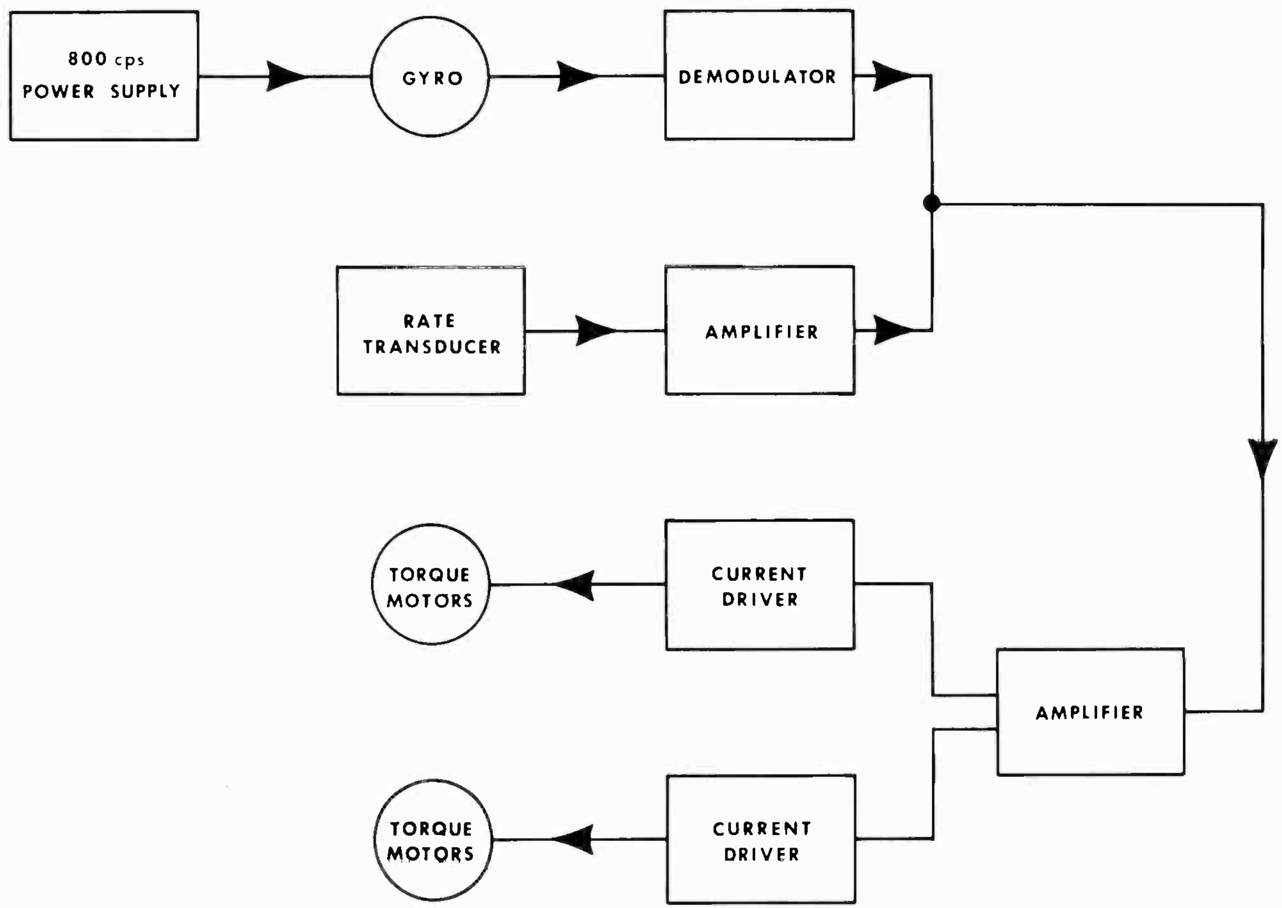

FIGURE 2. Servo Control System Block Diagram

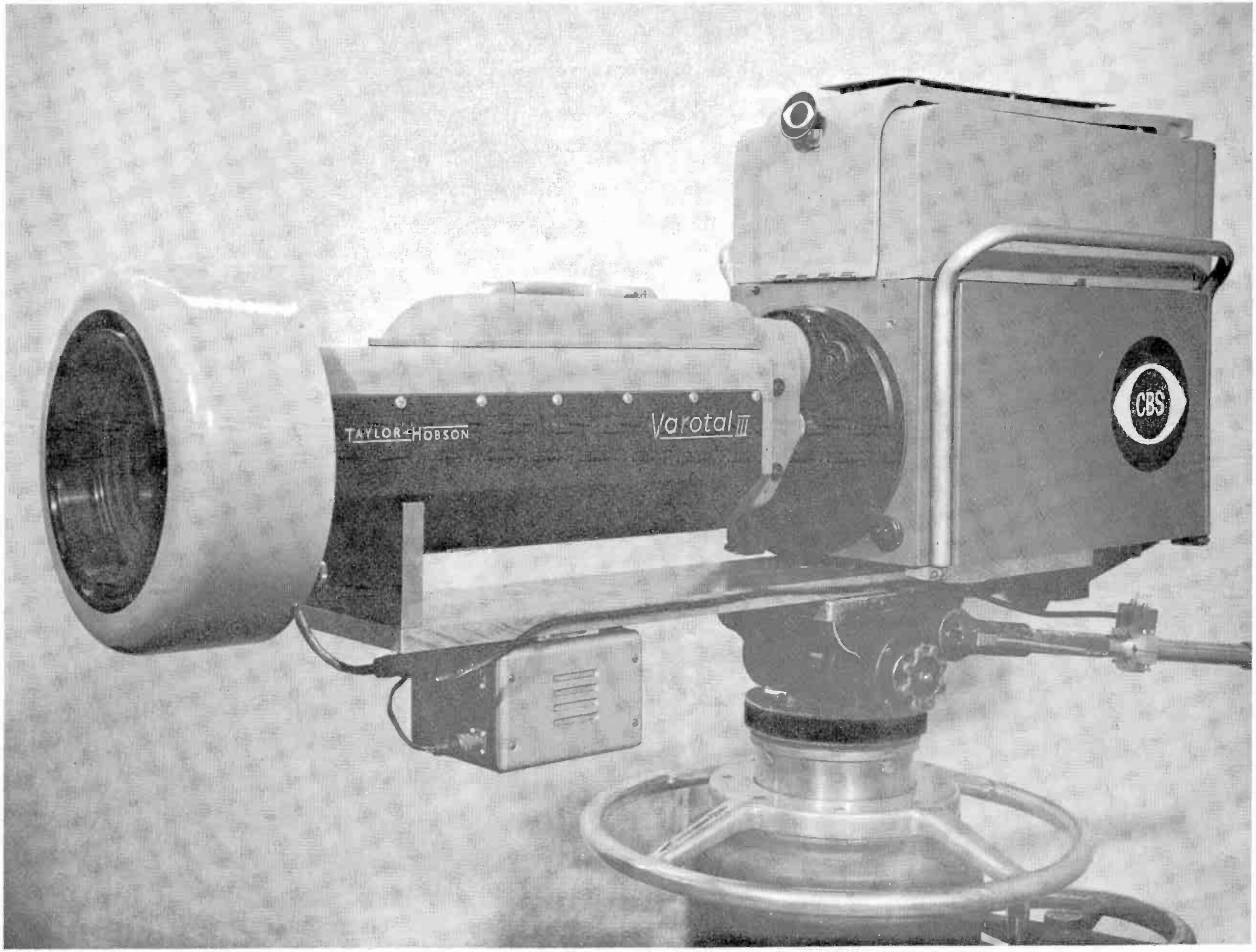

FIGURE 3. Dynalens assembled with a variable focal length lens on a 3-inch image orthicon camera.

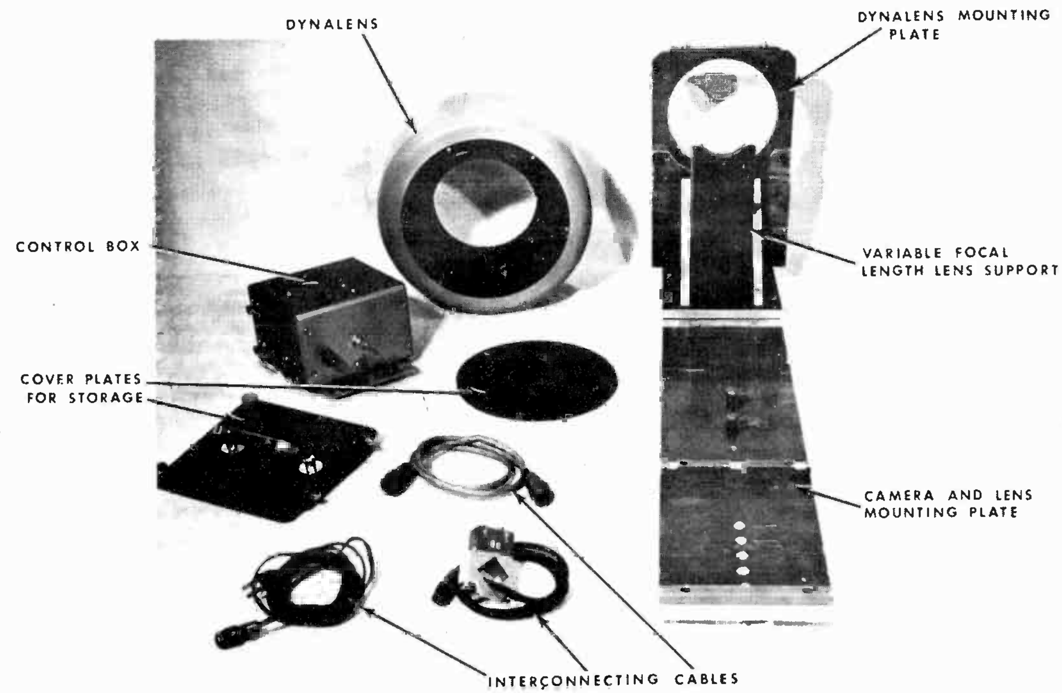

FIGURE 4. Dynalens, power supply, cables, and mounting accessories

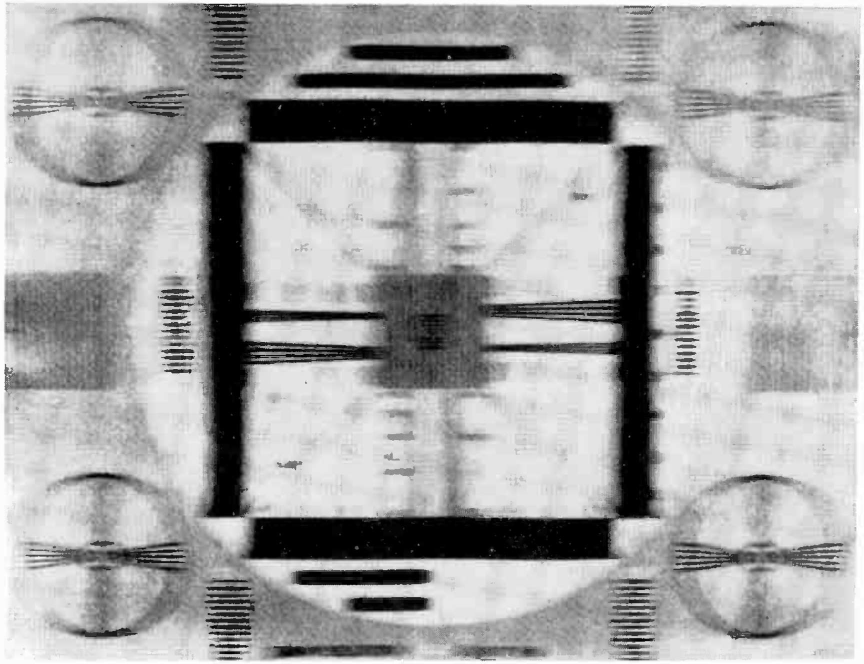

FIGURE 5. Test pattern photographed from monitor with camera panning at 25^{o}/sec and no correction

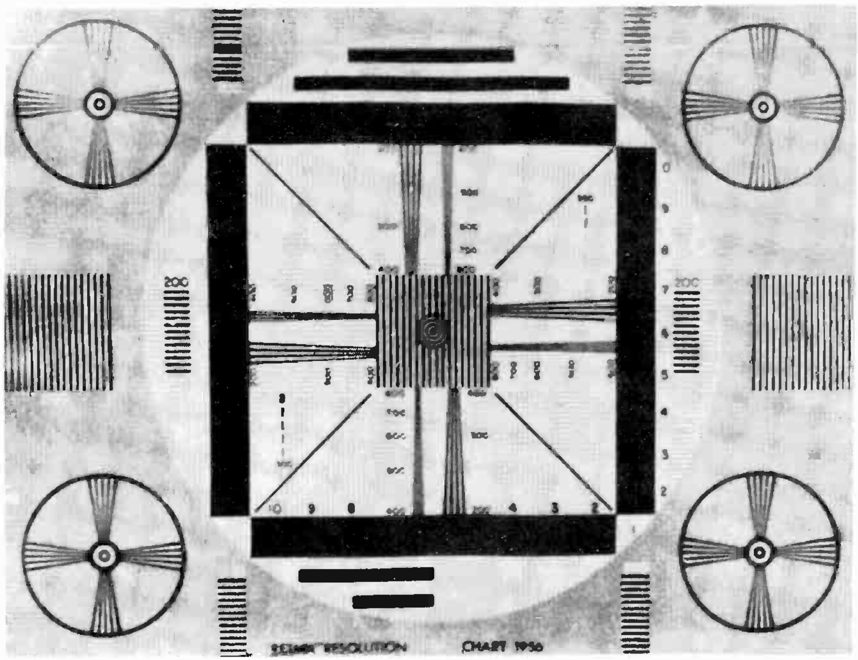

FIGURE 6. Same as Fig. 5 with Dynalens correction

EMPIRE STATE ZIG-ZAG ANTENNA: INSTALLATION AND PERFORMANCE

VISUAL COMMUNICATIONS
PRODUCTS BUSINESS SECTION
ONSUMER ELECTRONICS DIVISION
NERAL ELECTRIC
CTRONICS PARK, SYRACUSE, N. Y.

EMPIRE STATE ZIG-ZAG ANTENNA: INSTALLATION AND PERFORMANCE

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ABSTRACT

EMPIRE STATE ZIG-ZAG ANTENNA: INSTALLATION AND PERFORMANCE

An antenna design suited for the space allocated to WPIX on the Empire State Building must meet extremely stringent design requirements.

How these requirements are met with a custom designed Zig-Zag Antenna panel array is discussed and a description of the antenna design is given.

Pattern contouring for high-level close-in signal and electrical beam tilt is achieved with an array having only 4.6 wavelengths or 22 feet of vertical aperture at Channel 11.

EMPIRE STATE ZIG-ZAG ANTENNA: INSTALLATION AND PERFORMANCE

1. Empire State TV Antennas

The top 300 feet of the Empire State Building supports perhaps the most concentrated grouping of TV transmitting antennas in the world. Eight TV stations, one UHF and seven VHF, radiate signals from this space. Any major change in its antenna facilities presents a formidable challenge to the station planning the change. This is particularly true if the assigned space for the antenna is near the top of the structure. Installation procedures must be carefully planned to most efficiently use the short time available during which "neighbor" stations are off the air.

The engineering management of WPIX, Channel 11, faced this challenge in the Spring of 1964, when it decided to replace its old antenna facility with a new design.

2. WPIX Facilities

After 13 years of operation from the Empire State Building, WPIX engineers and their consultant, A.D. Ring & Associates, had clearly analyzed what was needed in a new antenna system to improve coverage of the difficult Manhattan area and to provide a major improvement in reliability.

Located 1,400 feet above street level, the WPIX transmitting antenna position is the second from the top of the vertical stack of antennas above the observation platforms. A vertical space of 22-1/2 feet on the tower, which is 2-1/2 feet square at this level, is allocated for Channel 11. This corresponds to 4.6 wavelengths of vertical aperture on a half wavelength square tower section.

3. General Requirements

Of paramount importance for a new antenna installation were a number of design objectives considered mandatory for the installation.

Physical

(a) Impose no greater wind loading on the tower by the new antenna than that of the existing antenna.

(b) Provide a means of access to the inside of the structure for installation and maintenance of the feed system and access to the Channel 4 antenna feed lines.

(c) Design the antenna to be broken down into assemblies that would be capable of assembly on the structure. The size and weight of the assemblies had to be limited in order to be transported to the top of the building in existing elevators.

Electrical

(a) Improve the horizontal pattern circularity to within plus or minus 1.5 db.

(b) Contour the vertical pattern to eliminate deep nulls to at least a 15-degree depression angle.

(c) Provide electrical beam tilt for more effective use of the available radiated power.

(d) Increase the input power rating of antenna to at least 100 KW.

(e) Have a power gain rating to provide effective radiated power of 100 KW with the existing 25-KW transmitter.

4. Zig-Zag Antenna Proposal

To achieve these objectives, the General Electric Company proposed a modification of its Zig-Zag Panel Antenna. The limited space available for the WPIX Antenna necessitated a reduction of the conventional panel size to 60%.

5. Conventional Zig-Zag Panel

Fundamentally, the Zig-Zag Antenna uses a radiating conductor bent at half-wave intervals to a Zig-Zag configuration. This creates an in-phase horizontal field component and cancels the vertical component on the horizontal as shown in Fig. 1.

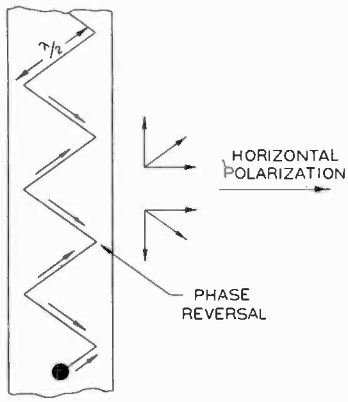

Fig. 1 Zig-Zag Current Vectors

Two such radiators are supported about one-eighth wavelength from a panel and fed at a single point at the center of the panel as shown in Fig. 2.

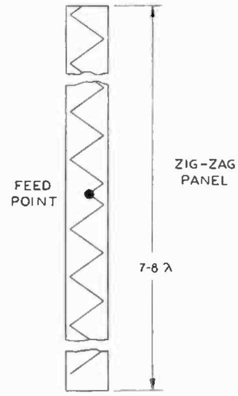

Fig. 2 Zig-Zag Panel Schematic

The conventional General Electric Zig-Zag design uses a rectangular panel about eight wavelengths long by about eight-tenths wavelength wide as shown in Fig. 3.

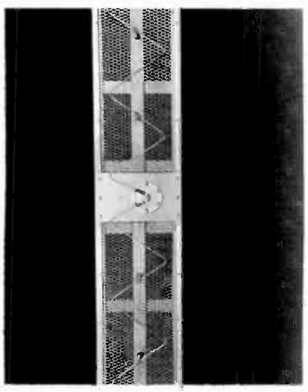

Fig. 3 Zig-Zag Panel

The maximum directive power gain of a single panel perpendicular to the plane of the panel is 50. The radiation characteristics of such a panel are shown in Fig. 4 and Fig. 5.

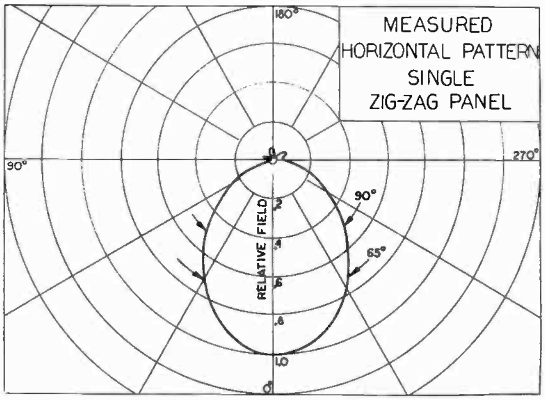

Fig. 4 Single-Panel Horizontal Field Pattern

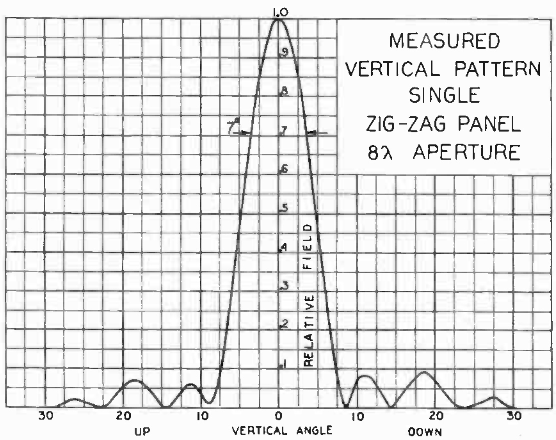

Fig. 5 Single-Panel Vertical Field Pattern

The horizontal field pattern approximates a cosine-squared function, while the vertical pattern is similar to the radiation from a broadside array of 24 dipoles spaced three-tenths wavelength apart, with tapered illumination.

6. Feasibility Study of the Short Aperture Zig-Zag

In the Fall 1963, various antenna designs were considered that could be adapted to the Empire State location. A feasibility study was conducted to demonstrate that the basic Zig-Zag design could be modified to work with a reduced vertical aperture and a narrower panel.

(a) The results of this study showed that when the length of a panel is reduced as required for the Empire State application, the result is a wider vertical beamwidth and an increase in the pattern bandwidth from about five percent to nine percent. These result from the reduction of the total number of half-wave segments from 24 to 17. A plot of the half-power beamwidth versus frequency is shown in Fig. 6.

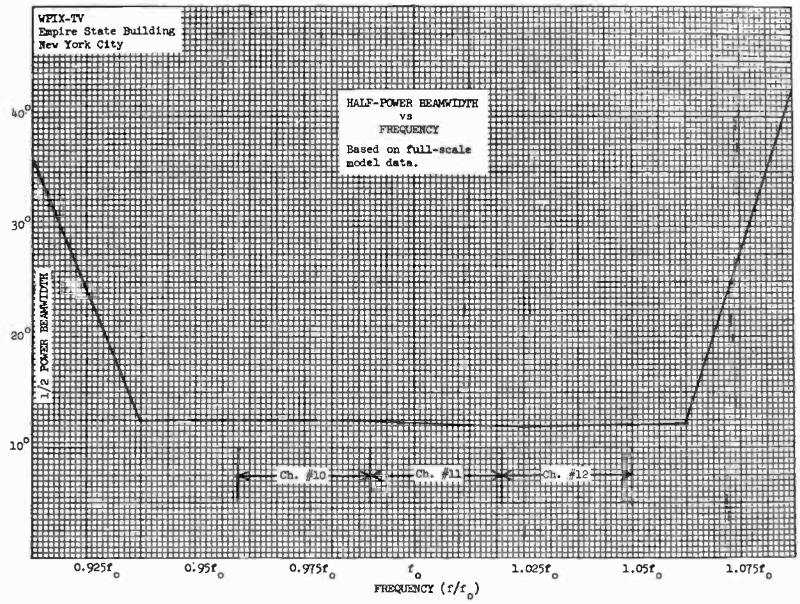

Fig. 6 Half-Power Beamwidth versus Frequency

(b) Since the rf energy at the ends of the panel is at a higher level because of the shorter aperture, a local standing wave exists on the aperture near the ends.

(c) By adjusting the phase of the reflection at one end of the panel, it was possible to keep the input impedance at the feed point near a constant value.

7. Design and Fabrication of the Full-Size Antenna

General Electric was awarded a contract to go ahead with the application of the Zig-Zag Panel design for WPIX in April, 1964.

Because of the limited hours of installation time available on the Empire State Tower (usually 2 AM to 7 AM), every effort was made in planning the design to facilitate the eventual assembly of the Antenna on the tower. Each panel, for example, was constructed in three sections, a small center section supporting the feed assembly and two end sections that were hinged so that they could be opened like a screen door. This provided access to the internal feed lines.

To expedite welding on the tower, a full-size welding jig was made to locate the required tower attachments for the panels.

Some design problems were worked out on the accurate scale model shown in Fig. 7.

Fig. 7 Scale Model of Zig-Zag Antenna

This model was constructed to be 30% of the full-size antenna and thus covered a frequency range of 660 to 680 mc. In addition, an exact replica of the Empire State Antenna tower section was built to test the full-scale assembly. This made possible a full evaluation of the design, both mechanically and electrically, prior to its installation on the Empire State Tower.

8. Pattern Contouring - Beam Tilt

The requirements for a contoured vertical pattern and electrical beam tilt were met by introducing a phase distribution over the vertical aperture. A relationship was worked out by using a digital computer and by checking the results on the scale model. It was possible by using this technique, to effectively reduce the energy above the main beam and to contour the beam to a 30-degree depression angle below the horizontal.

The resultant vertical field pattern as measured on the full-scale antenna at the Cazenovia Antenna Test Site is shown in Fig. 8.

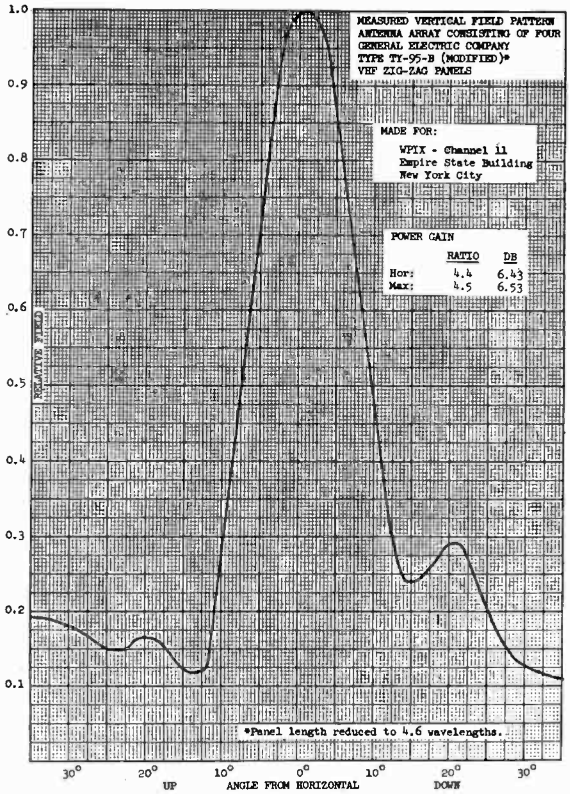

Fig. 8 Measured Vertical Pattern Plot

The associated horizontal field pattern is shown in Fig. 9.

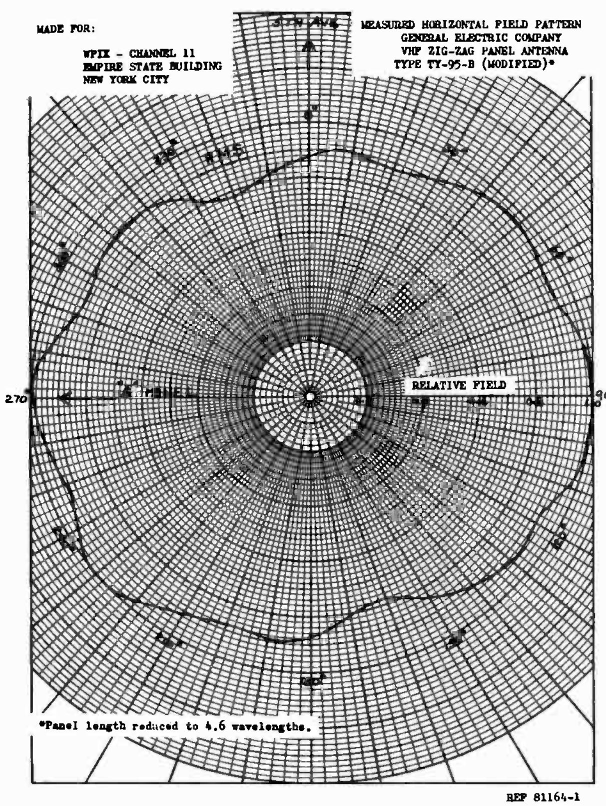

Fig. 9 Measured Horizontal Pattern Plot

This pattern was measured with the antenna mounted vertically on a rotating 15-foot test tower at the Cazenovia Site as shown in Fig. 10.

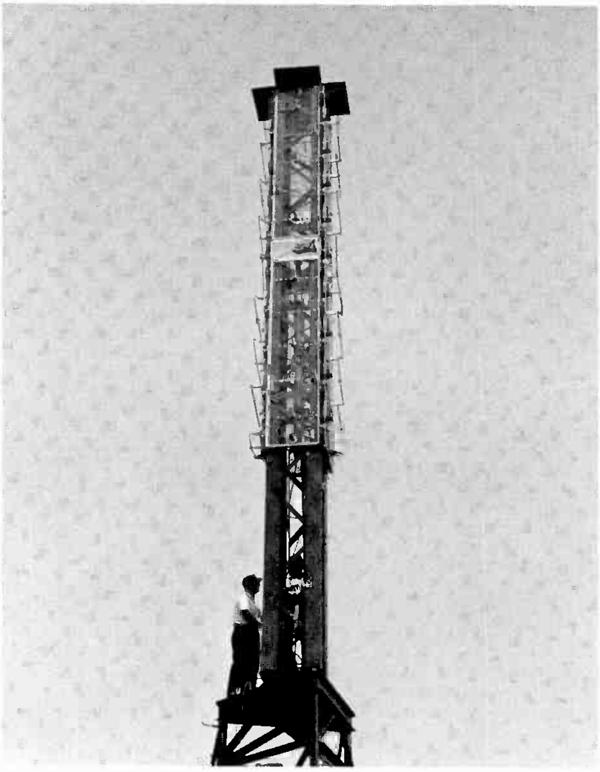

Fig. 10 Antenna Test Site Facility

9. Feed System

The feed point impedance of each panel was made 50-ohms by the design of the feed configuration at the center of the panel. A special connection was designed to transform the shunt impedance of the upper and lower Zig-Zag radiators to a 50-ohm value at the 3-1/8 inch feed bushing. In this way, each panel could be fed directly with a 3-1/8 inch, 50-ohm, rigid line without additional matching sections.

The input connection to the antenna array consisted of a 6-1/8 inch, 50-ohm, four-way power divider, with three and one-eighth inch outputs for the individual panels. An adjustable fine matcher was used near the input connection to make vernier adjustment on the input impedance after reassembly on the tower.

To facilitate adjustment of this matcher, a motor drive system for each of the four matcher adjustments was supplied by WPIX Engineering, so that final adjustment of the Antenna could be made from the transmitter room by remote control.

10. Installation

The installation of the panels on the Empire State Tower was started in late July, 1964. Sub-contractors having extensive installation experience on the Empire State Tower were selected for the installation. The electrical work was handled by the B. Eichwald Company, while the rigging work was assigned to the Gunner Olsen Corporation. During the installation period, WPIX operated on its emergency antenna facility. About six weeks were required to complete the installation, much less than the predicted time, based upon knowledge of previous installations on the tower. A helicopter view of men working on the tower shows the location where the extensive welding and assembly work was required. The upper panels were in place when the photograph was made. See Fig. 11.

Fig. 11 Work in Progress on WPIX Antenna

Finally, on September 9th, a slotted line was connected to the transmission line feeding the antenna at the JJ level of the tower just above the upper observation platform level for VSWR measurements. By 4 AM, the RF interference level was low enough so that the measurements could be made. The results of these measurements and those taken later when the remaining 6-1/8 inch line installation was completed, are shown in Fig. 12.

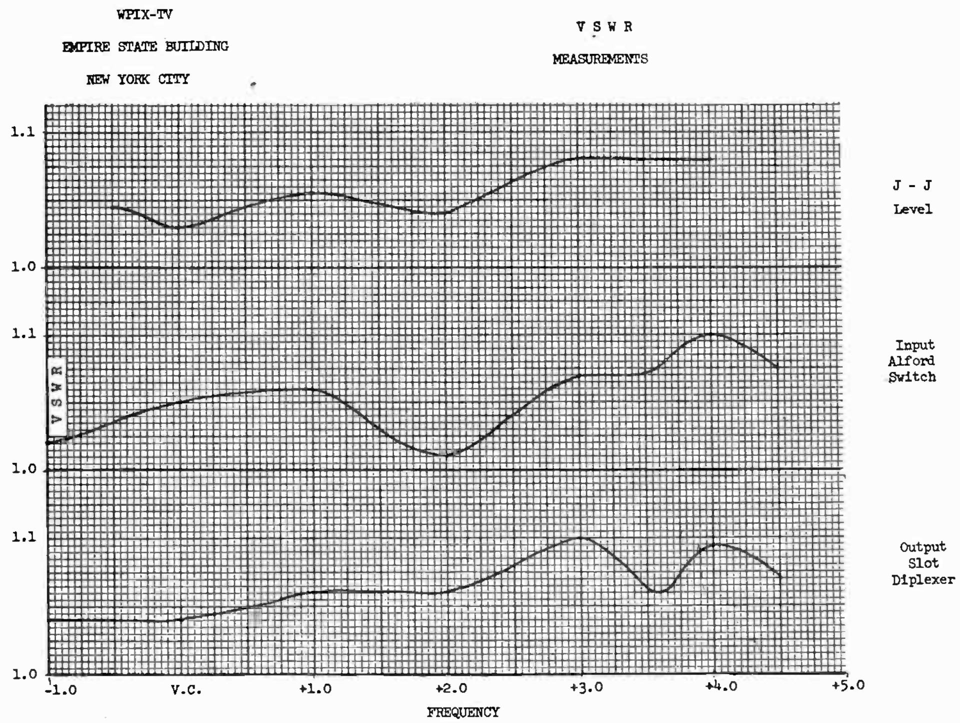

Fig. 12 Plot of VSWR Measurements

11. Performance

The new WPIX Zig-Zag Panel Antenna has been in service since September. On the basis of all of the measurements made by WPIX and its engineering consultants, including viewer surveys and helicopter measurements, all the design objectives have been fully achieved.

According to WPIX management, both the difficult Manhattan as well as outlying areas report improved signals, in some instances as much as a 6-db increase.

In an installation of this kind, close cooperation and coordination among the antenna manufacturer, the installation contractor, the Empire State Building Corporation and the WPIX Engineering Department was required. The willingness of each of these parties to appreciate the problems of the others contributed to the success of the installation.

Progress Is Our Most Important Product

GENERAL ELECTRIC

FCC TECHNICAL PANEL PRESENTATION

QUESTIONS AND ANSWERS

Moderator: James D. Parker
Director, Transmission Engineering
CBS Television Network

FCC Panelists:

Hart S. Cowperthwait, Chief, Rules & Standards Division

Ralph H. Garrett, Chief, New and Changed Facilities Branch

Otis T. Hanson, Chief, Aural Existing Facilities Branch

Wallace E. Johnson, Assistant Chief, Broadcast Bureau

Harold G. Kelley, Supervising Engineer, TV Applications Branch

Frank M. Kratokvil, Chief, Field Engineering Bureau

Neal K. McNaughten, Chief, Emergency Systems Division, Office of Emergency Communications

19th NAB BROADCAST ENGINEERING CONFERENCE
Washington, D. C.
Wednesday, March 24, 1965

FCC TECHNICAL PANEL

NAB Broadcast Engineering Conference
Washington, D.C.
Wednesday, March 24, 1965

MR. PARKER: The final and closing feature of this Engineering Conference will be the FCC Technical Panel. This is a program that was initiated last year and proved to be highly successful; being both constructive and informative.

At this time I would like to ask the FCC Panel members if they would come forward and arrange themselves at the table.

This Panel serves several purposes. Among them it gives you the opportunity to see and meet those individuals in the Commission's Engineering and Technical area. They are probably names to many of you, but they are all here. I would like to ask them, as a matter of introduction, to each one state their name, their position at the FCC, and to describe a little about what they do in their office.

MR. KELLEY: I am Harold Kelley and I'm located in the Commission's Television Application Branch, where we process applications for construction permits, modification of construction permits, and applications for licenses. We also handle special temporary authorities and issue program tests.

MR. COWPERTHWAIT: I am Hart Cowperthwait. Chief of the Rules & Standards Division.

As the name implies, we are charged with the responsibility of processing proposals to change the rules, standards and regulations. We receive these proposals from a variety of sources. Some are generated in our own staff. Some come from the Commission, and, of course, the bulk come from the industry.

Being bureaucrats, we like to receive these proposals in the form of original and fourteen copies. Sometimes this makes people mad, especially engineers. So, if you have a proposal that will revolutionize this system of broadcasting, please hand it to us over a cup of coffee and we'll be very grateful. Or even if you just have a simple suggestion for clarifying the wording in the rules, which are said by some to be a bit on the abstruse side, we will be happy to have them informally.

When we receive these proposals, we sit down with our engineers and prepare an analysis, accompany it, if it has merit, with a notice of proposed rulemaking, and take it to the Commission. If they agree to adopt it, public notice is issued, and a period of time is given for comments, usually thirty days or more. When the comments come in, we again examine the proposal and prepare a final report and order, which we take to the Commission and which they may adopt or deny.

MR. HANSON: My name is Otis Hanson. I am Chief of the Aural Existing Facilities Branch, Aural meaning AM and FM, to differentiate from my friend Harold Kelley.

We do practically the same work in my office. Primary responsibility, for the people on the outside, is program tests. Everybody wants to get on the air, of course, if they have a new station, or if they have made changes in their facilities, they want to get on the air.

We have the famous ten-day rule, where we are supposed to act on the applications within ten days, and believe me, we are pressed to stay within that particular ten days.

We also handle SCA operations, remote control operations and pre-sunrise complaints. We have referrals from the Field Engineering Bureau, from the Complaints and Compliance and from the Renewal Branch. The engineering portions of that are thrashed out in my shop. When we're not doing that, we're answering letters.

MR. KRATOKVIL: My name is Frank Kratokvil, and I am Chief of the Field Engineering Bureau. This is the Bureau that you probably have the greatest contact with. I operate twenty-four district offices in the major cities of the United States and Honolulu, Anchorage, Puerto Rico, San Juan, and I also operate through three divisions in Washington here, the Field Offices Divisions, the Monitoring Systems Division and the Engineering Division. I operate these district offices I have mentioned, and the eighteen monitoring stations, which are located in Alaska, Hawaii, Puerto Rico and the contiguous 48.

You have had an opportunity to see one of our cars, one of the three TV mobile units that we have parked right outside, to your left, and we invite you to inspect this unit, if you haven't already done so.

This is supplemented by what we call upper spectrum mobile monitoring units, but the old name was test cars. There are several of those. And there is a fleet of about 44 investigative cars.

In addition to policing the airwaves and checking by means of inspection, we also render a public service. Like every policing organization, we try to be helpful as well as serve a violation notice on you.

The public service is rendered in the form of helping you solve some of your problems, and believe it or not, we do, and also helping the public and industry.

There is another activity that we don't speak so much of because it is generally in the classified area. We do quite a bit of work for, shall we say, certain people and certain agencies.

In addition, you, no doubt, were following the Gemini flight. The monitoring system was standing by to render direction-finding assistance in case Mr. Grissom went down in the Indian Ocean or parts where he didn't figure he ought to go down. And by means of high frequency direction finding we might have assisted in locating him.

So you see we have quite a large span. Of course, our attention is devoted not only to the broadcast services, but to the other public services, such as citizens' radio, amateur radio and ship radio service in all of the Commission's activities.

MR. JOHNSON: My name is Wallie Johnson, Assistant Chief of the Broadcast Bureau. I haven't been at the Convention the last few days, mainly because I've been flat on my back, and I've had all sorts of wonderful people call me, asking what happened to me, wondering whether I had completely chickened out or not.

I thought this would be a good chance, and probably the last chance on this panel, to explain to you what happened.

Just as a little background, to give you an idea of what tickles we frustrated bureaucrats. The last couple of weeks there has been a wonderful story circulating around Washington, about the man that suffered pain only twice in his life. And I was doing my best to try to circulate this particular story. And if you haven't heard it, I think you should.

There is some connection between that story and what happened to me, because a few days ago I came down with a bronchial infection. I was laying in bed with a fever - got a fit of coughing, and threw my back out to the point that I had to have an orthopedic man come and straighten me out in bed.

So in my own little way, I suffered pain two ways during the week. And I think there is a direct correlation between my spreading that other story and what happened to me the last few days.

MR. McNAUGHTEN: My name is Neal McNaughten. I am Chief of the Emergency Communications Systems Division. This Division operates under the policy guidance of the Defense Commissioner, Commissioner Bartley, and under the administrative direction of the Executive Director.

The job that we perform relates principally to the emergency broadcast system. We have a field force of eight men, one each at the OCD regional offices. They are there for the purpose of assisting broadcast licensees, as well as all other licensees, in the development of their emergency communications plans.

Right now in the broadcast service we have plans in from 49 states, and the 50th state is working on it. We have issued approximately 2,300 national defense emergency authorizations, which, I believe, far exceeds that number that was issued under the old CONELRAD program, and I believe it attests to the popularity of it.

MR. GARRETT: I am Ralph Garrett, and I am in charge of the New Aural and New Changed Facilities Branch in the Broadcast Bureau. We process the applications for new broadcast stations and for major changes in existing stations. Having processed these applications, we write a report and make recommendations to the Commission. If it's in order, we feel that the proposal must go to hearing, we prepare an order, handling all the protests that have been filed with it, the petitions for and against it at that time, if possible.

I'm not too sure how much interest there will be in the processing area for new broadcast stations here, but I will be happy to try to answer any questions I can.

MR. PARKER: I have a few questions here which have been turned in. There are four microphones on the floor. If you have a question we would like you to go to the floor microphone and state your name, and give your question so it will be recorded. However, before getting into the question and answer period, I believe Mr. Kratokvil has a few comments he wants to make on some of his recent activities.

MR. KRATOKVIL: We opened the Chicago meeting last year by having me tell you what the roll of compliance was, and I thought you might find the most recent one interesting.

In AM, the biggest violation that we have encountered has been in maintenance logs. That accounted for 12.5 per cent.

The next biggest violation has been log requirements in general - 9 per cent.

So, you see, 12 and 9, that makes about 21-22 per cent just on logs alone.

9.5 per cent equipment performance measurements, failure to make them, or to keep measurements on file.

8.1 per cent equipment indicating instruments, remote ammeters, calibration and so forth.

7.3 per cent the transmitter, fencing around the tuning house, or the antenna base, either not there, or in such a state as to practically not be there.

Six per cent was devoted to radio operator requirements, failure to have the operator with a third class license, plus broadcast endorsement.

5.9 per cent operating power, maintenance of operating power.

5.7 per cent program logs, failure to indicate sponsor.

5.3 per cent operating logs, failure to make or to record the half-hourly entries.

3.8 per cent modulation monitor defective, and 3.7 per cent modulation, meaning over, or I suppose, grossly under.

In the FM, the picture was like this...

18.7 per cent logs in general.

11 per cent modulation.

10.1 per cent transmitter performance, failure to make or keep equipment performance measurements on file.

9.7 per cent maintenance logs, failure either to make or to log the required five days a week inspection of transmitting equipment.

6.3 per cent - there again you got it - operator requirements, failure to have a third class operator license plus broadcast endorsement on deck.

4.1 per cent logs operating failure to make or record half-hourly intervals.

3.9 per cent operating power, maintenance of operating power not proper.

3.2 per cent sponsored programs, the announcement of them lacking.

Three per cent station and operator posting.

In other words, 70 per cent of all the rule violations were chargeable to only nine sections of rules.

In TV, 34.1 per cent of the violation notices issued were for transmission standards, reference white level, and reference black level.

15.1 per cent were logs general requirements.

10.1 per cent frequency tolerance of the aural transmitter.

9.5 per cent transmitters. The aural transmitter, Rule 73.687 was violated in some respect.

6.2 per cent of the violations were operating power, calibration of transmission line meter was either faulty or not shown.

5.6 per cent maintenance, failure to make or record tower light inspections.

3.4 per cent was program log, failure to indicate sponsor.

And 1.7 per cent was identification.

in this case, 86 per cent of all the rule violations were chargeable to only eight of the rule sections.

I have available a series of reproduced papers showing a check-off system that our inspecting engineers use when they visit your stations.

Thank you very much.

MR. PARKER: One of the first questions which I have relates to that maintenance log. What type of entry is required in the maintenance log to meet the daily inspection requirements?

MR. HANSON: The rules on the maintenance log are not too clear, I'm afraid. It says you make an entry of the time you arrive, and the time you depart and what you do while you are there. I think this is all that is necessary. If there is no maintenance required, a simple statement, no maintenance required, everything is satisfactory. Whatever maintenance you do you should log. If there is no maintenance and you are satisfied no maintenance is required that day, fine.

MR. KRATOKVIL: I think most of the violations have been that you just didn't keep the maintenance log or you didn't record the tower light observations, and something like that would be entirely within your control.

MR. PARKER: Section 73.690 of the rules now requires television stations to measure their carrier frequencies "within intervals not exceeding one month". Our station employs an outside commercial measuring service for this purpose. Our past arrangement with the measuring service has been set up on the basis of a monthly measurement, scheduled for the second Monday of each month. This results in some monthly measurements being greater or less than thirty days apart.

For example: A check of our monthly measurements for 1964 showed five measurements were 35 days apart, but seven measurements were only 28 days apart.

Is the Commission going to be sticky, and require each one of these monthly measurements to be exactly thirty days apart, or will they accept these occasional measurements that are 35 days apart?

MR. KELLEY: It is the intent of this rule that you measure your frequencies once each calendar month, anf if you have a contractural arrangement with, let's say, a measuring service, that this schedule be set up, for example, the first Monday of each month, or the third Thursday of each month, or something of that nature, and there would be - let's see, sometimes it would be five days, five weeks apart. You've actually gone over four days of the ideal 31 maximum. But in a case like this, if you actually have an arrangement with a measuring service, I think that would well satisfy the intent of the rule.

What wouldn't be, I think, acceptable, would be the case where, let's say, you made a measurement at midnight on March the 31st, then one minute after midnight, you made another measurement on April the 1st. Then you made your next measurement 60 days later at the beginning or at the end of the following month. That would obviously be a violation.

MR. PARKER: What steps are being taken to relax the regulation concerning direct view of transmitting equipment, when more practical supervision can be accomplished with a few remote meters?

MR. HANSON: We had hoped by this time to have something to report. We're still working at it within the Commission, with the notice - looking toward the notice proposal - possibly spelling something out. But as of now, the policy is that the operator is supposed to be located and in charge of the transmitter. So, therefore, we say, if he is supposed to be in charge of the transmitter, then he has to be able to see it, and be near it and be able to control it.

Now, we have gone so far as to say, you don't have to be able to actually read the meter if the meters are visible to the operator. He has to read the meters every half hour but if he can see the transmitter through a window or a series of mirrors, that is acceptable.

The whole idea is that the operator has to be near and be able to get to that transmitter. We hope to have some rules out that will relax this requirement a little bit. But as of now, this is what we're telling the people who write in on this question.

QUESTION FROM THE FLOOR: I'm Gus Rountree from Austin, Consulting Engineer, and I would like to go back to this question of maintenance logs.

We had a case where a client of mine in west Texas was inspected some months ago and the inspector said that he didn't see how anyone could make the required daily inspection of transmitting equipment and certify to its operating properly in less than about two-and-a-half hours. Would you care to comment on that, Mr. Kratokvil?

MR. KRATOKVIL: No, I don't think it's reasonable. I don't think that was contemplated. I think that this is a new rule and as is the case with all new rules, we generally have a few problems.

Incidentally, I concluded my inspection tour many years ago, and before the Chicago Convention, I made my first inspection in twenty-five years. So I went out and I was introduced to the maintenance log. If I recall correctly, it was a very simple thing, and at that time one of my subordinates, who was accompanying me, showed it to me and we took a rather tolerant view of the thing.

And as Mr. Scanlon of my staff here has indicated - the large number of violations isn't because of the contents but the fact that you just haven't recorded anything in the log. It's blank, in other words, or it's threadbare.

I would imagine that as your maintenance is conducted - you certainly have a maintenance schedule in your station, or you should have - you will record it.

The same manager that would be concerned with general operation should also be greatly concerned that there is a maintenance program in the station. And, as these entries would be made in a log, it seems to me that we'd finally get tired of reading and concede that you were maintaining this log.

So I don't see any two-and-a-half hour weekly inspection. I don't think it would have to be presented in that particular manner.

QUESTION FROM THE FLOOR: Section 73.111 requires that a person keeping the log shall sign the log when going on duty, and again when going off duty. This also relates to the maintenance log.

There is also a requirement in the maintenance log that the person making the daily inspection shall sign the log and indicate the amount of time that he has devoted to maintenance.

Isn't there a conflict between these two, or an overlap somewhere in the rule?

MR. KRATOKVIL: Well, that hadn't come to our attention before. I would say that we have been reasonably tolerant, or thought we were.

MR. PARKER: The maximum aural effective radiated power for television stations was recently reduced from 70 per cent to only 20 per cent of the visual power. I understand the new rules permit us to continue to operate with our present aural power until next March.

My questions are, first: Will the Commission automatically lower the aural power specified on our license, or do we have to file the usual applications and submit another set of proof-of-performance measurements?

MR. KELLEY: No, we would not automatically correct your license to reflect the new power. It would be necessary for you to file an application on an FCC Form 301 to make the change in aural power. That would be necessary so we would know what constant you are going to operate the transmitter at, and to be sure that the manner in which you wanted to operate would conform to the new 10 to 20 percent rule.

In most cases this will be done on a multiplication-of-license basis, rather than going through the CP, and later filing proof of performance for your aural performance. In other words, there would normally be one application involved. That would be 301 and we will try our best to treat that as a multiplication of license to simplify it for you and us, both.

MR. PARKER: The second part of this question is:

Should we wait until next March to reduce our aural power or may we do it sooner?

MR. KELLEY: The sooner, the better. And I want to emphasize that an application is necessary and I hope that you won't wait until March 1966 to file your application. I would hope that all applications would be in by the end of the year to give us an opportunity to process these well in advance of the deadline.

MR. PARKER: The rules have recently been changed, reducing the maximum permissible aural power to 20 per cent of visual. This question that we have next relates to the permissible power for the auxiliary, or emergency transmitter. If the visual power of the auxiliary transmitter is less than the authorized visual power for the main transmitter, is it necessary to reduce the aural power proportionately when you go to emergency operation?

In other words, is it necessary to maintain the same ratio of aural to visual power for emergency operation as that which is authorized for the main transmitter, when the emergency operation is a reduced power?

MR. KELLEY: My theory is, on emergency operation, where you have auxiliary transmitters, that it's sort of like any port in a storm, to operate them any way that you can to maintain your service.

Now, our position also is that whatever auxiliary transmitting equipment you might have should obviously never be operated in excess of that permitted for your main facilities.

Remembering that, we should take the position, I think, that we do not want to maintain exact ratios on an emergency operation, as we would for the regular main operation.

We won't insist upon these 10 and 20 per cent ratios of the aural with respect to the visual during emergency operation, remembering that regardless how you operate it, we wouldn't want you to operate it greater than that authorized for the main facility.

I want to point out that we don't normally specify the ERP of auxiliary transmitters for this reason. You operate them any way you see fit, in any manner you see fit to maintain your normal operation.

MR. PARKER: The next question I have here is:

The FCC recently permitted TV stations to operate without a frequency monitor. How soon will this permission be given AM stations? Are there cases of stations being off frequency to not permit this?

MR. JOHNSON: First of all, I don't think there is anything contemplated to permit AM stations to operate without frequency monitors.

I think our experience indicates we probably have problems proportionately greater in AM than we do in the other services. We have a great many stations that are operating on a marginal basis. I think that if we start again giving the impression that we are relaxing technical rules, that this gives stations another chance to increase the margin profit. And I think that we'd go awfully slow in trying to relax the frequency monitor requirement as far as AM is concerned.

MR. KRATOKVIL: Actually, the number of off-frequency violations in the standard broadcast service is very, very small. In other words, there are very few standard broadcast stations caught off frequency. Now, how many of them operate 19-1/2 and 18-1/2 cycles off frequency, I don't know. But the way we look at it, if you're under 20, we sort of feel you are within the spot.

I don't have the Chief of the monitoring systems here to straighten me out on it, but I don't believe we've had very many off-frequency citations.

So we can't support the Assistant Chief of the Broadcast Bureau with reference to how bad you're acting, but if you've got them, why not use them.

MR. JOHNSON: The other problem on that, since we've got a little controversy here, it's just a feeling I guess I have, as far as the aural service is concerned. I think the aural frequency monitor is probably a much simpler device to operate, as far as a station is concerned. It has been through the mill. It's probably more effective, as far as the frequency monitoring system is concerned, than some of the other services.

But my feeling still is, that if we took the frequency monitor out of AM broadcast stations, that Frank's work would undoubtedly increase.

MR. KRATOKVIL: I think so.

MR. KELLEY: I just want to make one comment. This question reads: "The FCC just recently permitted TV stations to operate without a frequency monitor."

That isn't exactly true. We don't require a frequency monitor for daily use per se as we have known it up to this point. But I want to remind you that the rules do require a frequency check at least once each day, not an actual measurement, but a check against some type of apparatus which will satisfy you that you are within the operating tolerance.

MR. PARKER: Since the inception of the emergency broadcast system, EBS plan, in early January, 1964, are we still required to maintain receivers capable of receiving the notification signal two carrier breaks and the tone?

MR. McNAUGHTEN: Yes, this is true. I was a little surprised that Frank didn't mention this in the percentages of violations.

There are quite a number of them that come through. But the rule is still there, that receivers must be maintained. And this is one of the functions of our field liaison officers, that I mentioned earlier, to assist you in selecting the station to which you should listen and keep that receiver tuned.

While I'm on it, the rules are also in effect, that each and every station, AM, FM and TV must still, once a week, at a time of their option, conduct this test for the reception of other stations.

These two rules, since the demise of CONELRAD, have been slightly misunderstood, and there has been a little confusion about whether or not they are still effective. They are still very much a part of the rules and still very much in effect, and Frank is still issuing citations on them.

Sometimes they are a little difficult to come by - that is, answering the citation - because a man may, in fact, be in a very difficult geographical location, and at that point you need some help. This is one thing that our field liaison officers in the OCD regions can do for you.

QUESTION FROM THE FLOOR: My name is John Sherman. I'm Chairman of the State Industry Advisory Committee for Minnesota.

The NDEA stations - in fact, all of the broadcasting stations - are now receiving promo announcements from the Department of Defense, starting to educate the public about the emergency broadcasting system, and in an emergency, to tune to an emergency broadcasting system station.

These announcements, if you read them verbatim, do not have any place to include the call letters of the station making the announcement, if it has an NDEA authorization. This is also true in the FCC rule on the test-alert announcement.

For the stations who have NDEA's, and who would be operating in the emergency broadcasting system, would there be any objection from now on for those stations making the Department of Defense promo announcement, as well as a test-alert announcement, to include, "You can tune to an emergency broadcasting system station...." and then include the call letters of the station making the announcement. In other words, the broadcasters who have put a great deal of time and effort into this project, feel that the least courtesy that could be given to them for their cooperation, if they have an NDEA, would be to be allowed to use their own call letters in these announcements.

MR. McNAUGHTEN: The announcements to which you make reference were supplied by the Office of Civil Defense, and sent to, I presume, all stations. They even included slides for television stations. But those are not necessarily the same kind of announcements which are referred to in the rules.

When a station applies for a National Defense Emergency Authorization, one of the criteria of eligibility on which he has to make a statement, is that he, over his station, will promote the emergency broadcast system. In other words, try to educate the people in his area as to what it is, what it means and what it does.

Now, in the state plans, a state is requested to divide itself into several operational areas. These operational areas may consist of one country, or may consist of five, or six counties or any geographical configuration which has some semblance to a market, where people normally listen to one or two stations, or maybe more in the area, and their habits are already established. The ideal state plan is that there would be a common program in that operational area.

Some states have five or six operational areas, some have 12, 15, 20, but they are prepared to program that operational area.

Now, where the educational process comes in is advising the public what this operational area is, and in many cases the operational area has a primary station and a series of alternate stations, which would come on in the event the primary became inoperative. In the operational area, in my way of feeling, it has to be identified in such a way that the people who are listening know what you are talking about. As to whether or not you identify your station, I think this is something which has to be worked out at the state and local level.

When the emergency broadcast system actually is activated, the use of call letters at this point is not going to be permitted, because there is only supposed to be one station on in that area, and it may be any one of four or five that would cover that operational area.

This is something that I think has to be spelled out a little clearer yet.

QUESTIONER: For the purpose of oversimplification, the broadcasters who have NDEA's, in making the test announcement or the DOD announcements, hate to make them without being able to include their own call letters, if they are going to be one of the stations in that area, if they have an NDEA and they are going to be an operational station.

In other words, the stations have a lot of pride about this. They've cooperated, they've filed for an NDEA. All they want to do is include their call letters. There is a motion before NIAC on this matter.

MR. McNAUGHTEN: I think this is really something that NIAC has to make a determination on, because, you see, the Commission does not make these plans, or proposals. The Commission acts officially upon plans which are recommended to them by the National Industry Advisory Committee.

MR. PARKER: Another question along that line: A TV station receives an NDEA which they did not apply for. What is the significance of this action? Do you apply for them or are they issued automatically:

MR. McNAUGHTEN: To carry on the explanation a little bit more of the operational area....Ideally, here again, there would be one or more FM stations that would be used for interconnecting a multitude of AM stations, just as they would in the entire state.

This is another part of the State Defense Network. This plan is a coordinated plan. It is prepared by the State Industry Advisory Committee and, in most cases, very carefully checked out, tested, and parts of it are operational. When this plan is recommended by a State Industry Advisory Committee, we go on the assumption that it is operational in character, it has an operational capability. Therefore, without any further ado, the Commission issued the NDEA to the FM or the TV station which is involved, because the function of FM and TV in this system differs from that of the AM.

The AM is for general coverage of the public, and the FM and the TV is principally for the use of interconnection.

MR. PARKER: Why is it necessary for the first-class operator to write a narrative statement for the maintenance log? And, why is it necessary for the first-class operator to make entry that the tower lights are okay? Can a third-class operator be considered qualified to see if the tower lights are burning?

MR. KRATOKVIL: I think he is - especially if he has 20-20 vision we'd have an awful time proving that he wasn't competent. But the entries should still be made by the operator responsible for the particular maintenance log. I suppose he could have this man make the entry, saying I saw the lights on, and put his initials on there. I don't think we'd quarrel with that.

MR. HANSON: If I may carry on for just a minute, the maintenance is normally done by a first-class man, I believe. And he has to go out there. If the maintenance is to be done, why, he has to do it. If they send a third-class man out there and maintenance has to be done, he has to come back to get the first-class man out there. So I assume you'd send your first-class man in the first place.

QUESTION FROM THE FLOOR: I'm John Sargel from Syracuse University. I would like to ask a question about this tower light situation.

Why is it even in the maintenance log, as far as seeing if they are on in daily operation? That's a daily operation, not a maintenance job. And usually, unless you're working all night, the tower lights are not on until after the normal management has gone home.

What I'd like to know is, why can't it be transferred, or why wouldn't the Commission, aside from a daily inspection, which we do on the tower lights, prior to even having it indicate that they're on for the night, put that function over in the operating log, because that's an operational function, I would think?

MR. HANSON: I don't believe, as far as I'm concerned, there is any objection if you do log it in the operating log. And certainly, I think, Mr. Cowperthwait would entertain a petition to amend the rules to change it.

MR. COWPERTHWAIT: Sounds like a good suggestion.

QUESTION FROM THE FLOOR: With respect to the inspection of the lights and wiring the bulbs on the tower, I understand, or I was left the impression, that it goes further than just going out to see whether or not the lights are on or off.

Is it true that it is necessary to go up on the tower, and actually inspect the wiring, the sockets, the bulbs, etc., and is it necessary to have a man with a first-class ticket do this, or can you hire a steeplejack to do it? And if you do hire a steeplejack to do it, who signs the log?

MR. KRATOKVIL: It is not necessary for him to climb the tower. We don't require the first-class operator to climb the tower to actually inspect the physical condition of the filaments, or the connections, or the wiring there.

QUESTIONER: Well, isn't it necessary on a - say, every three months, to have a personal inspection, or a close inspection of the tower?

MR. KRATOKVIL: Yes. But your steeplejack - this guy makes twice, or three or four times as much as your first-class operator anyway - he's risking his neck up there. He'll fix whatever has to be fixed, I suppose, and then report to you. And then it's your responsibility simply to see if they're working.

QUESTIONER: Well, does the steeplejack sign the log or does the operator on duty sign?

MR. KRATOKVIL: I'd say the operator on duty to whom the steeplejack reported would sign. It's a delegated responsibility.

QUESTION FROM THE FLOOR: Dan Hunter, from Honolulu....We have a remote operation, where our transmitter is remotely located from our operating point, and as far as the tower lights go, they are noticed by the operator on duty, not by the man doing the maintenance. The man does the maintenance at the transmitter.

It's been our policy - maybe we're wrong - to put that as an operating function, and not as a maintenance.

MR. HANSON: I think maybe I may have misled you. The rules now require that the lighting entry be made in the maintenance log.

QUESTIONER: But the operator doesn't know whether the lights are on when he signs the maintenance log - especially if he's on duty during the daytime. How can he sign the log?

MR. KRATOKVIL: In life you find you have to take other people's word for things. Now what happens is, your man who is looking out the window, who knows the lights are on, all he has to do is phone out to your transmitter man, who will keep the major part of the maintenance log...

QUESTIONER: But nobody is at the transmitter...it's remote controlled.

MR. HANSON: Most of them are required to have remote indication of whether your tower lights are working or not.

QUESTIONER: If there is no first-class operator on duty, who can sign it?

MR. HANSON: The operator on duty.

QUESTIONER: He opens the door and looks. It's close enough. Besides that, we can measure it by metering. We can tell whether all the tower lights are on, whether the flash is gone. We can tell that by metering. Also, we can observe it. And what we have been doing, since we have no way of knowing from the maintenance man, we've been entering that in the operating log, because I do have a first-class man who is on duty on television and AM at the same time.

MR. HANSON: I don't see any reason why that entry can't be transferred into the maintenance log. You put it in the operating log. Then somebody has knowledge of that happening, and then you transfer it over into the maintenance log.

QUESTION FROM THE FLOOR: I have another question, regarding the new monthly requirement for measuring frequency on TV.

My interpretation is that we should measure both the aural and the visual transmitter. Could we measure just the visual and use our proof monitor to measure the inter-carrier, and then assume that our aural is satisfactory? Do you have to measure on both transmitters?

MR. KELLEY: Yes, in effect you do that. But you can do it by some other means, by getting the difference between the two, as you indicated. That would be satisfactory.

QUESTIONER: In other words, what it would mean is, that I would get a calibration of my approved monitor with WWVH, and then use that approved monitor to measure the inter-carrier.

MR. KELLEY: That would be all right.

QUESTION FROM THE FLOOR: I would like a clarification of the tower light inspection. Are we talking about two inspections - the three-month periodic condition check versus the daily check?

MR. HANSON: The maintenance log is a daily check presumably. And also, it would require the same thing for your three months.

QUESTION FROM THE FLOOR: I'm Ray Holtz from San Francisco. Regarding tower lights and the daily observation, in the case of a tower shared by probably three or four television stations and also some FM stations, must each licensee observe the tower lights?

The owner of the tower, who is a licensee, has the control of the tower lights, indicating meters, telling how many lights are running and a flasher.

Also, sometimes it's so foggy in San Francisco that we cannot see the tower lights from the building.

MR. KRATOKVIL: Where several stations share the same tower, the one who seems to have the primary responsibility puts it in his log, which he displays to our visiting inspector, also, an agreement among all other stations that he will be responsible for this observation.

In other words, I would presume just an exchange of letters would be sufficient and then we would inspect the one log to see that the tower lights were actually being observed and checked. If there were three of you sharing the tower, all three of you wouldn't have to make that check.

QUESTIONER: Going to the third part of my question, a situation whereby the other people using the tower cannot see the tower lights due to weather conditions quite often, would involve them actually going down to observe an indicating light or a meter in one of the other operator's transmitting rooms, which I don't believe is the Commission's intent.

Now, we were told at our last inspection, though we are a tenant in the building, we must make an entry each day in our log regarding the tower lights which we do not control.

So in a case where you cannot see the tower lights, are we supposed to follow through by having an operator leave our premises to go downstairs to find out if they are working or not?

MR. PAT SCANLON (Field Offices Division of the Field Engineering Bureau): Let's hypothesize and say you've got stations a, b, c and d. A is the agreed upon station that will maintain the tower and its lights. A makes the log readings, as required, he can see the tower lights. All stations b, c and d do is make an entry in their log - and it need not be made daily, just appear in the log sheets, that maintenance of the tower lighting is the responsibility of station a, and an examination of the logs may be made at station a.

QUESTION FROM THE FLOOR: My name is R. V. Robinson, Bristol, Virginia.

On the aural percentage power, I'm seriously wondering why a six db reduction in aural power is desired over a six db increase in visual power?

MR. COWPERTHWAIT: I think it came about as a result of discussions with one of last year's panels. If you increase the power of all these stations in the country, you'd probably be better off. Everyone would get a little stronger service within their own area, and the interference would stay about the same. The question is, I think, one of economics. Could everyone afford to increase their power?

MR. PARKER: I think this question is a little bit outside the scope of the Panel here.

We're running close to our closing time. I do have one question here which, I think, is of interest and does not require a very long answer:

I have an SCA authorization for 67 kc to transmit background music. I plan to add a store-casting service on another frequency. Do I need special authorization?

MR. HANSON: Yes, you are required to file another application, since each frequency in the SCA service is separate and distinct by itself. So if you have one, two or three SCA channels, it requires one, two and three applications.

MR. PARKER: I know we could go on for a long time, because I have other questions here. I see, at least, we've generated a certain amount of response from the audience.

I would like at this time to ask you to give a round of applause to the gentlemen here who have done such a noble job.

Thank you very much, and this concludes this morning's Engineering Conference session.

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