IRE TRANSACTIONS

ON BROADCASTING

Volume PGBC-7 DECEMBER, 1961 Number 4

TABLE OF CONTENTS

PUBLISHED BY THE

PROFESSIONAL GROUP ON BROADCASTING

IRE PROFESSIONAL GROUP ON BROADCASTING

The Professional Group on Broadcasting is an organization, within the framework of the IRE, of members with principal professional interest in Broadcasting. All members of the IRE are eligible for membership in the Group and will receive all Group publications upon payment of prescribed fee.

Annual Fee: $2.00

IRE TRANSACTIONS®

on Broadcasting

Published by The Institute of Radio Engineers, Inc., for the Professional Group on Broadcasting at 1 East 79 Street, New York 21, N. Y. Responsibility for the contents rests upon the authors, and not upon the IRE, the Group or its members. Individual copies of this issue and all available back issues may be purchased at the following prices: IRE members (one copy) $2.25, libraries and colleges $3.25, all others $4.50.

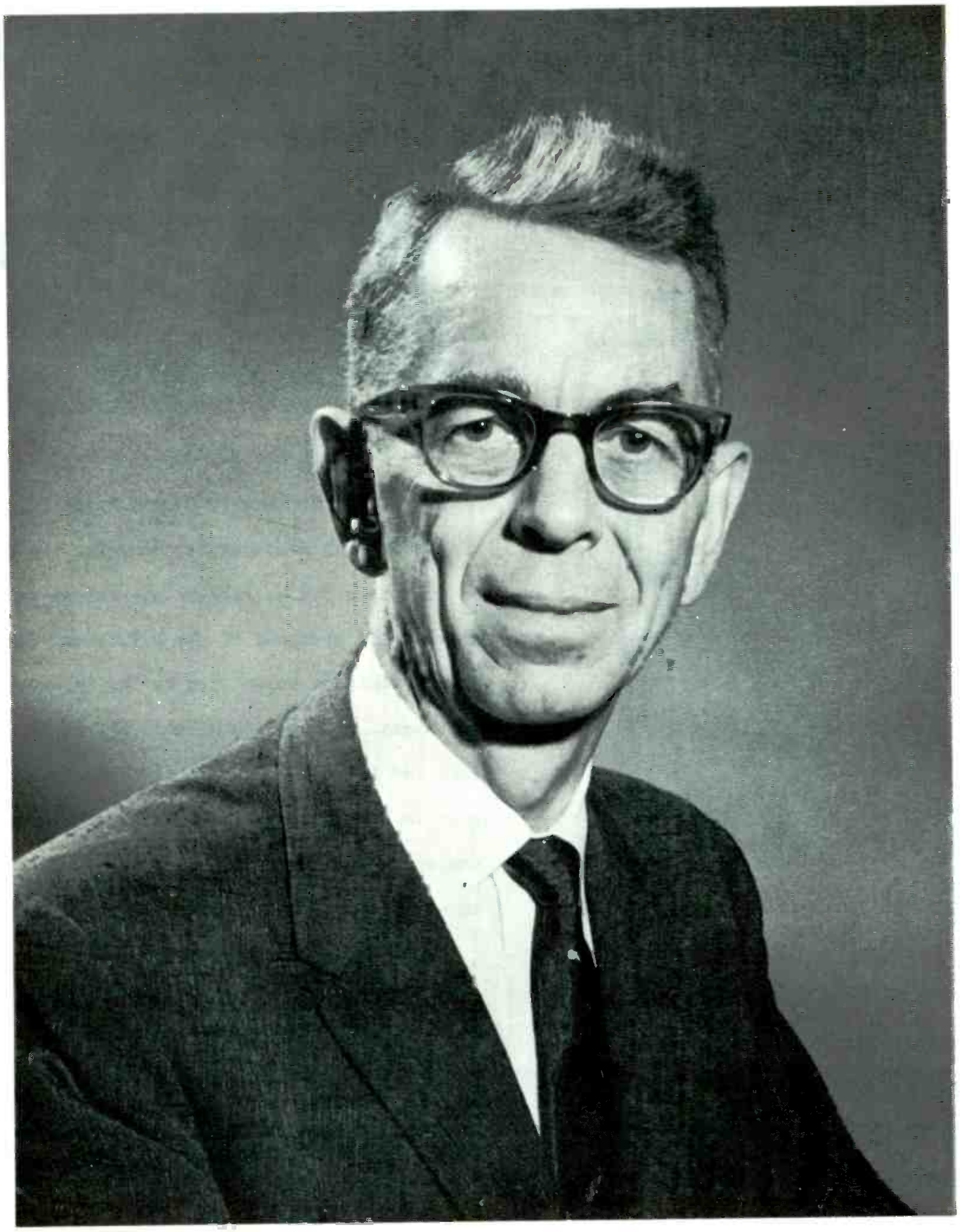
EDITORS PAGE---

The Fall Symposium for 1961 is now a thing of the past, but those who could not be there might enjoy some scenes from the event. To the right is our chairman, Ray Guy, presenting this year's Scott Helt award to Jim Greenwood while Mrs. Greenwood looks on.

At the left are Ray Guy and Francis C. Mc Lean. Mr. Mc Lean is Deputy Chief Engineer of the British Broadcasting Company. He gave an impromptu but extremely interesting talk on some of the problems of the B.B.C. and its relationship to television on the European Continent. We are grateful to Mr. Mc Lean, not only for helping us fill a last minute vacant spot in the program, but also for the gracious manner in which he answered a tremendous variety of questions on all aspects of B.B.C. activities.

At the right is a view of the head table at the annual banquet. Dr. George Town, Dean of Engineering at Iowa State University, was the toastmaster. Ray Guy was the banquet speaker. Ray told of his activities of the last several months, including both technical and non-technical aspects. His talk was centered principally on his work for the I.C.A. in Saigon, although he has recently travelled to other well known global trouble spots for the I.C.A.

---DONT FORGET--THE P.G.B. FALL SYMPOSIUM IS NOW THE PRINCIPAL TECHNICAL MEETING IN THE UNITED STATES DEVOTED EXCLUSIVELY TO THE PROBLEMS OF BROADCASTING AND TELECASTING---PLAN TO ATTEND NEXT YEAR--



JAMES H. GREENWOOD
DIRECTOR OF ENGINEERING
WTAE - TV
PITTSBURGH, PENNSYLVANIA

Mr. Greenwood is the 1961 recipient of the annual Scott Helt Award. The award was made for the paper entitled "Future Possibilities for Film Room Mechanization" which appeared in the August, 1960 issue of the I.R.E. Transactions on Broadcasting.

THE BROADCASTING INDUSTRY AS THE IDEAL USER OF WEATHER RADAR

by
Tony Sands
Chief Meteorologist
Crosley Broadcasting Corporation

Clyde G. Haehnle
Technical Advisor
Crosley Broadcasting Corporation

September, 1961

Since the dawn of time, man has pitted his knowledge against the elements in a never-ending struggle for survival. His habitat was altered to suit the climate and the abnormal eruptions of nature were accepted as having a religious connotation. With the passage of time, we have learned to understand and measure the elements and with a reasonable degree of accuracy, predict its motions and ascertain most of its violent eruptions. Despite the growth of the science of meteorology, literally thousands of people lost their lives during the first half of the century during severe and unexpected storms. During the past decade, electronic devices have been developed for the field of meteorology that will eventually diminish loss of life due to storms to a negligible factor. The tools for practically eliminating loss of life during severe storms and flooding are now available to the world. But, the weather warning systems have not kept stride with the forward progress of the electronics field.

The United States Weather Bureau is the finest and best equipped meteorological organization in the world. The fantastic life saving evacuation of coastal areas during Hurricane Carla was an excellent example of the value of large scale warnings and forecasts. But, even with full coverage of this enormous storm, there was some preventable loss of life, due to a time lag between the meteorological awareness of danger and the receipt of warnings by the public.

The United States Weather Bureau is charged by Congress to make weather observations and forecasts in the public interest. A broadcasting organization cannot morally compete with the United States Weather Bureau. Radio and television stations are actually the only voice that the Weather Bureau possesses and with a weather radar they can become an integral member of the meteorological community.

The weather bureau issues a forecast for a given location four times per day, under normal conditions, with little regard to timing of weather phenomenon and using the most general terms. A generalized forecast is issued not only for the sake of brevity, but is realistic, conforming to the current forecast limitations of the science of meteorology. With radar, a broadcasting organization can pinpoint the arrival of rain, snow and showers, both as to timing and specific location. Proper amplification of the weather forecasts is a good public service. But, during severe storm alerts, the <u>public mental and physical safety</u> can be protected through the proper use of weather radar.

The Crosley Broadcasting Corporation has been using a Decca Model 40 radar installation for approximately 5 years in its Cincinnati studios. Its staff of three meteorologists, with a fully equipped weather installation, service the area served by WLW radio and the television stations in Indianapolis, Dayton and Columbus. The U. S. Weather Bureau installed a long range radar about one year ago, at the Greater Cincinnati Airport, but this has not diminished the value of our 120 mile radar installation. Before the weather bureau obtained their own radar, WLW relayed the radar readings at given intervals to the local government office. These radar reports were placed on a national weather teletype network to be used by the severe warning forecast center and the field of meteorology in general. The U. S. Weather Bureau still maintains a private telephone line to WLW's weather station.

Five years ago when Crosley Broadcasting Corporation purchased the Decca Type 40 weather radar system, the Engineering Department made a site study and found that the roof of the transmitter building atop Mount Olympus gave us adequate line of site clearance in all directions. The Type 40 radar operates in the "X" band on 9 kmc with 20 kw peak power. The antenna has a horizontal beam width of 1.2° and a vertical beam width of 21° to the half power points. Range scales of 10, 30, 60 and 120 miles are provided. The equipment is originally supplied with the range scales calibrated in nautical miles which must be converted to statute miles.

The transmitter, receiver. and power units are located in the penthouse immediately under the scanner. The PPI display is located in the transmitter room behind the transmitter console. The display tube is a 12 inch long persistence with a P-7 orange phosphur. The PPI display is picked up by a transistorized Videcon camera and converted to a standard video signal. Numerous problems were encountered with the Videcon pick-up until our engineers located a Videcon tube with a sharp narrow-band spectral sensitivity that matched the P-7 phosphur of the display tube. An interesting point here is that the more stickiness the Videcon exhibits, the better the picture.

The sync generator at the transmitter site is locked to the main studio sync generator so that the radar display can appear on the switcher as a video source available for direct take, lap dissolves or special effects.

The weather radar has proven so successful in Cincinnati that we purchased a second Decca Type 40 for installation at WLWA, Atlanta, Georgia. This presented a unique problem since the studio location is surrounded by trees. Our engineers felt that the radar scanner could be mounted on the inside of the 500 foot self-supporting tower at the 190 foot level. Since the antenna aperature is large compared to the leg columns, it was felt that their shadowing effect would not be serious. This type installation has proven to be very successful and economical since most broadcasters have a tower available.

We realized at the beginning that an electronic device has a personality of its own and the idiosyncrasies of the device must be assertained and evaluated to make it fully effective. When the radar was first installed, we informed the public of our installation, its capabilities and our problems. We asked for public assistance in solving the evaluation problem. The public reaction was so great that we were able to select two observers in each county covered by the radar sweep.

The Crosley Broadcasting Corporation has its own airplane and pilot, and we installed a direct air-to-ground communications system between the plane and the weather station (weather reconnaisance). By using the combined services of the public weather observers and the reconnaisance aircraft we were able to adjust the radar to establish true distance and bearing. The tests also allowed the evaluation of power return versus output and to develop a linear evaluation of echo brilliance versus quantities of moisture and turbulence. The full scale testing extended over a six month period, until a full appraisal of limitation and capability could be made. The group of public observers have continued to serve as a constant checking element for radar efficiency, as our engineers continue to improve the system.

The weather radar is just one of the functional tools that is used in our fully equipped weather station. The six basic instruments for recording temperature, wind, pressure, humidity, and rainfall are mounted on a convenient panel for visual effect on television and for constant use by the staff of WLW's weather station. Three weather teletypes bring in a never ending stream of weather data from weather installations across the North American continent and adjacent ocean areas. These data include statistical information, forecast discussions and observations for not only the surface of the earth, but for levels up to 80,000 feet into the atmosphere. We prepare five complete maps daily for the entire continental United States and each hour the maps are changed over the Lakes area and Ohio Valley. The forecasts are kept up to the minute, coinciding with incoming weather reports and readings on our weather instruments. (including instantaneous radar observations). The weather station also has a facsimile service for bringing in weather maps from the U. S. Weather Bureau in Washington (Suitland, Maryland). The master analysis center in Washington is staffed by Weather Bureau, Air Force and Navy personnel using world-wide weather data, electronic computers and pictures from the Tiros satellites to prepare charts, diagrams and pictures to be used by weather installations across the United States. The WLW Weather Station is located in the same room as the News Department, which proximity offers the meteorologist on duty, the advantages of information from the press wire service and the physical assistance of experienced newsmen.

The WLW Weather Station is also a broadcast studio, with a broadcast line leading to each of the control rooms of radio and television. Weather programs are presented over the facilities of WLW with a regularity, consistent with good programming. There are 184 programs regularly on WLW Radio and 34 on Television weekly. During a weather emergency a bulletin may be issued immediately and as often as it is deemed necessary in the best public interest. Bulletins have been issued during heavy snows, floods and severe storms, during the past five years. Discounting snow bulletins, we have issued warnings of 312 severe weather occurrences, both of localized storms and phenomenon influencing the major portion of our service area. During the five years we have used weather radar, we issued only six weather bulletins in which no major property damage or bodily injury resulted. There were nine severe local storms in which no advance warnings were issued. Of these storms, which were not covered by bulletins, five occurred when WLW meteorologists were not on duty; two were freak disturbances that developed and disappeared in a few moments; two occurred during a period of mechanical breakdown in the radar system. A warning system can be completely ineffective if needless warnings are issued too often. Weather warnings must also be issued factually and with no alarm evident in the voice of the broadcaster. Also, occasional mention of protective measures that should be taken by the endangered persons is a necessary service. It is important to have warnings of possible danger reach the affected people as soon as the danger is in evidence, and it is equally important that the public be informed as soon as the impending danger has been passed.

Broadcasting of radar information to the public is straight-forward from the radio standpoint, but visual presentation requires the use of special techniques. The most popular television presentation of radar picture involves the placing of plastic overlays, with an area map engraved upon them, over the radar picture tube and placing this picture directly on the air. The overlay method presents contrast of light problems and also precludes the possibility of showing motion or development through the use of art techniques. An effective method of presentation that we have used on the air, is placing the picture of the map of the local area on one camera and then super-imposing the radar picture over that on the air. By watching a television monitor, the weatherman can point to the echoes and draw arrows, etc. This method is effective, but keeping a proper alignment of the super-imposed pictures is a major problem. The most effective and fool-proof method of radar presentation is that super-imposing the radar picture over a black background and allowing the weatherman to make the outlines of the geographical landmarks on the background with chalk. This method poses no alignment problems, and allows you to create an illusion of expanding the size of the radar by using a large black background. The methods of presenting radar weather information can vary greatly, but the presentation must be simple and accurate in order to be effective.

We feel that WLW's radar weather service is definitely a part of the meteorological community and the public acceptance and confidence in our service has been more than gratifying. During major floods over the past several years, the radar readings from WLW have been used as the final authority in evacuation of flood threatened areas. We were asked by NBC to tell the story of our flood forecasting on the "Today" program, during a major flood in Cincinnati three years ago. It was during this flood that we proved that a radar operating on the "X" band does have tremendous penetrating power. The Decca radar beam penetrated thirty miles of dense rainfall, allowing us to follow a storm center as it took an abrupt right angle turn just west of Cincinnati. During this major flood we were able to ascertain the exact rainfall, duration of precipitation and the latent reaction of the fallen water. During the peak of the storm we were able to direct the police helicopter around storm cells, while the rescue and evacuation work was in progress. Our meteorologists have made severe weather broadcasts on other radio stations in the midwest from the WLW weather station. On one occasion, the safety of fifteen hundred people living in the flooded low-lying areas of Marion, Indiana, was entrusted to the forecast prowess of our weather staff. The water level had reached the top of their levee and more rain would have meant disaster. We presented several broadcasts on WBAT in Marion, assuring the people that the rain was over, despite the lightening flashes that were visible on the horizon. The Civil Defense officials that enlisted our assistance, could have used the weather bureau facilities at Fort Wayne, Indianapolis, or Dayton, Ohio. These government installations have radar equipment and are much closer to Marion than WLW. The requests for private forecast services have grown steadily. We prepare special forecasts for many of the building contractors, the gas and electric companies, highway departments, private pilots and local industries. During the past two winters we have been making the exclusive weather forecasts for the Roadway Express Corporation. Roadway is the third largest trucking company in the nation and its trucks travel across the eastern two-thirds of the country.

We are constantly striving to improve our service to the public. Recently, a long range Decca Type MK41-IIA radar system was purchased fo replace the Type 40 in Cincinnati. This was done because we were faced with the problem of complete radar coverage of the combined service area of our four television stations in Ohio and Indiana. The new radar is now being installed which has an antenna approximately fourteen feet across with 0.6° horizontal beam width and 2.8° vertical beam width to the half power points. The antenna can be tilted to a vertical angle of 30°. This new system will provide us with a tool to see the weather conditions three hundred miles arom Cincinnati and well beycnd the combined service area of our four stations.

The WLW weather station has been in operation for seven years and its value to the region has been established. There has been complete cooperation between the Federal Weather Bureau and WLW's weather service. We actually have lessened the public service burden on the U. S. Weather Bureau by dispensing information, statistics and forecasts that the government would normally be obligated to furnish. Our meteorologists are professional members of the American Meteorological Society and are active in the local chapter of the organization in order to promote and improve the science.

A broadcasting organization with trained and experienced meteorologists can render invaluable public service through the use of an effective weather radar. The radar is an electronic device that can only be kept at its peak efficiency by electronic engineers. A breakdown of the equipment, without instant and competent maintenance, could cost many lives. It would be impractical for each weather bureau installation to have an electronics engineer on the payroll, but an engineer is always on duty at any substantial broadcast station. The weather bureau has no constant and instant communication with the public, and with delay and relay of information comes the danger of misinterpretation and of being too late. A meteorologist that would be acceptable for air work by station management and by the public would be capable of conveying information and warnings instantly in terms that would be understood by the general public. No one would expect the local staff meteorologist to compete with the Severe Warning Network and its huge staff of specialists in forecasting the possibility of storms. But once the storms have formed, the instant taneous reporting of the severity and movement of the storms in laymens language should not be a breach of meteorological ethics nor constitute a usurpment of the weather bureau's legal responsibility. Under the present weather forecasting and communications system, the Broadcasting Industry is the only organization capable of meeting all the requirements necessary for the ideal <u>severe weather warning system</u>.

DESIGN AND OPERATIONAL PARAMETERS OF IMAGE ORTHICON TUBES 4½ INCH AND 3 INCH FIELD MESH TYPES

Eric D. Hendry
Assistant Manager, Photo Electric Tube Division
English Electric Valve Company, Ltd.
Chelmsford, Essex, England

Summary

Although the 5820 Image Orthicon received universal acceptance in the United States of America as the camera tube for studio and remote telecasts,its progress in Europe was impeded due to the existance of other picture origina-ing equipment which produced pictures superior in all respects other than sensitivity. As a result, considerable modification of the image orthicon tube was undertaken, culminating in the develoment of the 3 inch field mesh and 4½ inch image orthicon tubes.

This development work has been instrumental in gaining acceptance for the image orthicon tube in Europe. The improved performance characteristics of these tube types are now being recognized and acknowledged in the United States of America as shown by their increased usage.

The operational parameters of the various 3 inch and 4½ inch tubes will now be discussed.

* * *

In the U.S.A. the first image orthicons commercially obtainable were the 2P23 type with the AgOCS photocathode. These were soon superseded by the types 5769, 5655 which both employed the SbCs photocathode with an improved color response. The difference between the two types was in target spacing, and reflected the desire by the TV industry for tubes with different characteristics designed to suit respectively studio and remote applications. The studio tube was close spaced and was designed to give the optimum performance when transmitting a scene of the relatively low contrast normally obtainable in the studio. The other type incorporated a wider spaced target and was designed to be a more flexible tube for remote use and provide an adequate performance from scenes of widely differing brightness and contrast.

With the development of the Silver Bismuth photocathode the 5769, 5655 were replaced by the types 5820, 5826 designed to fulfill similar functions to the two preceding types. The 5826 had a disappointingly short commercial life. It was soon decided that the improvement in picture quality, resulting from the use of the 5826, did not outweigh the operational difficulties associated with the use of the close spaced tube. As a result of the wider spaced 5820's introduction for studios by 1953 the demand for the 5826 was negligible.

The charge to the 5820, although deplored by the purists, was inevitable since the 5820 displayed two shortcomings which in a curious way went part way towards compensating the deficiences of the average American receiver of that time. Both of these shortcomings were associated with the use of wide-spaced targets and were respectively

1. Edge effect.
2. Unstable transfer characteristic.

The edge effect produced an artificial sharpening of the transmitted picture which improved the subjective sharpness of the picture viewed on the receiving set of inadequate bandwidth. Furthermore, its existence was appreciated by the viewers in the fringe area.

The unstable transfer characteristic or A.V.C. characteristic as it is sometimes called, not only simplified operation of the tube but produced a signal which was very suited to the non-restored receiver which was common at that time.

In Great Britain the image orthicon was introduced for remotes during 1949, but four years were to elapse before it was accepted for studio use. The reason for the delay was the existence in the B.B.C. of camera tubes, capable of producing pictures of better quality than those produced by the 5820 which was an improved orthicon, and the image iconoscope. It is not suggested that these tubes could match the sensitivity, flexibility or operational simplicity, of the wide-spaced image orthicon, but when used in studios, where the light level and contrast range could be controlled, they were capable of producing pictures of a superior quality, and reducing the difference between the live programs and those emanating from 35 m/m flying spot equipment.

This was thus the situation in the early fifties not only in Great Britain but also in Western Europe where various types of image iconoscopes held sway in the studios. The dependence upon the iconoscopes with their required high light levels was made easier by virtue of the fact that most studios were relatively small.

The production of image orthicons in Europe was first started in 1949/50 by the English Electric Valve Co. Ltd. Initially 5820 tubes were manufactured, but due to the opposition to their adoption in studios, ways of reducing the deficiencies, which precluded its use as such, were investigated.

The major decision was to undertake the commercial development of the 4½" image orthicon which had been previously investigated by R.C.A. but abandoned owing to lack of interest on the part of the TV networks.

In parallel with this development, modification to the 5820 was undertaken designed to reduce the objectional picture defects.

The major change was the introduction of the field mesh, which was designed to reduce the radial of electric field in the neighborhood of the target. This had previously been investigated as a means of avoiding the formation of an ion spot, with a consequent improvement in tube life. During the course of these experiments it was found that if the separation of the field mesh from the target was made small, the tube produced a picture which lacked the characteristic hardness of the accepted image orthicon picture. The reasons for this change in performance was not really understood for several years, until 1957 when Theile and Pilz of R.T.I. Germany published the results of their investigations into the generation of spurious signals in the image orthicon. However, the advantage of the field mesh having been experimentally established, the development of a 3" field mes tube was initiated.

The introduction of a field mesh into the image orthicon did not present any major difficulties. Three main requirements had to be fulfilled.

1. The mesh must not be resolved by the scanning beam.
2. The mesh must have a uniform high transparency.
3. The tube should operate satisfactorily within the range of potenials required by the existing image orthicons of the non-field mesh types.

Requirements 1 & 3 were not difficult to meet. The optimum position of the field mesh could, in theory, be calculated, but it was found that the placing of the mesh at an antinode of the beam was not necessarily satisfactory. Due to the fact that the beam makes two transits of the mesh, interference between the two images of the field mesh, so formed can arise appearing as strobe patterns of various frequencies. As a result the final position was determined empirically.

In order to ensure operation in existing image orthicon cameras the field mesh was mounted on the decelerator which was connected internally to the beam focus electrode. The decelerator control was thus inoperative, the geometry and shading being satisfactory without the radial electric field correction necessary in the case of the non-field mesh tube.

The combination of this structure and a wide-spaced target, was the first field mesh image orthicon offered commercially being known as the E.E.V. P.807. This tube was the first image orthicon accepted for studio use by the B.B.C., and was also adopted for remote applications.

The second requirement mentioned above proved to be the most difficult to meet, requiring considerable advances in mesh making technology.

This pioneer field mesh tube, fulfilled its initial promise, by producing pictures which lacked the characteristic image orthicon look but did not receive immediate acceptance in all quarters. Two defects were apparent:

1. Low signal to noise ratio.
2. Low amplitude response.

Similar defects had been noticed in the early field mesh 4½" tubes, develoment of which was progressing at the same time. It was established that the high noise level and poor resolution were both due to the secondary electrons emitted from the field mesh under bombardment by the beam. Those emitted as the result of the impact of the forward beam contribute a general background noise. Those released by the beam returning from the target produce an out of phase picture, the difference of phase being due to the difference in transit time between the electrons returning through the field mesh and the slow secondary electrons starting at the field mesh. The effect on picture of the out of phase signal was a trailing smear of short duration. This severely reduced the measured amplitude response at 400 lines but also led to a further reduction in the "edge effect".

Various "chemical" methods of reducing the secondary emission were investigated, that is coating the mesh with a material of low secondary emission. However, it was decided to stop the secondary emission contributing to the signal, by electrical means. In the case of the 4½" tube this was comparatively easy since no cameras had been manufactured at this time. The secondary electrons were prevented from entering the multiplier by the simple expedient of operating the field mesh at a slighly higher potential than that of the beam focus electrode.

This remedy was not applicable in the case of the 3" image orthicon since the bias potential required for the field mesh was not readily available on the many cameras already in the field. However, an elegant solution was developed by the English Electric Valve Co., Ltd. in 1957 and has since been adopted by all other manufacturers of field mesh image orthicons. The basis of the invention is the creation of a potential minimum at the entrance to the multiplier. The potential at this point is depressed to approximately 90 volts which is intermediate between the target potential and the potential of the G4 and hence the field mesh. As a result secondary electrons emanating from the field mesh are unable to enter the multiplier whereas the direction of the electron beam to and fromthe target is unaffected, although the velocity of the beam as it passes through the neighborhood of the potential minimum.

The required electrical field is produced by the introduction of a ring electrode at cathode potential at the entrance to the multiplier. This electrode is connected internally to the cathode, so that no additional electrical supplies are required.

The first commercially available field mesh image orthicon with suppressor was the E.E.V. 7293 introduced in 1958. This differed from the pioneer P.807 not only in the addition of the suppressor but also in the design of the target field mesh region. The close spaced version of the P.807 was used successfully in the B.B.C. colour cameras during the period 1956/57. Although registration was more easy than in the case of non-field mesh image orthicons, it was decided that further improvement would result from the introduction of a decelerator. As a result the E.E.V. 7293 was provided with a decelerator mounted between the field mesh and the target. This was operated in the accepted manner, that is adjusted for optimum shading and geometry.

The basic design of the E.E.V. field mesh image orthicon, that is a suppressor and a decelerator has since been used with minor modifications by all other manufacturers of field mesh image orthicons.

Two types were made available commercially available the 7293 and the 7294. The latter incorporates a close spaced target and is intended for colour applications and monochrome studio use.

The 7293 is the successor to the P.807 and incorporates a wide spaced target of the same capacity as that employed in the 5820. As such it is operationally interchangeable with the latter tube since its introduction in 1958, has made considerable progress at the expense of it.

In Canada the 7293 is used in preference to the 5820 by the majority of the C.B.C. and Commercial Stations, for both studio and remote applications. In the United Kingdom, no non-field mesh tubes have been used by the operating companies for twelve years. In Europe and Australia field mesh tubes with close spaced targets such as the E.E.V. 7294 and OS20F are preferred. These types are preferred since it is generally accepted that these are capable of substantially reducing the normal difference between the 4½" image orthicon pictures and those from the 5820.

Since its introduction in 1958, the 7293 has undergone further development, aimed at the elimination of the highlight ghost and an improvement in image geometry. This has been accomplished by a radical redesign of the image electrodes.

As mentioned above, the 7293 is operationally interchangeable with the 5820 and it is of interest to compare the performance figures for the two types.

	5820	7293
Operational Sensitivity (Scene Brightness at f5.6)	15 ft.L	15 ft.L
Signal/Noise Ratio	32 db	31 db
Amplitude Response @ 400 lines.	40%	40%

The only penalty paid for the removal of the spurious picture characteristics of the non-field mesh tube is a very slight increase in the noise level. This arises as a result of the attenuation of the signal during the passage of the return beam through the field mesh. It can be shown that the degradation of the S/N is given by a factor $T^3/2$ where T is the transmission of the field mesh.

It has been possible to develop uniform meshes of extremely high transparency. The resultant loss in signal to noise has thus been fractional.

The signal to noise ratio lost by the inclusion of the field mesh can be reclaimed by a small increase of the target capacity. In the case of the 7293 this has not been done, since such changes also produce changes in the transfer characteristic of the tube.

Alternatively, the signal to noise ratio can be improved by running the target at a target voltage slightly greater than the customary 2 volts. This remedy is not applicable to the non-field mesh types, as certain of the picture defects are a function of the target voltage and operation at increased target voltage would accentuate the effects.

The additional benefits conferred by the adoption of a field mesh, are considerable, and should be remembered if the protoganists of the 5820 type place undue emphasis on the minute loss in signal to noise.

1. Improved black shading.
2. Improved corner resolution.
3. Improved white shading. In this context, it should be mentioned, that when the 7293 is operated at its correct beam focus of 130 volts,

porthole shading is negligible, and as a result, the tube can be operated quite satisfactorily, in cameras with yokes of doubtful quality. This is not the case with non-field mesh tubes which quite often give consistent bad landing in particular yokes.

The operation of the 7293 differs in only one respect from the 5820. The alignment procedure which has been standarized for non-field mesh tubes, that is observation of the dynode aperture, is no longer possible, as the aperture is not readily discernable. The recommended alignment procedure is to adjust the alignment controls for maximum and most uniform modulation.

Alternatively the alignment controls may be adjusted for minimum rotation of the picture as the beam focus control is rocked. This operation can be facilitated by the use of a "wobbulator" or oscillator applying a low amplitude 30 cycle modulation locked to field drive and applied to the beam focus electrode. In this case the alignment coils are adjusted to cause superposition of the two images so formed.

The operation of all the other tube elements is similar but more definite than in the non-field mesh types. For instance the operation of the multiplier focus, is largely that of a gain control and has a very little effect on the uniformity of the black shading.

The lighting and staging practices required for the 7293 do not differ from those which have been adopted for the 5820. As mentioned above the capacity of the target is identical with that of the 5820 resulting in a similar contrast handling ability. The standard 5820 exposure adjustment, which relies on the linearizing of the Retma low contrast logarithmic wedge is equally applicable.

The major operational advantage to be gained by the use of the 7293 is a more accurate and faithful reproduction ofhigh contrast transitions. This reduces the constraints which normally have to be applied to the set and studio personnel when non-field mesh tubes are being used.

As stated above the development of three inch field mesh tubes was the result of one of the programs for eliminating the undesirable features of the picture produced by the wide-spaced 3" image orthicon.

The other program was the commercial development of the 4½" image orthicon. In addition to the faults associated with the existence of a weak decelerating field, the 5820 generates certain signals which result from the use of a low capacity target. This capacity can be increased by the reduction of the target spacing but a more elegant solution is to obtain the increase in capacity by an increase in target area. The use of the larger target area besides reducing the defects associated with a low target capacity, gives additional benefits which may be briefly enumerated as under:

1. Increased resolution.
2. Reduced redistribution (Halo etc.)
3. Extended life compared to 3" tube with target of same capacity.

The subject of the 4½" image orthicon has been covered more fully in an earlier paper and it is proposed to restrict discussion in the present paper to the application of the field mesh to that type.

Non-field mesh 4½" image orthicons were built in early stages of development by both R.C.A. and E.E.V. However, the deflection of the beam by the target potential pattern, which had previously been noticed in the 3" tube, appeared with a severity which considerably reduced the improvement in overall picture quality which had resulted from the adoption of the larger area high capacity target. Attempts were made to increase the strength of the decelerating field by operating the beam focus electrode at a high voltage but this introduced porthole shading.

The field mesh was therefore adopted, and in the first commercial versions of the 4½" tubes was mounted between the target and the decelerator, as in the present three inch tubes.

This arrangement was not found completely satisfactory owing to the difficulty, when this arrangement was used, of placing the field mesh at an antinode of the beam. Further porthole shading could not be entirely eliminated.

As a result the position of the field mesh and decelerator were transposed, and the field mesh placed next to the target. This resulted in an even stronger decelerating field and permitted operation at a higher beam focus voltage without the introduction of porthole shading.

The additional benefits resulting from the use of the field mesh in the case of the 4½" tubes, were even more marked than in the case of the smaller tube. Without a field mesh the scan on the dynode of the return beam is of a very large amplitude. It thus becomes difficult to control black shading and ensure uniformity. In the case of the field mesh version the scan is restricted to a smaller area thus ensuring more uniform collection from the first dynode. More recent cameras have provided for some adjustment of the potential of the field as a means of defocusing any dynode background. Such adjustment must not, however, remove the bias between the G4 and the field mesh designed to avoid collection of the secondary electrons emitted by the field mesh.

The increased amplitude of scan necessary in the 4½" tube, would lead to a greater loss in corner resolution due to deflection defocusing. However, the incorporation of the field mesh is instrumental in reducing this loss such that the resolution in the extreme corners is barely 40 db down on that in the center, when the beam focus is adjusted for optimum resolution in the center.

The combination of the field mesh and the large area high capacity target has resulted in the development of an image orthicon which has matched the picture quality of the earlier camera tubes, without sacrificing sensitivity. The E.E.V. 7295, and 7389 field mesh 4½" image orthicons have now been world wide in operation for seven years and this successful design is now being adopted by Companies who are just entering this field.

NEW IMAGE ORTHICONS

G. W. Iler
Cathode Ray Tube Department
General Electric Company
Syracuse, New York

Summary

The use of video tape recording equipment has increased the requirements for higher quality performance from image orthicons. The GL-8093 and its characteristics are described as a 3-inch image orthicon to meet this need. The GL-8092, a field-mesh version of the high sensitivity image orthicon, is described for color applications.

Last year at this conference we talked about two new image orthicons for broadcast service, the GL-7629 for high sensitivity and special applications and the GL-7293 for improved studio performance. This year we have the privilege of describing two additional types which represent modifications of these two for critical and special requirements in broadcast service.

A fact of life in the TV broadcast area for the last couple of years is the change in studio practices brought about by the video tape recorder. This new machine has wrought what practically amounts to a revolution in rehearsal, recording, commercial announcement, and maintenance techniques, plus other changes about which the author is gratefully unaware, to be sure. The video tape recorder has enjoyed such a tremendous boon and has found at least temporary favor over kine recording on film because the playback quality is essentially indistinguishable from a live performance, at least on a home receiver, as well as being available immediately after and even during the recording process. All the advantages of live image orthicon quality and customary TV studio practices can be exploited with more flexibility in scheduling facilities and talent.

VTR, however, as much as a boon as it has been, is not a panacea for all of your problems, and has in fact brought with it its own particular set of problems. As another "aperture" or link in the television system, it extracts its share of quality from the video information and therefore puts the onus on the rest of the system to perform better.

The part of the system which has shown the most picture quality improvement recently has been the camera chain where the 4-1/2" image orthicon has been introduced. Whether or not you use a video tape machine, the fact remains that the noise and edging effects are noticeably decreased with this larger tube, and the resulting picture even on our 525 line system has a crisper, more photo-like quality.

Like the video tape recorder, the use of the 4-1/2" image orthicon introduces its own unique problems along with its improvement in picture quality. Principal among these is the requirement for more rigid lighting practices that must be followed if all the advantages of the 4-1/2" tube are to be realized. Since we are dealing here not with manufacturing quality, but rather with basic design characteristics, in effect, we are trading some operating flexibility for improvement in picture quality. Actually doing this is, for an experienced manufacturer of image orthicons, not a difficult task; what is more difficult is to have a good, thorough understanding of what you as the representatives of the TV industry really want and need.

It is quite evident at this point that at least some fraction of the industry both wants and needs the 4-1/2" performance. It is also fairly evident that this fraction, although relatively small at present, will grow during the next several years to form a substantial market. In the meantime, however, there are also a great many station chief engineers and managers who would like to have improved performance without having to either invest heavily in new 4-1/2" camera equipment or to trade so much operating flexibility, and at relatively economical cost as well. The GL-8093 is, we believe, the answer to this situation.

The 8093 is a modification of the well-known GL-7293. Its target-to-mesh spacing has been reduced from the nominal 2.2 mils in the 7293 to about 1.4 mils to increase target capacitance. As in the 4-1/2" tube, the net effect of increasing target capacitance is to improve the signal-to-noise ratio, to reduce white edging effects from image side redistribution, and to increase gamma somewhat. The use of a field mesh behind the target as in the GL-7293 sharpens up the picture by minimizing white edging due to beam bending and by improving corner resolution. The field mesh also helps produce much flatter fields than image orthicons without it, and also eliminates background interference from the first dynode texture and aperture.

Let us examine these characteristics in somewhat more detail.

The most significant improvement that the 8093 brings to studio operation is the increased signal-to-noise ratio which is 50/1 on the average compared to 45/1 as a typical figure for the 5820 type image orthicon. In decibels, these ratios are 34db for the 8093 and 33db for the 5820. On paper, this does not sound like a very great difference, but in actual practice and operation, the difference in noise is quite noticeable on a monitor. Published figures for the 7295 which is the most commonly used 4-1/2" image orthicon are 56/1 or 35db. We therefore have an improvement in signal-to-noise ratio which although it does not quite match the 4-1/2" tube, is nevertheless a significant increase. The reasons for not going to higher ratios in a 3" image orthicon will be explained shortly.

The second most significant improvement in the 8093 is the further reduction of white edging effects. Those of you who have used the GL-7293 in the past have observed that the localized white blooming around black areas has been reduced by the use of the field mesh. By reducing the spacing between target and mesh in the 8093, redistribution effects which produce a very similar white border line are further reduced, giving a much cleaner black to white transition without over-shoots. It can be an advantage to start out with the least amount of over-shoot possible as often-times various video amplifiers, cables and terminations are not adjusted properly and tend to introduce their own over-shoots. In comparison with a 5820, the combination of improved noise figure and cleaner black to white edges produces a very clean, crisp picture.

And now, it would be well to discuss the reasons for choosing a target-to-mesh spacing of 1.4 mils which gives a signal-to-noise ratio significantly better than a 5820 but still not as high as a 4-1/2" tube. Certainly, a 3" tube can be built with a closer target-to-mesh spacing, as exemplified by the 6474 and 7513 types which are about 1 mil or slightly less. These tubes were designed for 3-tube color cameras and the very close target-to-mesh spacing expands the light transfer curve below the knee so that the full range of scene contrast can be accepted without pushing the highlights over the knee. In color this is necessary due to the color distortion of highlights over knee. Although these tubes offer a signal-to-noise ratio more comparable to the 4-1/2" class, there is a basic characteristic of such close spacing which introduces limitations when used for studio black and white pickup. That is, the closer the target-to-mesh spacing becomes the higher the effective gamma of the tube becomes, which in turn means the tube will not accept as wide a range of scene contrast and will tend to compress black more readily. In the color camera, a gamma correction circuit is utilized to restore the curve out of the camera to a lower slope such as is experienced in normal black and white set-up. The explanation for this effect is tied up, in a manner not completely understood, with the efficiency of collection of secondary electrons from the target, but it is nevertheless an observable characteristic that as the capacitance per picture element increases so does the dynamic gamma of the image orthicon. Because of its higher capacitance, the 4-1/2" tube exhibits the same phenomenon.

The significance of this characteristic and the reason an intermediate spacing was chosen for the 8093 is that control of lighting and reflectance values of materials in the scene become noticeably more difficult with either a very close-spaced 3" tube or any one of the 4-1/2" tubes. The 8093 therefore is a design which is intended to be an optimum considering the increased demands by broadcasters for improved signal-to-noise figures from 3" image orthicons on the one hand and the budgets, or lack of them as the case may be, in a great many stations for lighting specialists.

Figure 1 illustrates the light transfer characteristic of the 8093 compared to that of the 5820. Although it appears that the gamma is the same as the 5820, this results from the curve being taken with a small highlight, and a dynamic gamma characteristic which would be more representative of actual practice would show a slightly greater slope than the 5820.

\- - - - -

In the case of the second tube to be described we can't say too much about signal-to-noise ratio. However, we can say a great deal about operating flexibility, stability, and long life for color television applications. There is a substantial amount of talk in the industry right now about the coming of color television. Perhaps with all this smoke, something will ignite and really burn. Whether color comes soon or slow, big or small, it is certain that flexibility will be an important part of any broadcasting activity. As horrible as it sounds to you chief engineers who will be responsible for doing it, it will probably be extremely vital in many cases to be able to drag a pair of color cameras to remote locations and do pick-ups under a variety of conditions most of which are likely to be very difficult.

The GL-8092 is essentially a marriage of the high sensitivity, magnesium oxide target of the GL-7629 and the field mesh construction of the GL-7293. The first use of the magnesium oxide target for broadcast television was in the GL-7629 introduced two years ago and although fairly well known by now, some of its characteristics may be described to illustrate its applicability for color as well as black and white.

Resolution sensitivity (Fig. 2) is perhaps the most significant performance characteristic. At any light level the resolution from this tube is substantially higher than that from a 5820, which accounts for the ability of this tube to portray detailed scene information at extremely low light levels. The large reduction in lateral leakage on the target, due not only to the extreme thinness of this target but also to the conduction mechanism of the magnesium oxide, is responsible for this high resolution. As can be seen from the curves drawn on arbitrary axes, there is no cross-over point where the 5820 is higher in resolution. If we compare amplitude responses at the higher light levels found in a typical black and white studio, we find the 7629 and 8092 to have about 48% response at 400 horizontal TV lines, compared to about 26% for the typical 5820.

Now a look at the transfer curve of the 8092 related to that of the 5820 (Fig. 3) will give us a little insight into another characteristic of this new tube. At the lower light levels the output from the 8092 is substantially higher than that from the 5820, although at the higher levels near the knee of the 5820 the signal output from the 8092 is less. The reason for this is a wider target-to-mesh spacing, and the result of this lower signal output at higher levels is a softer gamma characteristic, somewhat like a vidicon, and a somewhat lower signal-to-noise ratio than the 5820. Despite the curve in the transfer characteristic, these tubes are essentially no more difficult to match dynamically in a color camera than the normal close-spaced glass target tube. The gamma characteristics are consistent enough from tube to tube so that with the aid of neutral density padding filters, three tubes can be made to track along a curved line as effectively as they would along a straighter gamma characteristic. Furthermore, no gamma correction is needed with the 8092. As is true in any image orthicon used in color, however, the field mesh construction contributes materially to the ease of setup as it eliminates shading problems which sometimes are mistaken for problems of dynamic registration of grey scale strips. The 8092 can be made to track quite faithfully over the whole range of iris control which permits pickup of a very wide range of brightness values.

The signal-to-noise ratio of the 8092 when it is given an exposure close to the knee of the 5820, is about 34 to 1 peak-to-peak signal versus RMS noise, compared to 45 to 1 for the 5820. In the lower region of the transfer curve where the signal output from the 8092 is higher, it will produce an appreciably higher signal-to-noise ratio than a 5820.

The life of the GL-8092, compared to the typical life of the 5820, is theoretically much greater because of the complete difference in conduction mechanisms through the target of the crystalline material, magnesium oxide. This tube will not be retired for sticking.

By way of illustration, Figure 4 portrays the general behavior characteristics of sticking during life of the 8092 vs. the 5820. The 5820 has practically no stickiness when it is brand new. However, with life and hours the 5820 does develop a degree of sticking which eventually leads either to retirement or to progressively more difficult operation. The 8092, on the other hand, starts with a small amount of after-image, but this gradually diminishes with life, generally rapidly at first, and reaches a point shortly after installation where it is not objectionable or bothersome in operation. In other words, with this tube, an I.O. Guard would be useful primarily during the first few hours, and then of little use thereafter.

Because magnesium oxide is inherently a very stable secondary emitting material, other characteristics of this tube remain much more constant throughout life than they do in a 5820 -- black compression, resolution, sensitivity, and target cutoff voltages being notable examples.

These characteristics of magnesium oxide make the GL-7629 and GL-8092 the most sensitive image orthicons for commercial television use. The field mesh construction was incorporated in the 8092 principally for use in color cameras where flatness of field and dynamic match among all three channels is very essential.

Much can be said for analyzing and measuring image orthicons on the basis of their individual performance characteristics such as signal output, signal-to-noise ratio, and dynamic matching properties. As far as evaluating a color picture, however, nothing can really substitute for the integrated response of the human observer viewing such a picture. I therefore submit that the results of a test of three magnesium oxide tubes in a G.E. color camera at 5 foot candles of incident light on the scene, were remarkable. The impression of the observers was that this was truly a very good color picture, but to describe these impressions it is again necessary to break down the picture into its component characteristics. Although the picture at this very low light level was noisy and the output video barely up to 1 volt, all colors were fully saturated and the detail in the scene was hardly any less than at full light level. Going to even lower exposures, video signal and color were lost before definition was. This demonstration is not described to propose in any sense that color sets be illuminated to 5 foot candles in order that the GL-8092 may be utilized effectively, but rather it is used to illustrate how sensitive the tube is and the degree to which it can handle wide ranges of scene illumination, such as encountered outside on a sunny day. A photograph of the results of this demonstration, if I had one, would truly be worth a thousand speeches.

Many television operations will be called upon to install studio color facilities in the next several years. In addition to long and stable life properties, use of the 8092 allows color to be broadcast from a black and white studio with excellent results without having to go to the expense and time of installing additional lighting facilities. In this application, a small sacrifice is made in signal-to-noise ratio for the advantages of resolution, cooler sets, lower lighting and air conditioning costs, and greater flexibility.

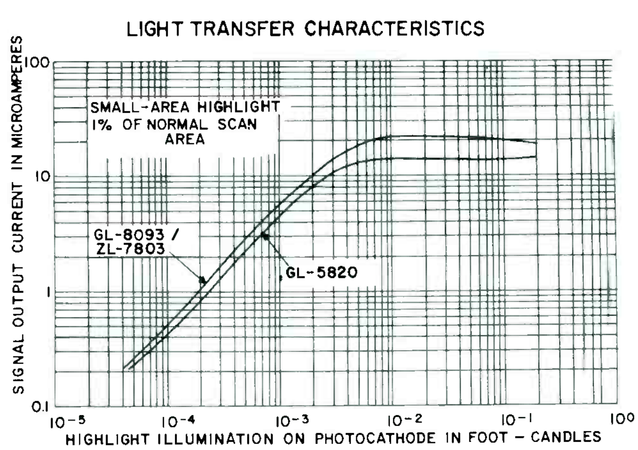


Fig. 1

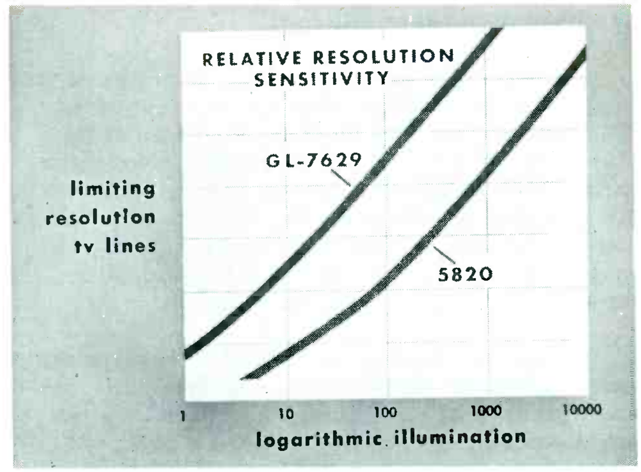


Fig. 2

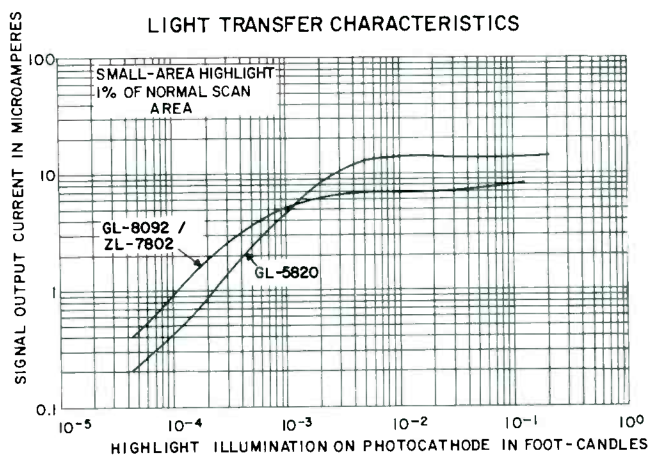


Fig. 3

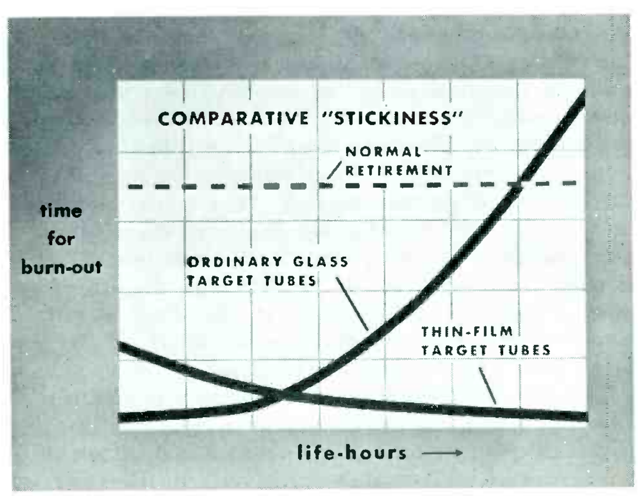


Fig. 4

SOME COMMENTS ON THE TECHNICAL REALITIES CONCERNING TELEVISION ALLOCATIONS

George R. Town
Dean, College of Engineering
Iowa State University

and

William L. Hughes
Head, School of Electrical Engineering
Oklahoma State University

ABSTRACT

A realistic engineering comparison of the service which can be provided at VHF and UHF is essential in the formulation of a television allocations plan. The critical technical factors are wave propagation, receiver noise figure, receiving antennas, interference, and transmitter power. A consideration of these factors leads to the conclusion that the service provided by the 70 UHF channels is far less than 70/12 times the service provided by the 12 VHF channels. It is suggested that VHF service may be increased by the use of directional transmitting antennas, and UHF service by the development of satisfactory on-channel boosters.

Introduction

The problem of allocations is the most important of the many problems facing the television industry[1]. Our present nation-wide television system, which serves a very high percentage of the area and an even higher percentage of the population of the continental United States, is built largely around the 12 VHF channels. Of the 544 commercial television broadcasting stations now in operation, 466 are VHF stations and only 78 are UHF stations. It is generally conceded that if any significant number of new stations are to be added, either more VHF channels must be provided or more effective use must be made of the UHF channels. Since the first alternative appears to be at best a remote possibility, those seeking to find ways of increasing the number of television stations quite naturally look toward the greater utilization of the UHF region for television broadcasting purposes. Many proposals have been made to this end. Some call for either the immediate or the eventual shift of all television broadcasting from the VHF to the UHF region; some for continued use of both regions with complete de-intermixture, complete intermixture or various degrees and kinds of intermixture. Regardless of the logic or lack of logic of these proposals, the fact remains that for both technical and commercial reasons UHF television has not been generally successful; and efforts to move any or all television broadcasting to the UHF region have been received with little enthusiasm.

In 1956, the Federal Communications Commission (FCC) invited the television industry to join in a concerted, cooperative attack on the problem which has been paraphased as that of "making UHF television as good as VHF television." This the industry declined to do, a principal reason being that Federal anti-trust laws made such cooperative development and research illegal. The industry did, however, form the Television Allocations Study Organization (TASO) which made a comprehensive study of the engineering factors underlying the allocation of frequencies for television broadcasting. The results of this extensive study are contained in the TASO Report dated March 16, 1959, and the Supplementary TASO Report dated June 13, 1960. The tests of UHF television in New York City which are currently being implemented by the FCC will provide further information regarding the degree of success which can be achieved with UHF in metropolitan areas.

In the TASO reports and elsewhere, there exists a large body of technical information regarding UHF and VHF television. It is the purpose of this paper to present a summary of this information as it affects television allocations. There is no intent either to advocate or to oppose the use of UHF for television broadcasting, but rather to present facts. In an attempt to write a paper of reasonable length, many details are omitted. It is hoped that the references cited will furnish the reader with adequate supplementary information. The authors will be happy to discuss details with anyone who is interested.

The 70 Channel Question

A principal attraction of the UHF region of the spectrum as far as television broadcasting is concerned, is the fact that 70 channels in this region (470-890 Mc) are available in comparison with 12 channels in the VHF region. One can easily fall into the trap of concluding that therefore approximately six times as much television service can be provided at UHF as at VHF. To a considerable extent, however, the vision of 70 channels may partake of the nature of a mirage. The problem is to examine the situation quantitatively and determine how much is mirage and how much is real. One or two examples will show what is meant and will introduce the discussions which form the remainder of the paper.

One of the great differences between UHF and VHF is the factor of propagation, which is directly reflected in station coverage. The TASO data showed that with existing stations, the range of a UHF station is significantly less than the range of a comparable VHF station. If the VHF range is R times the UHF range, the area covered by the VHF station is R^2 times as great as that covered by the UHF

[1] Statement of FCC Commissioner Frederick W. Ford (at that time Commission Chairman) as reported in The New York Times, March 27, 1960.

station. Therefore, if the same total area is to be served by UHF and by VHF, and if the spacing between co-channel stations were the same at UHF and at VHF, the effective ratio of UHF to VHF channels would not be 70:12 but rather would be $70:12R^2$. Actually, the necessary co-channel spacing is somewhat less at UHF than at VHF, as the undesired interfering field, like the desired service field, is not propagated as well at UHF as at VHF. More information may be needed here but it probably is reasonable to accept the figures set forth in the FCC rules for minimum co-channel spacings, although further experience with UHF may (hopefully) prove that the required spacings at UHF may be reduced. The ratios of the FCC specified minimum co-channel spacings at UHF to those at VHF vary between 0.91 and 0.93 in Zones I, II and III. Taking an average ratio of 0.92, the effective ratio of the number of UHF channels to the number of VHF channels becomes $\frac{70}{12 \times 0.92^2 R^2}$ or $\frac{70}{12 \times 0.85 R^2}$. Again, the "taboos" set by the FCC further limit the number of UHF channels that can be assigned in any given locality. Some of these taboos are doubtless too strict. Nevertheless, such factors as receiver local oscillator radiation and receiver image response are basic in nature and do decrease the effective number of UHF channels available for assignment, say by a factor of T. This again reduces the effective ratio of UHF to VHF channels to

$\frac{70}{12 \times 0.85 R^2 T}$ or approximately $\frac{7}{R^2 T}$. The values of R and T do not have to be very great to reduce this ratio to the neighborhood of unity. If the ratio were unity, this would mean that the 70 UHF channels would serve the same total area as the 12 VHF channels at, incidentally, a cost for transmitters of approximately R^2 times as great.

These considerations appear to be too obvious to merit emphasis, but their importance must not be overlooked. _If_ the service provided by 70 UHF channels should prove to be no greater than that provided by 12 VHF channels, there would be no point at all (with respect to total coverage) in substituting an all-UHF television system for an all-VHF system.

Propagation

Within line-of-sight distances from a transmitting antenna, smooth-earth theory predicts that field strength at a receiving antenna will vary directly with carrier frequency. In areas where the terrain closely approached smooth-earth conditions (Lake Pontchartrain Bridge in New Orleans and San Joaquin Valley south of Fresno, California), the TASO data showed that these predictions were fulfilled. Unfortunately, most terrain is not smooth and, at the limiting ranges, most receiving antennas are not within line of sight from transmitting antennas. Under these practical conditions, UHF signals are lower, rather than higher, than VHF signals for the same transmitter power and antenna locations.

The extensive body of field strength measurements made by TASO was analyzed by A. H. LaGrone[2]. His conclusions were that at low VHF (Channels 2-6), the average field strength is one db below theoretically-predicted median field strength curves; at high VHF (Channels 7-13), four db below; and at UHF, 22 db below. Other analyses of the TASO data give direct comparisons between UHF and VHF field strengths (per kilowatt of effective radiated power) at identical measurement positions. These comparisons showed that when averaged over all positions measured by TASO, the low VHF band field strength exceeded low (lower half of band) UHF field strength by 7.5 db. Also, high VHF band field strength was 4.5 db above the low UHF band field strength. Curves published by the FCC show similar differences between VHF and UHF. For example, consider Figure 1 which was obtained by plotting the FCC propagation curves on the same sheet of paper[3]. This figure gives data taken from the F(50,50) curves for 600 and 1,000 foot transmitting tower heights and one kilowatt effective radiated power. The solid curves are for 1,000 foot tower heights and the dotted curves are for 600 foot tower heights. The differences in signal strength at various distances from the transmitter are quite striking.

It is true that there is some argument among engineers as to the validity of these curves, but these arguments are over minor numbers of decibels. When final curves are arrived at, if they ever are, they will differ only in detail from the present FCC curves[4]. Work is continuing on propagation studies by both private and public organizations. Nevertheless, the writers of this paper are willing to stand by the statement that as far as television allocations are concerned, the propagation information is essentially in.

These comparisons of median field strengths do not tell the complete story. Again, the TASO data showed the much greater variability of UHF fields

---

2 TASO Report, p. 413-447.

3 The data for the VHF curves were taken from FCC Document 60-766 (90114), Docket No. 13340 entitled Further Notice of Proposed Rule Making and dated July 1, 1960. The propagation curves attached to that document (from which the data of Figure 1 were taken) are dated June 20, 1960, and are entitled Television Channels 2-6, Estimated Field Strength Exceeded at 50 Percent of the Potential Receiver Locations for at Least 50 Percent of the Time at a Receiving Antenna Height of 30 Feet. The data for the UHF curves were taken from the propagation curves on page 411 of the TASO report. These curves, in turn, were plotted from data obtained from the so-called "Appendix A" curves of the FCC T.R.R. Report No. 2.4.16, dated October 22, 1956, for a frequency of 700 Mc.

4 For example, the authors do not believe that the same curves should be used for low VHF and high VHF. In particular, they believe that high VHF signals attenuate slightly faster than low VHF signals and can cite data to support this belief. The important point, however, is that the differences probably are trivial; for allocations purposes, the FCC curves are, in the authors' opinions, sound.

from the median values. When continuous runs were made over distances of 100 feet or more, the average variation of low VHF fields was 3.8 db; of high VHF fields, 6.2 db; and of (lower half) UHF fields, 9.4 db. This is in accord with the common experience that deep nulls are more frequent and more pronounced at UHF than at VHF.

Data taken by H. T. Head and given in the TASO reports show another serious problem at UHF, namely the deleterious effects of trees in the neighborhood of receiving antennas. These effects can be very serious in areas which are only moderately wooded.

Still another, and probably the most important, factor is that at and beyond the fringe areas, UHF field strength falls off much more rapidly and more completely than does VHF field strength.

There are three things that might help to overcome this propagation handicap as far as UHF is concerned. They are (1) an improvement in receiver noise figure, (2) the ability to make more efficient receiving antennas for UHF, and (3) the ability to run massive amounts of power in UHF transmitters. These things and various combinations of them have been cited as the solutions to the UHF propagation problem. Therefore, it is vital to realize that while all of them help, none of them or any combination of all three of them can be a cure-all. We shall examine the situations, with respect to receiver noise and receiving antennas, in detail in the following sections of this paper. The situation with respect to transmitter power depends upon the current state of the art rather than being truly basic in nature. The current status of television transmitting plants is presented in detail in Section 7, p. 58-111, of the TASO Report and need not be repeated here. Probably the only really significant change since the publication of the TASO Report has been the development of UHF transmitting tubes having greater operating life than those used formerly. This, of course, results in somewhat lower UHF transmitter operating costs than those reported by TASO. But it does not change the UHF power limitations indicated in the TASO Report.

Receiver Noise Figure and Various Amplifying Devices

There has been a lot of talk about parametric amplifiers and tunnel diodes curing UHF problems. Some of these amplifying devices currently look as

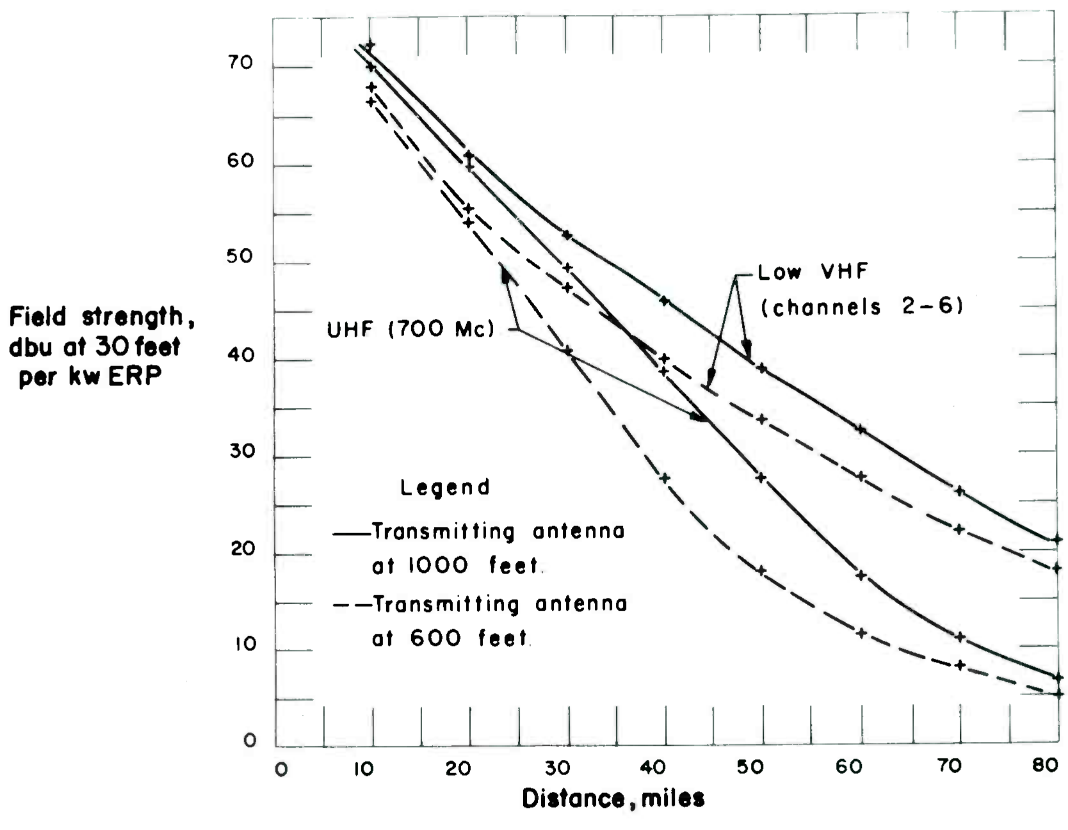


Figure 1 - VHF and UHF propagation curves for typical conditions.

though they may be too expensive for commercial UHF receivers but let's ignore this economic situation for the moment and suppose that they could be put in a receiver for nothing. The best of current UHF tuners have a noise figure from 10.5 to 12 db over the UHF band[5]. Parametric amplifiers and tunnel diode amplifiers have been built in the laboratory with noise figures of around three decibels, although this depends somewhat on the configuration of the circuit in which the device is used[6]. Therefore, the best improvement we could hope to get even using the best available amplifier is somewhere between 7 and 9 decibels. This is closely approaching the theoretically ultimate noise figure, and we will never do better than an improvement of 10 to 12 decibels.

It has become customary to rate a television picture as one of six grades. These six grades are excellent, good, passable, not quite passable, poor, and not usable[7]. Panel 3 of TASO did extensive work in an effort to establish the signal strength required for a given grade of picture. If field strength at 30 feet is taken as standard, it was found by TASO that for a passable picture at low VHF frequencies, a field strength of roughly 42 dbu was required. At high VHF frequencies, 52 dbu was required. At low UHF (Channels 14 to 40), roughly 57 dbu was required, and at high UHF (Channels 41 to 83), about 64 dbu was required. If we ever develop the ability to put essentially zero db noise figure amplifiers in television sets, the best we could hope for is that all four of these figures would become the same; and this could be achieved only if UHF receiving antenna efficiency were vastly improved. (See next section). There is room for argument in terms of a db here and there, but this means that the best we can ever do for a passable picture in a television set for the receiving antenna at 30 feet is to have a signal strength somewhere between 35 to 40 dbu. A more practical lower limit is probably about 40 dbu, and even this is based on the assumption that very low noise devices will be available. At this point, it is interesting to quote the report of the Airborne Instruments Laboratory where an extensive study has been made of the economics of this situation. Their conclusion is that from an economic point of view, the best that probably can be expected for several years to come is to have an optimum tuner with a noise figure of about 8 db[8]. If this is true, then at UHF around 45 dbu signal strength at 30 feet is required to get a passable picture (even if the receiving antenna problem is completely solved).

Receiving Antennas

One of the interesting and difficult things about antennas for UHF receivers is the following. For any given type of antenna, the effective voltage delivered to the receiver transmission line terminals falls off inversely as the frequency. This means that a half wave dipole subjected to a field of 1,000 micro-volts per meter at 100 megacycles gives five times as much voltage output as a half wave dipole subjected to a 1,000 micro-volt per meter signal at 500 megacycles. The first thought one might have is that since the half wave dipole at 500 megacycles is one-fifth as large, why not simply make it five times as big and perhaps this capture area factor can be overcome. If we could be sure that the UHF wave front was always perfectly coherent and if we could make and efficiently match the larger antenna, the capture area problem might well be overcome.

A study has been made of the coherence of UHF wave fronts by Brown, Epstein, and Peterson[9]. The conclusions were that in open smooth country, the theoretical antenna gains were approached. In shadowed locations, the gain was greatly reduced and in some instances was less than unity. Unfortunately, as pointed out by Brown, Epstein, and Peterson, it is in these regions of weak signal that the antenna gain is needed the worst. A great deal of work remains to be done in this area but again there are limits. It would be highly unlikely for any given size of antenna (appreciably larger than the half wave length at all frequencies concerned) to do better at UHF than at VHF. Practically, it is always true that one will do somewhat worse at UHF than at VHF with large antennas because of antenna efficiency problems. Nevertheless, a few db of improvement might be picked up here, in comparison with present designs. Considering both improved receiver noise figure and reasonably improved antenna design, the 40 dbu figure of the preceding section for a passable UHF picture becomes more realistically around 45 to 50 dbu.

Interference

External noise has an important influence on television reception, especially noise of an impulsive nature. Quantitative data are rather scarce, but all available information shows that the effects of impulsive noise are much less at UHF than at VHF. This is due to two factors. The first of these appears to be a rather slow, but nevertheless steady, decrease in the magnitude of impulsive noise fields as frequency is increased. The second is the fact that because of the characteristics of receiving antennas, transmission lines and receivers, a higher signal field strength is required at UHF than at VHF for pictures of comparable quality. Thus the ratio of signal strength to impulse noise strength is more favorable at UHF than at VHF if the UHF picture is usable at all. This immunity of UHF receivers to impulse noise (or any other externally generated noise) will decrease somewhat as UHF tuner noise figures are improved. Nevertheless, greater immunity

5 Evaluation of Receiving Techniques Suitable for UHF-TV Reception - Airborne Instruments Laboratory Report No. 8432-1 to the Federal Communications Commission, August, 1960; page 31.

6 Op cit, p. 13, 19

7 This practice was established by the first National Television System Committee and was found useful by the second National Television System Committee and the Television Allocations Study Organization.

8 Op cit. p. 35

9 Comparative Propagation Measurements; Television Transmitters at 67.25, 288, 510 and 910 Megacycles. RCA Review, Vol. 9, No. 2, Pages 177-201, June, 1948.

to impulse noise is a plus factor for UHF.

A second type of external noise also favors UHF operation. This is cosmic noise or galactic noise. Here again, consistent quantitative data are lacking but it is certain that cosmic noise should be entirely negligible at UHF while it may well be very significant at the lowest VHF channels.

Echoes or ghosts or multi-path effects appear to be less bothersome at UHF than at VHF, although the TASO data indicate that they are not serious problems at any frequencies except in large cities. In cases where multi-path effects are severe, the smaller size of a highly directive UHF receiving antenna permits the easier alleviation of the difficulty at UHF than at VHF. Airplane flutter is a special case of multi-path interference. It is frequently very bothersome at VHF, especially in the vicinity of large airports, but it is for all practical purposes non-existent at UHF. This again is a significant plus factor for UHF.

Confirmation by Field Study

The foregoing factors are summarized in the TASO report from which the following table was taken. Critical distance was defined as that distance at about which, on the average, with currently used effective radiated powers and transmitting antenna heights, service fell off rapidly.

Frequency Range	Channel Range	Critical Distance in Miles
Low VHF	2-6	65
High VHF	7-13	55
Low UHF	14-40	40
Medium and High UHF	41-83	30

One may, if he wishes, quibble about a mile or two here and a db or two there, but the fact remains that the area served by a UHF transmitter is very substantially less than that served by a lower power VHF transmitter.

Things That Can Be Done at VHF

Another aspect of the television allocation problem is that of what might be done to increase the service rendered on the present 12 VHF channels. One obvious approach is to consider what might be done to decrease the spacing between co-channel stations and between adjacent channel stations. This would permit additional "drop-in" assignments. The new stations would serve the areas in their immediate vicinities but would increase the amount of interference in the areas served by near-by stations. These near-by stations would, of course, also cause interference in the areas served by the new "drop-in" stations. There are, however, certain techniques which could be employed to reduce the amount of interference caused by and to stations at reduced mileage separations. These techniques should be used judiciously and only after a consideration of the circumstances existing in individual cases. Certainly few, if any, engineers wish to see television broadcasting deteriorate (as some feel that AM radio broadcasting has deteriorated) through the use of ever more closely packed station assignments. Judicious use of directional transmitting antennas and perhaps also of very precise carrier frequency offset could permit reductions in co-channel spacing in at least some instances. Likewise, certain changes in adjacent channel allocation practices could result in a reduction in adjacent channel station spacing.

The Supplementary Report of TASO presents the results of the tests of directional transmitting antennas at WBZ-TV and WKY-TV. While these tests admittedly did not cover all types of antennas, all channels and all types of terrain, they did show quite conclusively that under the conditions under which these tests were made, directional antennas with a 15 db null worked well. These antennas performed in the field in accord with predictions made by theory and with predictions made from tests at experimental antenna test sites. TASO quite conservatively, and quite wisely, recommended that <u>if</u> directional antennas were to be used, certain specified auxiliary test antennas should be installed and certain specified tests should be made of the installed directional antennas to insure their proper operation. These conditions are not burdensome and their use would permit the performance of each directional antenna to be determined both when originally installed and thereafter as necessary.

The one major unresolved problem is that of the amount of null fill-in, or reflections into the null from reflecting surfaces in the direction of high field strength, which would be experienced in rugged terrain or in the case of injudiciously located antennas in the neighborhood of large cities. It seems reasonable to expect that this difficulty can be minimized through judicious choice of antenna sites relative to the area served, the area protected and the terrain. This emphasizes the necessity of considering the use of directional transmitting antennas on a case-by-case basis. Moreover, the performance of a directional antenna in every instance can be determined through the use of the methods recommended by TASO.

There appears to be no good reason why the FCC should not proceed to authorize the operation of a few carefully-chosen television broadcasting stations at reduced or "sub-standard" co-channel spacing with these stations using directional transmitting antennas with nulls not exceeding 15 db to protect the service of neighboring co-channel stations[10]. The results obtained from the operation of a few such stations would be strongly indicative of what can be achieved through the use of directional transmitting antennas and the FCC would then be in a position to proceed intelligently in a study of the extent to which the television allocations problem could be relieved through the use of this technique.

The second technique having an implication on co-channel spacing is that of very precise carrier

10 Essentially this has been done by the FCC Report and Order of August 3, 1961, which was released after this paper was written.

frequency offset. By this is meant operation of television broadcasting stations geographically near-by, with carrier frequencies offset by carefully selected amounts of the order of a few hundred cycles with a frequncy tolerance of plus or minus one cycle. The need for this technique arises when four neighboring television stations are located at minimum standard spacings. With normal nominal carrier offsets of -10, 0 and +10 kc, it is obvious that two of the four stations must operate on the same nominal frequency. Laboratory tests made by TASO indicated that if very precise carrier frequency offset is used for stations operating nominally on the same frequency, the interferring effects would be no more worse than those existing between adjacent precise carrier offset (±10 kc with a frequency tolerance of ±5 cycles) stations. The use of very precise carrier frequency control would not lead directly to reduced co-channel spacings, but it would give assurance that interference between "second-ring" co-channel stations would be no worse than interference between adjacent stations. The achievement of very precise carrier frequency control at VHF appears to be technically possible, though somewhat expensive.

The general problem of adjacent channel interference has been studied by the Iowa State University Engineering Experiment Station under the sponsorship of the Association of Maximum Service Telecasters. The purpose of the study was to determine just what ratio of undesired sound carrier to desired picture carrier could be tolerated for lower adjacent channel interference and what ratio of undesired picture carrier to desired sound carrier could be tolerated in upper adjacent channel interference. Again a six point scale was used as established by the first NTSC in terms of rating picture quality. The details of this work are in a report submitted by AMST to the FCC in Docket 13340. The results are essentially as follows.

For a passable picture on the average, the lower adjacent sound carrier should be no higher than 12 decibels above the desired picture carrier (in terms of measured field strength at 30 feet). For upper adjacent channel interference, if the picture criterion is taken as a passable picture, the upper adjacent undesired visual carrier should be no greater than 26 decibels above the desired sound carrier (same field strength measuring conditions). In both cases, it is the beat between the sound and picture carriers appearing in the desired picture that is objectionable. It is interesting to note that this same problem has been studied by Jansky and Bailey, Radio Engineering Consultants of Washington, D. C. The figures that they use are 10 db for lower adjacent channel interference and 24 db for upper adjacent channel interference. Thus from a practical point of view the two results are in essential agreement. The Jansky and Bailey report[11] was also submitted to the FCC under Docket 13340. It was found in both studies that when adjacent channel station spacings are reduced to 40 miles as proposed by the Federal Communications Commission, there are considerable increases in undesired interference. This means that in order to add a station at this spacing there will be considerable degrading of other television services.

An interesting possibility arises at this point. Suppose adjacent channel stations instead of being spaced 40 miles were spaced zero miles. That is, suppose their antennas were put on the same tower. Further suppose that the radiated powers were equal for the visual carriers but that the lower adjacent sound carrier was dropped about seven decibels. It has been shown in at least two cases that to drop the sound carrier seven decibels has essentially no effect on the coverage of the station, especially when its coverage is interference limited[12]. It will then be found that essentially nowhere in the coverage pattern of both stations will the undesired to desired signal ratios exceed those allowable for a passable picture. The difficulty of adjacent channel interference comes when one of the stations is very much stronger than the other station. Nowhere in the coverage area of both stations will this occur[13].

The possibility of decreasing sound power to reduce lower adjacent channel interference in conventionally spaced adjacent channel stations should not be overlooked. If adjacent channel spacings are reduced appreciably from the present standards, certainly the increased lower adjacent channel interference in interference limited situations could be partially or wholely overcome by reducing sound power. In the opinion of the authors, a reasonable reduction in sound power, say of the order of seven decibels below present standards, could be made without adversely affecting the effective coverage of a television station[14].

Things That Need to Be Studied if Television Is to Be Moved to UHF

In the event that all television were switched to UHF, the success or failure of such a move would be determined primarily by four major factors. These factors are:

1. The practical limits of transmitter powers that can be achieved.

2. The ultimate limits in receiver noise figures that can be economically achieved.

3. The degree to which the receiver antenna capture area problem can be overcome. This means that study of the coherence of wave fronts and the physical design of large antennas for UHF must be undertaken.

4. The success with which a network of on-channel boosters can be made to operate surrounding a given UHF high power transmitter. On-channel boosters rather than

11 Memorandum on Adjacent Channel Television Interference.

12 TASO Report, p. 230-236.

13 It might be necessary to put attenuation pads in receivers located close to the transmitters to avoid intermodulation in the receiver tuner.

14 A favorable attitude of the FCC toward such a proposal is indicated in FCC Report No. 3848 entitled Comprehensive Actions to Foster Expansion of UHF TV Broadcasting, dated July 28, 1961.

translators are desirable because if translators are used, the 70 channel allocation will become a mirage.

Even if all-UHF television is 10 years away, these things should begin to come under intensive study. It is probably true that the first and second items (those of transmitter power and receiver noise figure) can be fairly well established now. Items three and four present as yet unanswered questions. The success or failure of all-UHF television could easily hinge on these two items.

Educational Television

So far, no mention has been made of one question which is really of basic importance. This is the question as to whether or not the public really needs additional television service. This is a question of basic policy. If the public really needs, say, double the amount of television service which it now receives, there should be no thought of abandoning either the UHF or the VHF region. Both should be used as both would be needed.

There may well be many who would say that, particularly in view of programming trends, there is no urgent need for more television service and therefore no need for more usable channels. In this case, it might be concluded that certainly the television broadcasting industry could relinquish some UHF channels or some VHF channels or some of each. One should not, however, overlook the possibility of a greatly expanded use of television broadcasting for educational purposes. Some leaders in the industry have predicted that in the not far distant future, the needs of educational television for space in the frequency spectrum will equal, or even exceed, those of commercial television. It would appear, therefore, that since the expansion of both commercial and educational television is a distinct possibility, the FCC should continue to reserve both the present 12 VHF and the present 70 UHF channels for television broadcasting.

Conclusions

This paper has presented some facts that the authors hope are not too generally drawn and yet are shorn of supporting details for clarity and brevity. Taken together, they present no easy allocations solution; but the authors are firmly convinced that while subsequent tests will provide much useful information, the allocations problem will never become easy. It will probably never even become equitable. The fact remains, these are the practical technical limitations in which an allocations plan must be developed. It is freely acknowledged that technical facts alone do not provide a full basis for allocations but neither can they be ignored.

NEW YORK UHF-TV PROJECT OF THE FCC

Arnold G. Skrivseth, Project Chief
Office of Chief Engineer
Federal Communications Commission
Washington 25, D. C.

SUMMARY

The Federal Communications Commission is in the process of conducting a test of UHF television in New York City to determine the technical and economic feasibility of using this band to provide satisfactory television service to large cities with special emphasis on the canyon areas of such cities. This paper summarizes the Project organization and provides a progress report. Since the transmitting installation has just been brought into a near completion stage, and the Project will last for another year, this is a discussion of the method of attack rather than a report of results obtained.

- - - - - - - - - -

The Television Allocations Study Organization (TASO) did not study certain facets of the UHF television problem. Among these are the following: The utility of a UHF station in a canyon-like city, the use of circular polarization, field surveys by use of television picture quality coordinated with field-strength, and multicasting. The Commission considered the utility of a UHF station to serve a canyon-like city to be important and made a request for funds to conduct such a study in the New York City area. A sum of $2,000,000 was made available in the appropriation bill of the 86th Congress, which sum was designated to remain available until June 30, 1962. Since that time the 87th Congress has extended the time until December 31, 1962 at the request of the Commission.

Within the Office of the Chief Engineer there has been set up a UHF-TV Project unit which has the assignment of administering this study. The work of this unit is divided into four main fields, namely: transmitting, receiving, observations and measurements, and analysis with an engineer responsible for each. In addition, industry advisory committees have been organized in similar fields so as to obtain the best possible ideas and information on all phases of the Project. An additional industry advisory committee has been set up for general guidance, thus making five industry advisory committees. The total membership in these industry advisory committees numbers over 100. Meetings of each of the various committees have been held at least once in addition to a recent joint meeting. The committee meetings have served as fruitful sources of advice as well as forums for discussion of the various aspects of the Project.

A 50 kilowatt transmitter has been installed in the Empire State Building in New York City under lease from RCA. This transmitter has been checked out and is now operating on Channel 31 (572-578 Mc).

The main antenna being installed on the Empire State Building was selected after model testing of several possible designs. This antenna was manufactured by Melpar, Inc. and will be discussed in the following paper. Installation is expected to be completed by about November 1, 1961.

In order to test the characteristics of circular polarization as compared with horizontal polarization on UHF a temporary horn antenna is being installed in a window of the Empire State Building. This antenna will also be discussed by the next speaker. The antenna was originally scheduled for delivery early in September but now a date of early October is projected.

The original plans for this Project included a second station on a different frequency to test multicasting, as well as to make observations and measurements on a higher frequency. However, costs for the main station have been higher than originally estimated, so insufficient funds are available for a full-fledged multicasting experiment. In addition, an engineering analysis of the tower at Alpine, N. J., which was proposed to be used, showed that additions could not be made to this tower without excessive costs in modifying the existing structure. It may be possible, after operating costs are more fully known, to engage in a small scale multicasting experiment using TV translator equipment. However, it will be a month or two before such a determination can be made.

During the initial circular polarization tests, programming of the station will consist mainly of test patterns and station identification slides. As time progresses it is expected that some regular programming will be used on the directional antenna. Near the end of October the main antenna should be installed and in operation. At that time it is expected that programming will consist of duplication of programs from six of the New York VHF stations as well as some independent programming originated through the facilities of the City of New York. From the point of view of the Project group, the programming of this station is merely a means of obtaining a signal that is modulated with a picture that is representative of the type viewed by the public. New York City is expected to conduct program experimentation, but this is to remain secondary to the technical requirements of the Project.

100 monochrome table model receivers have been purchased for location throughout the area within 25 miles of the Empire State Building. 15 portable monochrome receivers have been purchased for use by the measurement crews in determining picture quality prior to making measurements. 10 color receivers will be used for obtaining as much information regarding color reception as possible with this limited amount of equipment. These receivers will have a noise figure on the UHF band in the vicinity of 10 db. In order to simulate the performance of a UHF set that might have a lower noise figure, single channel amplifiers with a noise figure of 5.5 db are being purchased for use in locations where it seems likely that better noise performance would improve the reception.

The locations for installation of the receivers and for making measurements within 25 miles of the Empire State Building are being selected on a statistical basis by the United States Census Bureau. These locations are selected in a random manner from existing data available to the Census Bureau. The initial contacts with the householder will be made by the Census Bureau to determine whether or not the installation or measurements will be permitted on the premises. If a given site is not available, a substitute location will be selected under predetermined rules for such substitution.

Portable field-strength meters have been contracted for with Smith Electronics, Inc. These meters cover both the VHF and UHF television bands. Although they are not intended to be as accurate as the usual precision type of field-strength meter, the reduction in weight to about 15 pounds results in a much more practical type of instrument for carrying in and out of houses, on roof-tops and the like. The FCC Laboratory has designed and built tunnel diode voltage calibrators for channels where measurements will normally be made. The meters used in conjunction with these calibrators should provide data which are sufficiently accurate for the purposes of the Project.

A contract has been signed with the Jerrold Electronics Corporation to make observations and measurements. They will supply 11 teams of two men each along with the required supervisory and office staff. These teams have undergone training in New York with apparatus to simulate various degradations of pictures both as to kind of degradation and its amplitude. This training should result in reasonably uniform judgments as to picture quality, between the various teams.

The method of approach at a given measurement location is planned to be as follows: A measurement team (2 men) will arrive at a given location. This location will be one previously determined by the U. S. Census Bureau and at which the office staff of Jerrold has previously made an appointment to obtain access. The team will use a portable television receiver, a portable field-strength set, a standard antenna for VHF and a standard antenna for UHF along with miscellaneous accessories such as cables, baluns, etc. The best possible picture will be obtained indoors for any practical location of an indoor antenna. Measurements will then be made of the voltage obtained on the receiving antenna in use. These observations and measurements will be made on Channels 2, 7 and 31. The antenna used for VHF will be a standard type of indoor antenna. On UHF a dipole in a corner reflector will be used.

Wherever possible, the measurement crew will try outdoor locations with the same equipment except that on VHF a 3 section travelling wave antenna will be used since there will be sufficient space for such an antenna. Although it is realized that many roof-tops are not accessible for one reason or another, an attempt will be made to obtain access to as many of the roof-top locations as possible.

Data sheets have been prepared and the crews will note thereon the picture quality with respect to thermal noise, man-made-noise, and ghosting. In addition, displacement and estimated amplitude of ghosts will be noted. These data will be taken for each location and each of the three channels.

The measurements noted above will be made at approximately 5,000 locations within a radius of 25 miles of the Empire State Building. Half of these locations will be on Manhattan Island since the prime reason for conducting this study in New York City is because of the canyon-like nature of many portions of Manhattan.

At approximately 1,000 of the locations, table model television receivers will be installed in addition to making the measurements noted above. Since we have only 100 of these receivers, this means that each receiver will be moved to approximately 10 different locations. The installation crews will start with the simplest possible antenna arrangement and increase complexity of the antenna installation until the best possible picture is obtained up to grades 1 or 2 of the TASO scale. Data will be taken on the results obtained with the various complexities of antenna installations. The installation will include both VHF and UHF and either the same antenna or a different one, will be used depending upon the needs of that installation.

The 10 color receivers will be installed in a manner similar to the monochrome receivers except that, since they are so limited in number, they probably will be moved more frequently. In addition, since in New York most of the color programs at present are on Channel 4, this Channel will be used for reference with respect to those color programs that are also on Channel 4.

It may appear strange that VHF observations and measurements are being made in a project designed as a UHF experiment. The logic of this is quite simple. Since no broadcast service is perfect, it can be assumed that UHF will not be perfect. With this in mind, a reference is needed to determine what kind of service is adequate or tolerable for existing viewers. As a result, the same kind of observations and measurements will be made on both VHF and UHF, at the same locations, so as to determine how much better or how much worse UHF is than that service which the viewers now obtain. It would not be proper to compare a new UHF installation with an existing VHF installation since there is no way of knowing the state of repair of the existing installation. We are, of course, open to some criticism that our installations will all be new installations. However, we are treating both bands alike and from existing information, such as that from TASO, deterioration of installations can be added as a separate factor. You will note that we have selected a transmitting site as identical as possible with the VHF stations so as to make the above comparisons on a sound basis.

Data will soon be obtained from the observations and measurements. These data are ultimately expected to be transferred to punch cards. The actual mechanics of this transfer have not yet been worked out since we desire to obtain samples of data for review by data processing people prior to arriving at the best method of processing the data.

The location selection is being made in such a manner that the entire area under consideration will be sampled approximately each month. In this manner a rough idea of the overall result should be obtained early in the project, with continuance of the project resulting in increased accuracy.

Beyond a distance of about 25 miles from the Empire State Building observations and measurements will be made in the more conventional manner of using a mobile vehicle with a pneumatic mast. This vehicle will also be used within the 25 mile circle in an attempt to obtain some correlation between mobile type measurements and those made at the fixed locations.

It is hoped that a check of the antenna patterns can be obtained by roof-top measurements on tall buildings, compared with the data obtained from the model tests of the antennas. If these spot checks show satisfactory correlation, this should be sufficient to prove the antenna patterns. If they are unsatisfactory, it is expected that other means, such as helicopter measurements, will be used to check the antennas.

In order to make long range measurements over a relatively long time, recording installations are being made at Princeton, N. J. (by RCA), Philadelphia, Pa. and Laurel, Md. The data obtained from such installations will be added to the other propagation data which have been collected by the Commission.

MODULAR SEMI-CONDUCTOR TELEVISION BROADCAST TERMINAL EQUIPMENT

Donald E. Quinlan
Manager Video Products Engineering
Visual Electronics Corporation
New York, N.Y.

Summary

In order to realize the advantages which solid state devices may bring to television broadcast operations, a program has been undertaken to provide solid state modular components in building block form for television broadcast terminal equipment, featuring low power consumption, small size and great reliability.

The basic 5 1/4 inch rack mount frame containing DC power and 24 video distribution amplifier outputs or 48 pulse distribution amplifier outputs will be described.

Other modules to be described will include a clamped sync and blanking adder, a mixer amplifier, a video gain and output amplifier, and video switching matrix cross points.

A typical television broadcast master control package from these modules will be discussed briefly.

Introduction

The position of transistors in the electronics industry is undeniable. They have become accepted by manufacturers of all types of commercial, industrial and government equipment. It is becoming common place for the public to speak of transistorization and miniaturization. Even the early skeptics have been converted.

Why has this relatively rapid change taken place? Because transistors have the outstanding features of low power consumption, small size, low heat dissipation, long life, and proven reliability - features that cannot be overlooked in electronic equipment design and procurement.

The broadcast industry, the founder and long the leader in electronics has lagged behind in the use of transistors. Now, however, many broadcast operators desire to have the advantages of this miniature component, and semi-conductor designs based on proven circuitry are appearing. One of the most logical types of television broadcast equipment to be transistorized is terminal equipment. Here, the use of multiple pieces of the same type of equipment makes the advantages of transistors obvious.

Semi-conductor B plus supplies have been available for some time and now are standard. Audio equipment has been converted to transistors, and these new designs have previously been reported. There is now available a complete line of transistorized, plug-in module construction, TV terminal equipment. Today, we will describe several of these new units of video terminal equipment that we believe will be of interest to you. These include video and pulse distribution amplifiers, mixer amplifiers, sync and blanking adders, and video switching cross points. Typical of the modular packaging that this terminal equipment exhibits is the 5 1/4 inch rack mount frame, the shielded individual amplifier cards, the card extender for circuit access during operation, and the plug-in semi-conductor power supply for a video and pulse distribution system.

Video and Pulse Distribution Equipment

See Figure 1.

In most stations at least one rack is used for video and pulse distribution. Add to this the power supply required to operate this vacuum tube distribution equipment and you can visualize the power, heat and space going to waste.

When we think of each video output being only 13MW and each pulse output being only 300MW, and yet in most cases kilowatts are used to distribute only a few of these signals, we are really quite startled. It is a good thing our transmitters are a little more efficient than our distribution equipment.

By transistorizing this equipment in a basic 5 1/4 inch rack mount frame containing its own power supply we can now have 48 pulse outputs at an input power of approximately 30 watts or we can have 24 video outputs with an input power of 15 watts. If we so desire, pulse and video distribution amplifiers can be put in the same frame utilizing the same power supply.

It is quite obvious that transistors can help us save space, power and air conditioning costs.

Video Distribution Amplifier

Figures 2 & 3.

The video distribution amplifier is constructed as a plug-in module. Some of the features of this unit are; separate power regulation to eliminate cross talk in the power supply, high input impedance to facilitate bridging, separate adjustments for tilt, mid frequency and high frequency compensation to obtain extremely close tolerances of the D.A.'s so cascading amplifiers does not degrade the video signal, input power of less than 1 watt, frequency response extending beyond 15mc, to prevent overshoot due to phase shift, plus all the normal requirements of a video distribution amplifier as to gain, gain control, multiple outputs, differential gain and phase.

The high input impedance of this unit is accomplished by two emitter followers in series on the input. This gives the highest possible input impedance over the complete bandwidth without a feedback loop which is frequency selective and only operates as a high impedance when the unit is on. The third stage is a normal video amplifier with a high frequency adjustment in its emitter. The point of compensation is set by the value of the emitter resistance and the value of the trimmer capacitor. In this stage the effective start of compensation is at 4.5mc. The next stage is the same except the point of compensation starts at 1.5mc and is effective in the range of 1.5 to 6 mc. This control is to compensate for that last .1db in frequency response. The tilt control varies the amount of low frequency compensation applied to straighten the vertical interval.

The output stage is identical to its vacuum tube equivalent used in video work for years. The video signal is brought into the base of the top transistor and drives the output load as an emitter follower. An opposite signal is developed across the collector load and is injected into the base of the bottom transistor. The output of this drives the load in the same phase as the top transistor of the cascaded pair. Since the driving impedance of this output stage is less than 2 ohms, two outputs can be taken from this point by using series resistor matrix to give a sending and termination of 70 ohms.

The power regulator is incorporated in each individual amplifier primarily to eliminate cross talk. This provides better isolation than a power supply with an internal impedance of less than 1 ohm. The reference voltage as well as the supply voltage provided by the plug-in power supply. The individual amplifier regulator acts as an emitter follower with its output just slightly lower than the reference. The DC supply voltage can vary up to ± 30% without change in the regulated voltage to the amplifier. This will allow the AC line to be extremely poor.

Pulse Distribution Amplifier

Figures 4 & 5.

The pulse distribution amplifier is constructed in a similar manner to the video distribution amplifier and can be plugged into the same frame. It features many of the same characteristics as the video D.A.: Individual power regulator, high input impedance, slow roll off in bandwidth, tilt adjustment and an input power of only 2.5 watts.

The first four stages are identical to the video DA except no emitter peaking is used, thus allowing a gradual fall off at 10mc. The collector load is low to give a low sending impedance to the output stages. The fourth stage is DC coupled to the output stages with the bias point set by the fourth transistor and its load. The tilt control is a variable AC impedance to allow vertical tilt to be adjusted either positive or negative. The silicon output transistors are emitter followers with an internal impedance of approximately 40 ohms. A series of resistors is used in the output to give a sending impedance of 70 ohms.

The power supply regulator is used on the pulse DA to eliminate cross talk as in the video DA, although the DC supply voltage may vary only ± 20%.

Switcher Schematic

Figure 6.

The same transistorized modular packaging arrangements as used in the video distribution amplifiers can be applied to video switchers.

This drawing shows a typical video switcher with 6 non composite video inputs with one input for black. Two of the output busses feed the mixer amplifier. In this case, the fader output has blanking and sync added.

The other three output busses feed sync and blanking adders to provide composite video.

The latter part of the switcher has mixer reentry and three other busses as composite inputs. The preview, take and video tape output busses feed into output amplifiers. The switcher shown has 50 cross points which are diode controlled.

Clamped Sync and Blanking Adder

Figure 7.

This unit was designed to take a relatively low level non composite video signal input clamp it, add 5% set-up to blanking, add sync, and deliver it as a composite signal.

The video signal is brought into the grid of the first video stage which is a nuvistor. The nuvistor is used here because it has a very high input impedance. We find that for very high impedance circuit requirements such as a clamp, the nuvistor have an advantage over transistors. The video signal is clamped by a four diode clamp that is driven by equal and opposite pulses from a phase splitter. The output of the video amplifier is mixed with blanking which is inverted by NPN transistor. This blanking is clipped and 5% is not clipped. At this point sync is added by another NPN transistor to form the composite video signal. The composite video signal is now amplified and sent to the video output stage which is an emitter follower. This output is not required to be as elaborate as the one used in the video distribution amplifier since only short cable runs are involved.

Mixer Amplifier

Mixing of two non composite video inputs is accomplished by adding a second 4 diode clamp and video amplifier to the clamped, sync blanking adder circuit.

Mixing cut-off is controlled remotely by biasing the lower junction of the 4 diode clamp.

Blanking and sync may be inserted to produce a composite output or omitted to produce a non composite output.

Video Switching Cross Point

Figure 8.

The video input is tapped down by two resistors in series. This tap is low to isolate any possible loading that takes place when the switch is on in another output buss.

The two diodes that are in series back to back are the actual switching diodes. If the voltage applied at the two cathodes is positive the diodes are cut off, or effectively a high resistance in the order of 2 meg ohms is created. If the voltage applied at the two cathodes is negative, the two diodes conduct and pass the video signal on to the load resistor.

In the off condition a low impedance circuit is provided to the cathode junction of the switching diodes to short out any signal to ground. This is a diode biased into its conducting state by the positive voltage applied through the series resistor to its plate. The control voltage for this video cross-point can come from a mechanically interlocked push button, a flip-flop which is controlled from a momentary contact push button or a flip-flop that is triggered from a vertical drive locked signal.

Switcher Package

Figures 9 & 10.

This slide shows the rear of the unit described by the switcher schematic.

At the top of the unit the switching cross point modules may be seen. There are eight stacked four to each side.

At the rear of the unit are the seven plug in amplifiers on the right are the three clamped sync blanking adders. At top left is a mixer sync and blanking adder and below are three output amplifiers.

All signals enter and leave via coax at the rear of the unit. The power and remote control cables are all on screw locked connectors.

Size Comparison Vacuum Tube Vs Transistor Terminal Equipment

Figure 11.

This slide shows the size comparison between a typical group of vacuum tube terminal equipment and its transistorized equivalent. The space, power, and heat savings are immediately obvious.

Even more important advantages are gained in actual operation. Vacuum tubes age and deteriorate constantly. The heat generated by vacuum tubes affects the life and stability of associated components. This means gain changes, pulse width changes, frequency response changes and many other slow changes which must be compensated for by manual maintenance. Transistors have an extremely long life with 95% of their failures within the first 50 hours of operation. By "cooking in" the semiconductor modules for 48 hours in their final manufacturing test, these units provide stable operational equipment of a new order for the television master control.

With this new semi-conductor equipment, prices are down, performance is up, and maintenance is at a minimum.

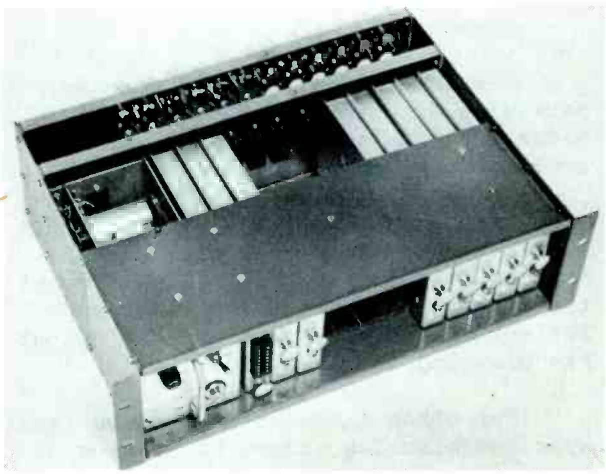


Fig. 1 - Video & Pulse Distribution Equipment.

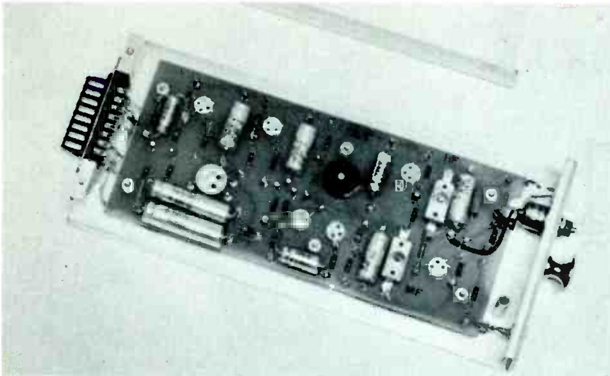


Fig. 2 - Video Distribution Amplifier.

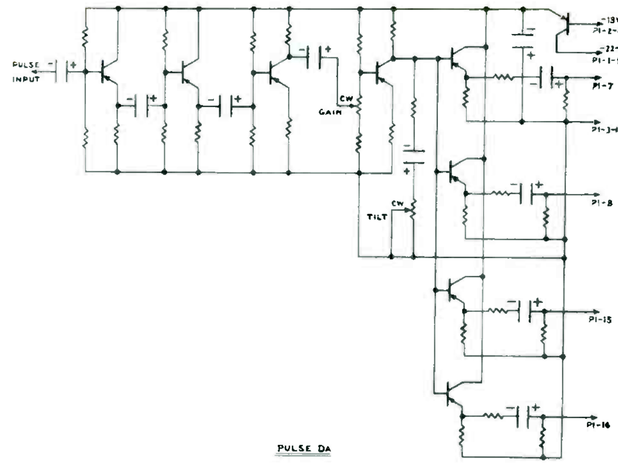


Fig. 5 - Pulse Distribution Amplifier.

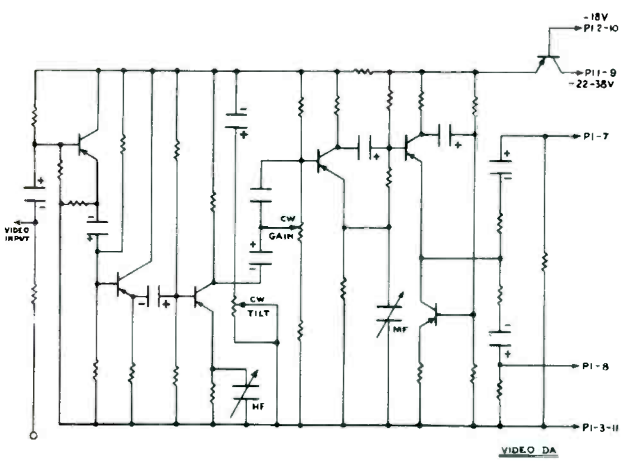


Fig. 3 - Video Distribution Amplifier.

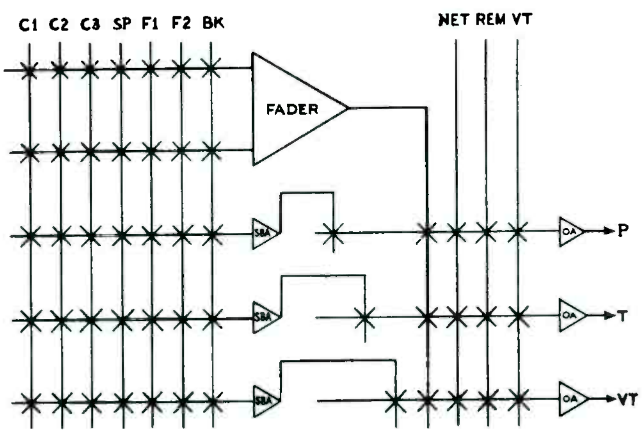


Fig. 6 - Switcher Schematic.

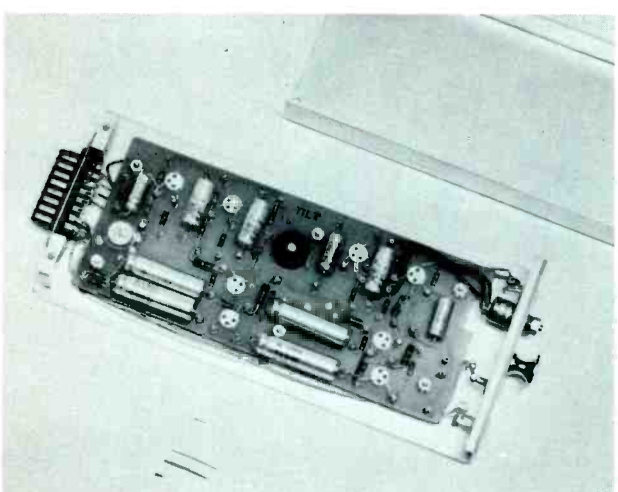


Fig. 4 - Pulse Distribution Amplifier.

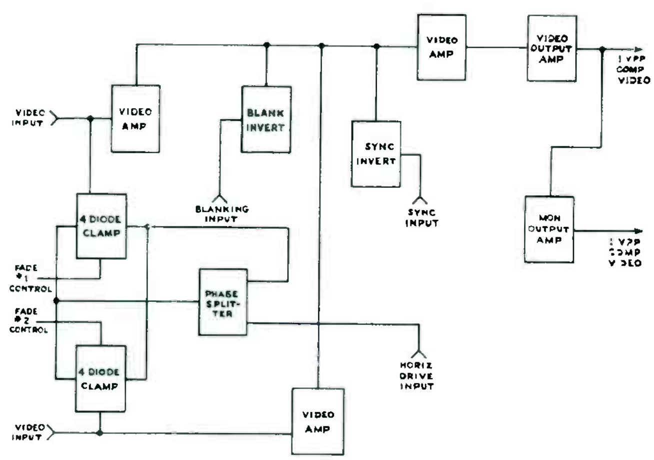


Fig. 7 - Clamped Sync & Blanking Adder.

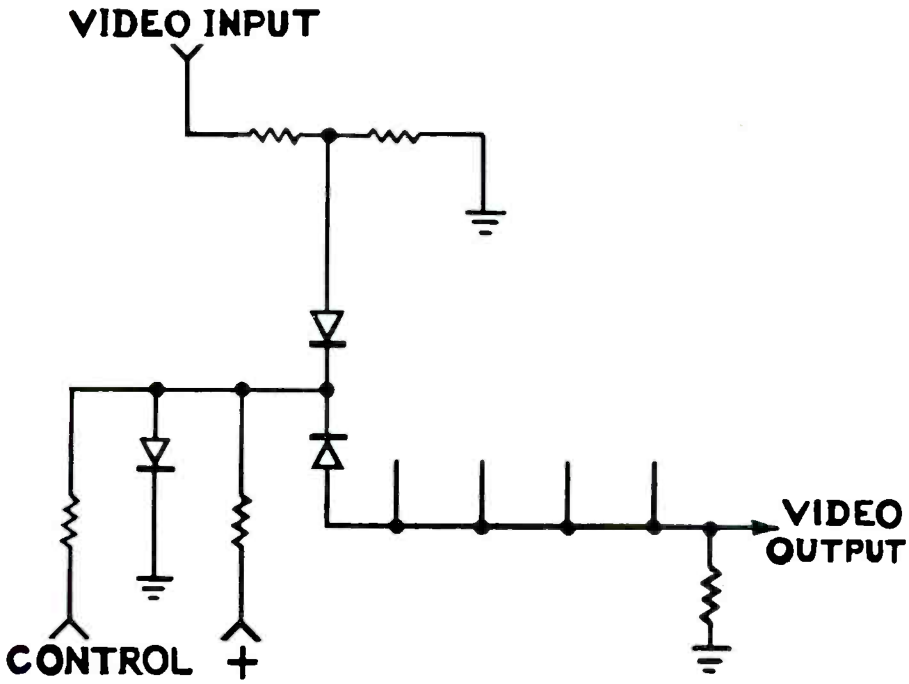


Fig. 8 - Video Switching Cross Point.

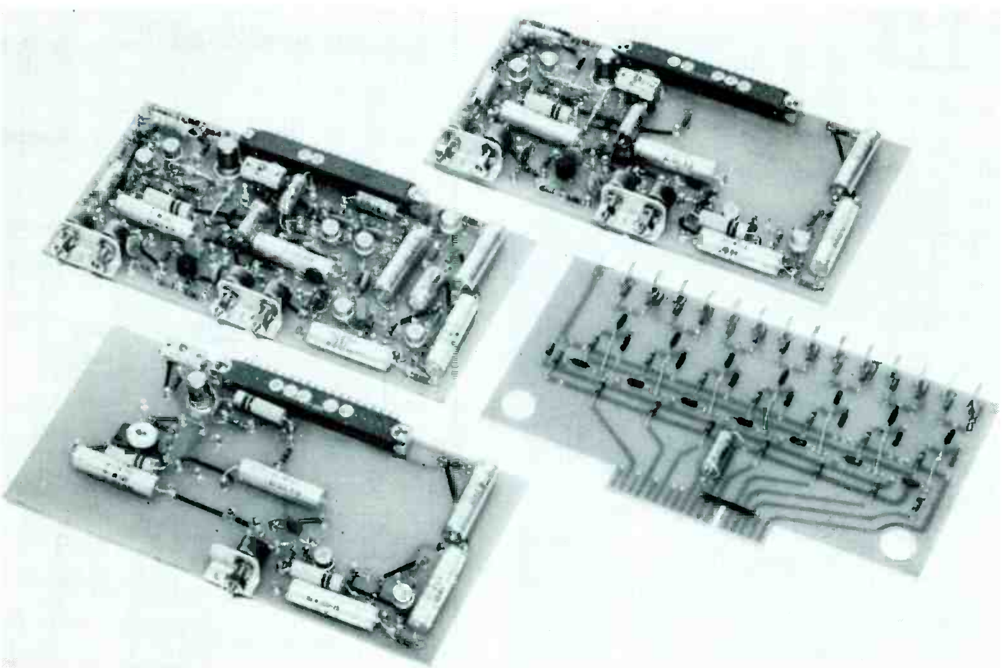


Fig. 9 - Switcher Modules.

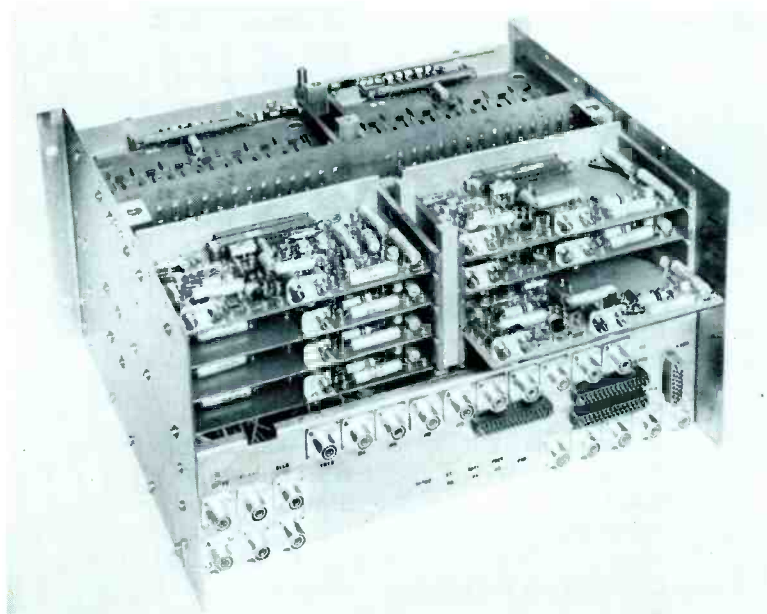


Fig. 10 - Switcher Package.

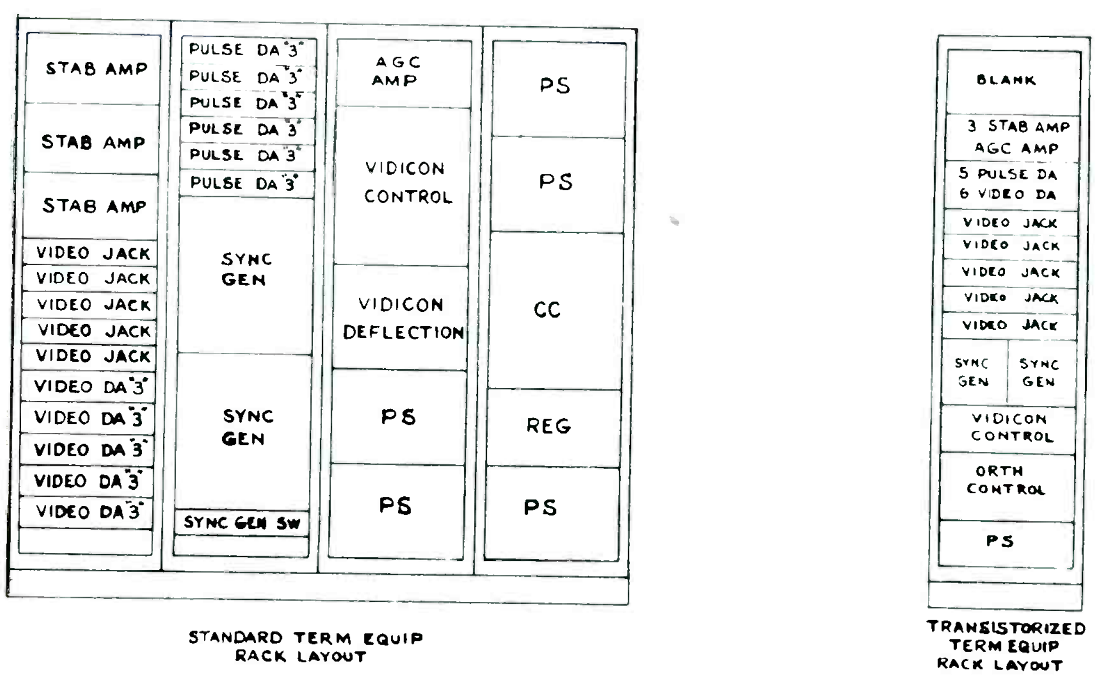


Fig. 11 - Size Vacuum Tube Vs Transistor Terminal Equipment.

PROFESSIONAL GROUP ON
BROADCASTING (G-2)
MEMBERSHIP ROSTER AS OF
NOVEMBER 24, 1961

REGION 1

Binghamton Section

Greene, T. A.
Hallinan, Charles

Boston Section

Adams, G. J.
Alford, Andrew
Arthur, G. M.
Bickford, W. J.
Bliss, Z. R.
Britto, J. D.
Brown, C. R.
Browning, E. A.
Bushnell, R. R.
Cestaro, A. T., Jr.
Crocker, D. C.
Dandreta, William
Day, P. F.
Dix, T. S., Jr.
Edwards, L. C.
Ellsworth, E. A., Jr.
Halle, C. F.
Hauser, W. H.
Hayden, P. C.
Hodgkins, R. W.
Howe, D. W., Jr.
Hurd, P. A.
Kimura, E.
Kruse, F. A.
Lewis, F. D.
Lewis, G. A.
Lowd, L. R.
Mack, R. A.
Malone, W. R.
Martin, S. J.
Mercer, W. R.
Molla, J. J.
Obreza, W. S.
Parke, N. G, III
Randell, T. C.
Ratts, B. H.
Rojak, F. A.
Shively, E. H.
Sinclair, D. B.
St. Andre, G. O.
Stevens, W. J.
Taylor, K. A.
Van Benthem, Ben
Ventresca, Pietro
Von Recklinghasuen, D. R.
Warren, R. M.
Weissman, R. E.
Welti, G. R.
Wilson, E. F.
Wise, D. P.
Wolfson, J. A.
Woodward, J. H.
Wurzel, L. H.

Buffalo-Niagara Section

Barker, H. F.
Blohm, C. F.
Bolland, P. E.
Devlin, J. N.
Fiedler, Leroy
Franclemont, H. J., Jr.
Hoffman, K. B.
Johnson, R. C.
Korabell, Irwin
Nicoletti, R. J.
Niles, R. O.
Ridgeway, F. B.
Schwartz, R. N.
Steeb, E. C., Jr.
Timberlake, F.. A.
Tribou, P. W.
Veath, M. S.
Whyman, E. W.

Connecticut Section

Bauer, B. B.
Benson, K. B.
Dorschug, H. A.
Geist, H. J.
Goodnow, A. C.
Lapin, S. P.
Rand, P. S.
Schwartz, H. .E., Jr.
Shlank, M. E.
Smith-Vaniz, W.R., Jr.
Stocking, M. H.
Wessenberg, H. W.

Elmira-Corning Section

Franklin, B. A.

Ithaca Section

Dann, C. A.
Mayer, H. F.
Smith, H. G.

Rochester Section

Gardner, K. J.
Grace, J. W.
Lombardo, M. M.
Malone, W. J.
Veal, T. G.
Wager, G. F.

Rome-Utica Section

Ainsworth, M. G.
Baldridge, B. H.
Smith, D. R.
Spanbauer, C. J.
Taranto, T. J.

Schenectady Section

Browne, R. E.
Hacker, L. C.
Iler, G. W.
Lundgren, R.
Mc-Elhiney, R. S.
Richards, E. L.
Schaffer, C. A.
Smith, D. H.

Syracuse Section

Abrahams, L C.
Bias, F. J.
Burdick, A. H.
Ciccoricco, F. A.
De Angelo, J. N.
Eichel, J. H.
Glasford, G. M.
Goetter, W. F.
Hjortzberg, A. B.
House, H. J
Jones, J. L.
Lavin, H. P.
Lipnitz, J. W.
Muir, D. A.
Priest, C. A.
Putman, R. E.
Rodems, J. D.
Simon, C. J.
Ticen, W. E.
Towlson, H. G.
Wiggin, J. F.

Western Mass.

Mellon, R. E. P.
Sheehan, J. J.
Townsend, G. R.

REGION 2

Long Island Section

Augenbaum, Jerome
Aull, Wilson
Barker, V. S.
Baston, W. M.
Berglund, E. B.
Bicknese, F. H.
Burr, R. P.
Cosmas, Athan
Crosby, M. G.
Davidoff, Frank
Di Toro, M. J.
Dressler, Robert
Duttera, W. S.
Efstatos, Nicholas
Emsig, A. B.
Flynn, W. J.
Friedman, E. D.
Gommo, F. J.
Granese, D. G.
Haback, D. H.
Hammer, R. M.
Hartmann, Zoltan
Hille, P. F., Jr.
Holter, H. A.
Jacobson, Jesse
Jasik, Henry
Jensen, A. J.
Loughren, A. V.
Malang, A. W.
Meyer, S. S.
Ottenberg, L. A.
Pasternack, C.
Peduto, R. J.
Popkin-Clurman, J. R.
Ross, Richard
Rugge, R. A.
Ryan, W. R.
Shulman, Irving
Sperling, J. G.
Svoboda, R. G.
Teevan, G. H.
Wheeler, H. A.
Young, D. B.
Young, V. J.

New York Section

Adler, Benjamin
Auditore, C. J.
Barkey, Robert
Berger, Louis
Bickel, H. J.
Bierman, Howard
Boguslawski, H. A.
Brickman, A. F.
Brock, R. E., Jr.
Brooks, G. W.
Bryson, W. B.
Burden, R. W.
Campbell, C. H.
Chamberlain, A. B.
Chertok, A. B.
Cohen, C. B.
Cotter, M. A.
Cronin, Daniel
Darrigo, L. L.
De Beer, B. C.
De Bragga, J. W.
De Satnick, Steve
Ehrlich, W. E.
Espersen, George
Evans, A. P., Jr.
Farrankop, A. T.
Feldman, Sidney
Feldman, Sidney
Ferolito, A. P.
Fine, C. R.
Fitch, W. A.
Flemming, F. L.
Foley, J. F.
Freudenberg, Boris
Fritsche, A. J.
Goldsmith, A. N.
Guenther, Richard
Hagerty, G. N.
Haney, F.
Hergenrother, E. C.
Hoffman, J. D.
Howard, W. A.
Kagan, Jerry
Kearney, J. E.
Klansko, Gregory
Koenig, Stephan
Korkes, Henry
Lodge, W. B.
Loffer, G. W.
Looney, L. A.
Maginnis, W. P.
Malavenda, Peter
Martinson, F. L.
Marx, F. L.
Mattila, P. A.
McCabe, R. P.
Moerck, William

Nunan, K. W., Sr.
O'Brien, R. S.
Onder, Kerim
Owen, C. H.
Parisier, Maurice
Parker, J. D.
Parrish, R. L.
Pegram, J. B.
Porter, H. A.
Pourciau, L. L.
Rauffer, W. M.
Reiss, Lester
Ripp, Hugo
Rosner, I. S.
Rukin, M. B.
Saron, R. B.
Sather, O. J.
Schanker, J. Z.
Schenck, L. S.
Schoenfuss, A. F.
Seimes, M. S.
Seitz, F. A.
Smith, F. W.
Smith, J. H., Jr.
Sobel, I. J.
St. Clair, B. W.
Stern, J. L.
Striker, R. G.
Strysko, W. J.
Taylor, R. S.
Taylor, W. H., Jr.
Wai, K. N.
Walton, J. S. V.
Winner, Lewis
Zicchino, J. G.

Northern New Jersey Section

Arnow, P. L.
Austin, J. E.
Bolgiano, D. R.
Breidt, S. J.
Carson, D. N.
Dawson, R. S.
Doba, Stephen, Jr.
Dolinko, Louis
Duerig, W. H.
Dumont, A. B.
Ebersol, E. T., Jr.
Elizondo, E. L.
Ennis, F. T.
Forsyth, P. G.
Gall, D. J.
Godley, P. F., Jr.
Gray, L. F.
Grayson, E. L.
Guy, R. F.
Halina, J. W.
Hamilton, R. D.
Hefele, J. R.
Kertesz, Z. J.
Kiss, M. L.
Leggett, E. P.
Lieberman, I. J.
Matter, L. E.
McKenzie, A. A.
Mount, Ellis
Newborg, D. S.
Osborn, P. H.
Pollack, Louis
Razdow, Adolph
Wintringham, W. T.
Zeier, A. J.
Wojcik, M. H.
von Kunits, Paul
Walker, H. R.
Twinem, J. B.
Schwartz, E. I.
Seda, O. L.
Seibert, J. L.
Shell, E. A.
Simpson, L. C.

Princeton Section

Bishop, J. D.
Brown, G. H.
Epstein, Jess
Hansell, C. W.
Moles, W. H.
Morgan, W. L.
Morton, G. A.
O'Connor, R. A.
Pearce, P. F.
Wilmotte, R. M.

REGION 3

Atlanta Section

Adamson, H. D.
Aderhold, H. J.
Andrews, J. S.
Berry, G. C.
Bondy, H. A.
Brandfute, G. A., Jr.
Briscoe, H. R., Jr.
Cassilly, J. H.
Downey, R. T.
Evans, R. C.
Fattig, W. L.
Graham, Edward, Jr.
Holbrook, R. A.
Miles, E. M.
Murphy, G. L.
O'Connor, T. S., Jr.
Stowers, J. S.
White, W. H.
Young, B. A.

Baltimore Section

Blotzer, W. L.
Campaigne, H. H.
Claus, O. R., Jr.
Cook, W. S.
Dunn, J. E.
Eckels, A. E.
Garrison, C. P., Jr.
Getz, W. W.
Haller, E. J.
Houston, G. P.
Hutchinson, F. W.
Ishman, N. H.
Karns, L. W.
Morgan, R. H.
Nopper, C. G.
Romei, W. T. L.
Stephenson, J. O.
Visher, W. A.
Wilner, J. T.
Wolfe, Benjamin
Yeich, V. B.

Florida West Coast Section

Boyd, R. M.
Codding, W. J.
Harris, L. R.
Kimberlin, D. E.
Lampkin, G. F.
May, T. W.
McDaniel, C. B.
Metcalfe, W. L.
Mitchell, J. H.
Murphy, Raymond
Potter, F. N.
Reynolds, G. E., Jr.
Rich, D. F.
Whitely, G. H.

Huntsville Section

Baker, W. B.
Barr, T. A.
Burch, C. E.
Dewitt, J. H., Jr.
Duke, C. R.
Garrison, J. P.
Hucaby, R. L.
Montgomery, L. H., Jr.

Miami Section

Boundy, G. G.
Castle, C. X.
Cook, H. A.
Lockwood, E. C.
Rider, F. E.
Rosenson, A. H.
Topmiller, C. H.

Mobile Section

De Lashmitt, C. M.

North Carolina Section

Bateman, F. F.
Caudle, L. L., Jr.
Duncan, V. D.
Ebhardt, C. A.
Fatkin, T. G.
Fullen, R. E.
Hamrick, W. H.
Howard, T. E.
Hulick, Henry, Jr.
Idol, C. A.
King, L. C.
Long, T. E.
Macintyre, A. B.
McIver, W. L., Jr.
Nelson, M.
Sprague, G. F.

N. W. Florida Section

Clifton, C. L.
Hicks, W. S.
Ragsdale, W. E.

Orlando Section

Ford, H. P., Jr.

Philadelphia Section

Allen, C. D.
Austin, W. J.
Bailey, R. E.
Berkowitz, R. S.
Boothroyd, W. P.
Bott, A. H.
Bowman, D. F.
Brunner, D. H.
Buxton, P. T.
Chambers, A. B.
Chen, D. B.
Cooke, K. R.
Cramer, B. G.
Creamer, E. M., Jr.
Cummings, E. J.
Everett, F. C.
Farr, K. E.
Fisher, J. F.
Friend, A. W.
Garcia, S. C.
Garfield, E. E.
Gihring, H. E.
Gluyas, T. M.
Green, R. E., Jr.
Gutsmuth, H. R.
Hart, D. J.
Higgins, C. A.
Houck, R. D.
Jensen, C. L.
Kushner, E. E.
Lappin, L. S.
Leitch, J. G.
Lewis, George
Licata, M. J., Jr.
Ling, R. F.
Luddy, E. N.
Major, R. P.
Martin, Alastair
Mathiot, J. E.
McNicol, F. R.
Meisenheimer, R. L.
Meyer, C. B.
Meyer, Saul
Monro, C. R.
Murphy, R. B.
Neely, W. J.
Noll, E. M.
Osbahr, B. F.
Pratt, Dana
Rao, G. V.
Reiner, Carl
Rhea, H. E.
Risse, J. A.
Robinson, C. W.
Roe, J. H.
Ropp, R. W.
Ross, I. L.
Roth, J. H.
Rudzitis, Janis
Ryan, W. J.
Schantz, J. S.
Shields, P. H.
Sichel, A. T.
Simons, K. A.
Smith, O. J. III
Sonntag, W. A.
Stahl, R. W.

Taylor, R. R.
Veldhuis, A. C.
Wentworth, J. W.
West, L. G.
Wetzel, L. D.
Yeder, R., Jr.

South Carolina Section

Funderburk, Oscar, Jr.
Goodman, K. E.
Lambert, R. D., Jr.
Leach, R. E.
Sellars, E. A.

Virginia Section

Braun, W. L.
Briggs, J. P.
Garcia, J. R.
Hastings, C. E.
Hoffman, G. R.
Jackson, R. C.
Jones, T. B., Jr.
Kyle, J. W.
Lindell, R. L.
Peffer, J. C.
Quarles, L. R.
Varn, S. P., Jr.

Washington, D. C. Section

Alberts, W. S.
Albertson, F. W.
Allen, D. A.
Andrus, A. H.
Bailey, S. L.
Battison, J. H.
Begue, G. P.
Bell, W. S.
Benjamin, R. P.
Bergen, Serge
Bode, G. F.
Booth, R. M., Jr.
Bower, H. D.
Braum, C. M.
Burleson, M. M.
Busby, E. S., Jr.
Cannon, R. E., Jr.
Carpenter, R. J.
Carr, L. H.
Carreras, L. M.
Cohen, Jules
Creswell, D. C.
Crutchfield, A. E.
Cuellar, O. L.
Culver, R. H.
Davis, E. D.
Davis, G. C.
Dettra, J. E., Jr.
Diels, J. C.
Dippell, R. E., Jr.
Dutton, W. P.
Fabre, Guy
Fine, Harry
Fleming, H. S., Jr.
Fullen, W. E.
Gautney, G. E.
Gilbert, J. N.
Gillilland, Kitt
Griffith, K. E.
Head, H. T.
Hill, J. S.
Hollis, J. L.
Hunt, C. M.
Jansky, C. M., Jr.
Jenkins, Merl
Kear, F. G.
Keel, J. J.
Kennedy, R. L.
Kershner, S. W.
Kiichli, J. A.
Light, Louis
Lockwood, R. O.
Lorentz, E. F.
McKenna, J. A., Jr.
Meeker, C. W.
Mischler, E. F.
Moffet, J. A.
Novik, Joseph
Osborn, M. E.
Partello, P. E.
Peterson, R. E.
Reed, O. W. B., Jr.
Regardh, C. B.
Renton, R. J.
Roher, R. E.
Rothrock, H. B.
Russell, P. H., Jr.
Sanborn, R. L.
Schlegelmilch, R. O.
Schmitt, C. H.
Singer, C. H.
Snowberger, A. A.
Steel, D. L., Sr.
Tate, J. P., Jr.
Underwood, V. T.
Varhus, Henry
Williams, D. G.
Yllescas, J. H.

REGION 4

Akron Section

Bidlack, C. S.
Dieringer, F. A.
Edeker, D. W.
Knopp, I. L.
Nerhood, H. E.
Williamson, W. P. III

Cincinnati Section

Braden, P. F.
Dooley, E. B., Jr.
Haehnle, C. G.
Lepple, Howard
Rockwell, R. J.
Stein, J. L.

Cleveland Section

Ackerman, E. K.
Bird, J. R.
Butler, A. H.
De Lany, R. H.
Dennis, Harry
Epperson, J. B.
Gooch, B. R.
Huth, B. G.
Hutton, W. G.
La Moreaux, D. D.
Lawrie, A. W.
Louis, W. B.
Sanderson, J. K.
Slater, R. J.
Smith, C. E.
Spiller, H. A.
Stadig, S. V.
Thayer, J. W.
West, S. S.
Wozniak, A. J.
Yambor, E. P.

Columbus Section

Boggioni, A. J.
Harmer, J. D.
Hayden, J. R.
Slutz, R. A.
Woodward, R. O.

Dayton Section

Adams, E. L.
Makinson, G. E.
Smith, E. C.
Podesta, J. F.
Wehrman, R. B.

Detroit Section

Allman, R. L.
Browne, J. F. X, Jr.
Burns, J.
Chapin, W. R.
Chute, G. M.
Clark, E. H.
Connolly, D. J.
Ikola, R. J.
Kemp, D. J.
Kossuth, A. K.
Kubala, A. M.
Lebermann, A. A.
Leydorf, G. F.
Mast, J. G.
Pomish, I. E.
Reiser, J. W.
Remley, F. M., Jr.
Roman, D.
Ryan, G. E.
Schlorff, R. F.
Stewart, P. H.
Strand, John
Whitacre, J. W.
Winner, D. H.
Woods, R. A.

Emporium Section

Mueller, W. P.

Pittsburgh Section

Augenstene, M. G.
Berninger, J. W.
Brick, G. R.
Campbell, T. E.
Chandler, A. M.
Clay, J. P.
Daubenmeyer, H. L., Jr.
Drury, G. R.
Ferry, D. D.
Furgerson, D. F.
Golla, E. F.
Greenwood, J. H.
Heess, E. L.
Hough, R. D.
Hunt, W. A.
Kaiser, H. R.
Kenney, T. C.
Ketterer, R. L.
Komar, J. C.
Magee, C. H.
Maser, F. A.
Mitchell, J. B.
Pitts, L. A.
Rodgers, R. W.
Twaska, V. M.
Tury, S. F.
Vrooman, A. L.

Toledo Section

Polus, J. D.

Western Michigan Section

Kubicz, A. P.
Morse, F. L.

Williamsport Section

Gardner, G. F.

REGION 5

Cedar Rapids Section

Beck, I. C.
Damm, Fred
Goodnow, Jim
Hixenbaugh, G. P.
Larson, R. P.
Loyet, P. A.
Melloh, C. I.
Pappenfus, Ernest
Quentin, C. F.
Sawyer, R. E.
Stauffer, R. E.
Tink, E. M.
Town, G. R.

Chicago Section

Baker, K. L., Jr.
Campbell, D. C.
Cichorz, Joseph
Cawthon, E. F.
Cummings, E. M.
Dalietos, S. A.
Damm, G. J.
Demmer, L. T. Rev.
Detert, D. G.
Druz, W. S.
Eilers, C. G.
Frankart, W. F.
Freedman, M. D.
Holpuch, D. J.
Hoyt, W. A.
Jauniskis, K. P.
Kabrick, W. J.
Kulosa, A., Jr.
Kusack, W. P.
Newman, C. R.
Nicholls, W. C.
Pape, L. W.
Peck, R. E.

Reese, F. D.
Remley, H. L.
Schwartz, H. R.
Shirk, K. C.
Tanner, D. J.
Trapper, R. P.
Treaday, R. T.
Turner, K. W.
Weise, Duane
Weiss, John, Jr.
White, E. S.
Wine, J. W.
Zellner, F. L., Jr.

Evansville-Owensboro Section

Schoeny, E. P.
Stoltz, G. F.

Ft. Wayne Section

Wallace, C. E., Jr.

Indianapolis Section

Brockway, R. M.
Egelhoff, L. T.
Gresham, Stokes, Jr.
Haag, K. E.
Lai, Jack S. S.
Moench, H. A.
Parmerlee, D. A.
Presti, Biagio
Rollins, M. F.
Shapiro, Michael
Weber, J. W.
Wood, T. F.

Louisville Section

Folsom, F. L., Jr.
Helt, Sanford,
Hendrick, R. J.
Owens, L. M.

Milwaukee Section

DuBois, J. R.
Hahn, N. G.
Hariu, W. R.
Hebal, W.H.
Laeser, P. B.
Mayer, H. J.
Randall, A. E.
Ribbens, W. F.
Sadler, L. S.
Talbot, V. R.
Weller, D. A.
Williams, N.
Wuertz, E. G.
Wulliman, J. C.

Omaha-Lincoln Section

Allison, D. B.
Bates, A. G.
Beshore, P. S.
Bitner, R. J.
Davidson, Stanley
Dvorak, A. R.
Ebel, A. James
Gettman, W. C.
Lynch, U. L.
McKinney, J.

Petrik, J. S.
Seide, J. H.
Shadbolt, M. H.
Smith, A.H.
Snyder, H. C.
Taylor, D. R.

So. Bend-Mishawaka Section

Kelly, Lanny
O'Neil, A. R.

Twin Cities Section

Baeten, W. A.
Baumann, G. M.
Coil, N. B.
Collier, George
Compton, C. G.
Cross, R. W.
Dettman, R. A.
Graf, E. A.
Hetland, J. M.
Hird, F. S.
Jorgenson, T. O.
Kolbert, D. E.
Krieg, A. R.
Leeman, Alvin
Mayer, W. A.
McGinnis, W. J.
Miller, C. B.
Nelson, E. A.
Persons, C. B.
Reinke, J. A.
Renk, B. J.
Seils, H. A.
Seter, A.
Sheppard, H. F., Jr.
Sherman, J. M.
Simacek, H. A., Jr.
Stoltenberg, K. D.
Thomforde, Clifford

REGION 6

Beaumont-Port Arthur Section

Hale, T. D.
Patterson, S. C.
Rawls, E. A.
Riley, H. E.
Schaefer, Don
Summers, G. R.

Dallas Section

Banks, B. M.
Brown, R. A.
Bullock, M. W.
Carnell, R. E.
Chun, M. E.
Cullum, A. E., Jr.
Daniell, C. M.
Griffith, B. W., Jr.
Harris, C. M.
Meadows, R. A.

Meny, J. J.
Peterson, D. A.
Robinson, G. C.
Rutherford, C. R.
Seay, C. F., Jr.
Stegall, M. D.
Strock, R. E.
Tucker, D. J.
Tucker, R. W.
Weldon, J. O.
Wright, T. A.

Denver Section

Barsis, A. P.
Blanchard, R. R.
Butts, J. H.
Davidson, Sidney
Francisco, S. S., Jr.
Grove, W. C.
Herbstreit, J. W.
James, V. N.
Kirby, R. C.
Kirby, R. S.
Koch, J. W.
Maggard, A. D.
Russell, J. D.
Stacey, D. S.
Turnquist, E. R.

El Paso Section

Bouvier, F. C.
Cohen, R. L.
Talbott, E. P.
Rojas, A. M.

Ft. Worth Section

Adams, John
Carr, W. B.
Grubbs, C. L.
Hutcheson, G. C.
Hutson, R. N.

Houston Section

Bates, E. J., Jr.
Biggs, M. A.
Burrows, R. C., Jr.
Chinski, G. R.
Cox, W. B.
Huhndorff, E. P.
L'Roy, R. E.
Mullan, L. A.
Schafer, E. L.
Schmidt, P. S.
Weidner, C. P.
Wheeler, H. T.

Kansas City Section

Ellis, T. H.
Heffelfinger, J. B.
Heimlich, C. J.
Kring, C. I.
Troeglen, Karl
Robertson, A. J. L.
Simcoe, K. W.
Wilcox, J. V.
Williams, R. P.

Little Rock Section

Meyer, J. A.

Lubbock Section

Carver, D. H.
Hutton, C. D.
Lee, R. F.
Schock, W. R.
Torrey, W. H.

New Orleans Section

Ballow, J. C.
Boyd, R. L.
Brady, P. D.
Cronvich, J. A.
Du Treil, L. J. N.
Hart, W. S.
Manzanilla, O. G.
Often, C. G.
Otto, J. L.
Tong, Edward

Oklahoma City Section

Beavin, Michael
Easum, C. M.
Hamilton, D. K.
Marrinan, H. J.
Phillips, H. E.
Stewart, B. C.
Thomas, M. W.
Warren, J. D.
Wood, G. J.

St. Louis Section

Ceries, R. E.
Day, R. T., Jr.
Hirsch, O. C.
Klipp, J. E.
Mitchum, M. M.
Risk, J. E.
Sisson, A. R.
Vogel, E. H.

San Antonio-Austin Section

Imparato, E. T., Jr.
Ing, G. W.
La Grone, A. H.
Rountree, J. G.
Sellars, R. L.
Simpson, S. H., Jr.
Jeffers, C. L.
Wardwell, H. W.
Willett, N. W.
Zazvorka, Jerry, Jr.

Tulsa Section

Brady, D. F.
Bushnell, J. M., Jr.
Hughes, W. L.
Nichols, W. R.
Orsak, A. J.
Walden, J. M.

Wichita Section

Rogers, L. W.
Temaat, J. A.

REGION 7

Albuquerque-Los Alamos Sec.
Dodds, L. F.
Johnson, G. S.
Stringfellow, W. M.

Anchorage Section
Gray, C. M.
Miller, J. M.
Scott, R. C.

Hawaii Section
Brill, G. D.
Kato, R. S.
Miller, R. W.

Los Angeles Section
Barnes, R. B.
Barton, R. W.
Billingsley, S. V.
Binkey, R. A.
Blatterman, H. L.
Bleil, F. J.
Brewer, M. S.
Browdy, A. A.
Bucher, F. X.
Caler, J. W.
Chew, T. W.
Cochran, E. D.
Cubbage, J. C.
Denechaud, R. G.
Dreese, W. R.
Einsohn, I. A.
Faris, E. M.
Foster, D. E.
Fraher, R. J.
Friedman, T. B.
Fugate, K. O.
Goodart, W. T.
Grenier, T. B.
Grill, F. J.
Grossman, S. J.
Hayden, R. J.
Henry, D. S.
Homer, G. E.
Huntsman, H. F.
Jensen, A. K.
Jobbins, C. W.
Johnson, J. H.
Johnson, R. E.
Jones, H. J.
Knight, J. B., Jr.
Kuwahara, D. J.
Lambert, J. D.
Laritson, L. P.
Lark, E. J.
Lewis, Richard, Jr.
MacKenzie, L. G.
Mallach, L. W.
Mead, J. A.
Mesak, Charles
Mescall, John
Morton, W. B., Jr.
Moseley, J. A.
Murphy, M. M.
Ort, H.
Patterson, G. E.
Penter, J. L.
Poulson, W. A.
Pro, Stanley
Raines, O. E.
Rodgers, V. P., Jr.
Seitz, F. R.
Sigmon, L. C.
Silva, L. M.
Sodaro, J. F.
Somers, F. J.
Spayth, Frank
Speen, G. B.
Stagnaro, J. A.
Stearns, J. R.
Stevens, Frederick, Jr.
Sumner, T. B.
Tapp, J. E.
Ulrich, William
Woerner, J. J.
Wolcott, C. F.
Wright, P. B.
Zeitlin, Sam

Phoenix Section
Edwards, M. J.
Elsner, R. W.
Simpson, E. J.

Portland Section
Feikert, G. S.
Heck, L. D.
Hodges, D. N.
Hollingsworth, K. M.
Jerron-Quarshie, S. B.
McCann, F. H.
Richardson, W. E.

Sacramento Section
Berger, E. W.
Hartman, W. H.
Hoeflich, A. F.
Julian, C. E.
Karpisek, W. J.
Lohner, K. E.
Lynch, Cecil
Onnigian, P. K.
Petros, J. D.
Roberts, E. A., Jr.

Salt Lake City Section
Baker, L. R.
Carpenter, B. R.
Clayton, V. E.
Wall, L. W.
Whitman, D. A.

San Diego Section
Abel, C. F.
Babits, V. A.
Behrends, P. O.
Easton, J. D.
Guthrie, W. R.
Kershaw, J. E.
Markle, R. L.
Smith, W. R.

San Francisco Section
Anson, C. T.
Arne, R. E.
Athey, S. W.
Baer, M. M.
Bartholomew, H. C.
Bauer, Fritz
Becker, H. J.
Berryhill, J. L.
Berthold, W. L.
Bjerke, O. G.
Brinkman, H. A.
Capiello-Llamozas, E.
Case, M. D.
Cummings, R. W.
Dowling, R. H.
Downey, C. E.
Duck, S. W.
Edison, Edward
Fong, W. W.
Gates, W. F.
Goldsmith, Erwin
Granberry, H. W.
Gregg, P. E.
Hammett, R. L.
Hancock, J. B.
Isberg, R. A.
Jacobs, H. N.
Kietz, E. K.
Kline, S. H.
Latham, R. A.
Meadows, F. D.
Mealey, K. L.
Noon, J. R.
Norris, W. E.
Oliver, B. M.
Olson, A. E.
Paulson, C. R.
Pfefer, B. L.
Ross, Albert
Scrievers, B. J.
Smith, D. C.
Stromberg, R. T.
Taleporos, A. D.
Towne, A. E.
Tudor, B. J.
Westbrook, E. P.
Wilber, L. E.
Williams, P. A.
Wilson, L. H.
Woodruff, R. L.

Seattle Section
Bice, M. H.
Bowles, T. V.
Flatt, W. A.
Green, D. I.
Lopuch, A. J.
Martin, B. A.
McClamrock, J. M.
O'Hara, R. N.
Parmelee, W. G.
Smading, R. E.
Taylor, A. S.
Welch, P. L.
Williams, Kenneth, Jr.

Tucson Section
Talpis, Nathan

REGION 8

Bay of Quinte Section
Burkett, K. V.
Csia, J. Z.
Jarvis, J. A.
Waller, M. J.

Hamilton Section
Heys, D. M.
Papper, M. P., Jr.

Kitchener-Waterloo Section
Anthes, R. G.
Thomas, E. A.
Turchan, P. J.

London Section
Cameron, D. L.
Kiss, J. A.
Onn, W. R.

Montreal Section
Beaulieu, J. W. R.
Berube, Roland
Bilooq, Raymond
Demers, Pierre
Desaulniers, R. R.
Doucet, Maurice
Douglas, J. C.
Frenette, Charles
Frenette, R. H.
Gilbeau, L. E.
Hamel, Y. R.
Hodgson, Alan
Knight, J. P.
Komlos, S. G.
McLean, M. D.
Migneault, G. B.
Negoro, Takashi
Olding, N. R.
Oxley, A. B.
Pappas, N. J.
Pugsley, J. D.
Quinn, S. F.
Wilson, D. S.

Ottawa Section
Brown, H. C.
Chrome, J. T.
Cole, W. A.
Dashney, D. R.
Levy, M. M.
Schliebener, Guenten
Tanner, R. H.
Welsh, William

Quebec Section
Boulet, Lionel
Fortin, G. J. F.
Nadeau, A. G.

Regina Section
Beck, Rodger

Southern Alberta Section
Connor, E. C.
Dickson, F. J.
Evans, P. R. N.

Toronto Section
Byers, H. G.
Draht, P.
Easton, K. J.
Elder, J. G.
Hackbusch, R. A.
Hames, A. L.
Heath, F. J.
Irwin, D. N.
Jones, G. E.
Jones, K. R.
Kufluk, Andrew
Mac Gregor, A. R.
Marchand, W. C.
Meszaros, A. L.
Nachoff, G. L.
Norton, R. J.
Philipowich, S. G.
Sipila, O. A.
Taylor, A. K.

Vancouver Section
Bealle, D. F.
Chandler, A. H.
Darcus, R. J.
Hoyles, H. A.
Liang, J. D. S.
Maddison, R. R.
McCarter, W. L.
Seabrook, H. B.
Wilson, C. M.
Wyatt, T. E.

Winnipeg Section
Allen, D. E. M.
Cahoon, R. D.
Marzotto, E. J.
Ross, J. D.

OVERSEAS MILITARY

Batson, J. A.
Earle, J. L.
Hudson, D. E.
Kibling, C. A.
Magrish, C. J.

FOREIGN SECTIONS

Benelux Section
Bouchier, Pierre
Boxma, Y.
Grossi, J. J. M.
Van Egmond, A. J. L.

Buenos Aires Section
Pereyra, L. A.

Columbia Section
Amore, I.
Clavijo-J, L. G.
Gabriunas, K. B.
Guitierrez, J. D. H.
Nassar, J. E.
Pick, L. M.
Ramirez-Saenz, Angel

France Section
Berline, S. D.
Deschamps, J. D.
Ferrier, P. A.
Grivet, P.
Klein, G. J. P.
Labin, Emile
Mandel, Paul
Sauvanet, M. M.
Van Rennes, A. B.

Geneva Section
Guanella, G.
Holtz, R. F.
Strohschneider, Walter

India Section
Rao, K. L.

Israel Section
Kamil, Tsvi

Italy Section
Egidi, Claudio
Formato, D. F.
Koch, Renato
Maione, G.
Monti-Guarnieri, G.
Schiaffino, Paolo
Vergani, Angelo

Rio de Janiero Section
Frederico, J. C. B.

Tokyo Section
Aoi, Saburo
Harashima, Osamu
Hayashi, Isuo
Hayashi, Tatsuo
Ibuka, Masaru
Imahata, Kenroku
Kohno, Shishu
Kojima, Yoshiaki
Komai, Mataji
Kuroiwa, Y.
Matsuyuki, Toshitada
Mii, Nobuo
Mikami, Tetsuzo
Miyakoshi, Kazuo
Mizutami, M.
Morimoto, Shigetake
Morita, Kazuyoshi
Nishizaki, Taro
Niwa, Yasujiro
Nojima, Susumu
Nomura, Tatsuji
Ogawa, Toru
Okada, Tadasuke
Osada, Shohei
Sasaki, Tadashi
Sawada, Ryoka
Sawada, Toshio
Shimbori, Masayoshi
Sugi, M.
Suzuki, Keiji
Taki, Yasuo
Tanabe, Yoshitoshi
Taniguchi, Fusao
Terao, Mitsuru
Tomono, Masami
Tukizi, Osamu
Yamano, Masura
Yoshida, Tsuguo

FOREIGN COUNTRIES

Australia
Brownless, S. F.
Finney, K. L.
Honnor, W. W.
Hope, R. S.
Paluka, J. R.
Stevenson, M. H.
Webb, A. L. C.

Austria
Zemanek, Heinz

Bermuda
Harries, J. H. O.
Spershott, J. H.

Brazil
Borda, J. A.
Dantine, W. A.
Lignon, J. R.
Rubin, Leon
Senise, J. T.
Sos, A. J.

British West Africa
Rowe, J. M.

Central America
Rahn, R. H.

China,
Man Pau, R. C.
Vargas V., Arnoldo

Cuba
Barguez Leonard, Roberto
Valdes Pages, Enrique

Czechoslovakia
Vackar, J. F.

Denmark
Svensson, Regnar

England
Harris, K. E.
Kinross, R. I.
McLea, F. C.
Rantzen, H. B.

Ethiopia
Fraemer, E. H.

Germany
Grasselt, K. H.
Moller, Rolf
Nestel, Werner

Guatemala
Whitehead, Jack

Haiti,
Moore, C. W.

Jordan
Shaweesh, H. M.

Malaya
Trafford, William

Mexico
Diaz, J. S.
Guaragna, L. F.
Higuera-Mota, H. R.
Joaquin, D. S.
Marquez, Jose
Rodriguez Villa, Angel
Yovanovich, J. M.

North Africa
Melliard, Dennis
Sheriff, K. A.

Norway
Mack, Erik
Nickelsen, J. C.

Peru
Pereyra, A. A.

Philippines
Reynolds, R. A.

Poland
Ryzko, Stanislaw

Puerto Rico
Serra, M. A.

Russia
Goviadinov, V. A.
Kubec, Josef
Zahvatoshin, K. V.

Saigon-Vietnan
Fozda, J. K.

Saudi Arabia
Rieg, R. V.

Singapore
Whitely, R. H.

Spain

Colino, Antonio
Espinosa, Manuel

Sweden

Braune, E. H. J.
Elfving, A. L.
Fredrickson, K. V.
Josephson, B. A. S.
Karlstedt, Lennart
Lofgren, E. O.
Olving, Sven
Persson, N. I. E.

Thailand

Sindhavananda, Kamthon

Turkey

Hananel, M. D.

Uruguay

Moran, W. F.

Venezuela

Alamo-Segovia, J. A.
De Mello, William
Suez-Gutierrez, Jose