SECTION V

PICKUP TUBE DEVELOPMENT

Considerable development work to improve the sensitivity of television pickup tubes and to reduce the size of the television camera had been done by RCA before Government contracts were awarded for the purpose. The Signal-Multiplier Iconoscope, the Image Iconoscope and the portable Orthicon Camera are historic examples of this. Thus, the work under Navy Contract OEMsr-171, begun in 1941 and later merged with NDRC Contract OEMsr-441, was a development and refinement, looking toward increased sensitivity, improved signal-to-noise ratio and greater resolution. Much thought was also given to solving problems in production, culminating in the product design of the 2P21 standard size Image Orthicon and the 2P22 Miniature Image Orthicon.

At the beginning of the contract, effort was spread over several types of pickup tubes, but as the work progressed, it became evident that one type of structure, that of the Orthicon, offered the greatest promise of increased sensitivity. Hence, the Orthicon became the subject of development, and work on other types of picture tubes was stopped.

Pickup Tubes Originally Considered in the Developmental Contract

Tube	RCA Status As of July, 1941
6" Iconoscope	Commercial Type 1850
4½" Iconoscope	Commercial Type 1848
4" Orthicon (magnetic focusing)	Commercial Type 1840
4" Orthicon (electrostatic focusing)	Developmental
2" Orthicon	Developmental
4" Orthicon (with image multiplication)	Experimental
4" Orthicon (with signal multiplication)	Experimental
4" Orthicon (with image and signal multiplication)	Experimental

Low-Velocity Scanning in the Orthicon: The promise of increased sensitivity afforded by the Orthicon derived from its operating principles, which differed fundamentally from those of the

Iconoscope. In the Iconoscope, the target, which is operated at a much higher potential than the electron gun, is scanned by a beam of electrons travelling at high velocity. Under bombardment by this beam, the target emits secondary-emission electrons which are in turn redistributed on the target, neutralizing the positive charges caused by the departure of photoelectrons from an optical image focused on the target. The secondary-emission electrons not required for neutralization, return to the collector. This otherwise uniform flow of secondary emission from the target to the collector is thus modulated.

In the Orthicon tube, the target is operated at only a few volts above cathode potential. As the low-velocity beam strikes the target, it deposits enough electrons to bring the target to cathode potential, and, until an element of the target is lighted by the image and photoelectrons are released, the beam returns to the collector and no further electrons reach the target. When an element of the target is lighted, photoemission is drawn to the collector, and the target element is thereby driven positive during the time when it is not scanned by the beam. When the scanning beam again arrives, it deposits enough negative charge to drive the target potential back to cathode potential. The beam current is thus modulated depending on the electron requirements of the target.

In high-velocity scanning, which is the method employed in the Iconoscope, the redistribution of secondary-emission electrons is not uniform over the target surface and therefore gives rise to a spurious signal known as the "dark spot". The dark spot, a nonuniform shading of the picture, limits the usable beam current and amplifier gain.

In low-velocity scanning, the absence of electron redistribution prevents the formation of a dark-spot signal. Furthermore, the collector field can be made sufficiently high with respect to the target to saturate photoemission and secondary emission from the target, making possible one-hundred-percent efficiency.

A direct comparison of the operation of the Iconoscope and the Orthicon cameras was provided in flight tests made in 1943 by the National Broadcasting Company in the development of "RING" equipment for the Navy. The object of the RING project was to determine what useful visual information could be transmitted to a remote receiving location by a television-equipped plane engaged in reconnaissance.

Other studies within the scope of the investigation included: a trial of lenses to determine desirable optical systems, a study of optical filters and their ability to penetrate haze and clarify the television picture, determination of the reliable range of a television transmitter with a given antenna and rated power output, a study of directive antenna receiving arrays, and the use of 16-mm motion-picture equipment to obtain a permanent record of scenes from the Kinescope screen.

NBC furnished the portable, two-camera Orthicon equipment, special monitoring equipment and trained personnel. The Navy furnished the BLOCK I transmitting and receiving equipment and the necessary plane and other facilities for carrying out the field tests. The Orthicon equipment utilized the RCA 1840 Type Orthicon pickup tube (Figure 111). BLOCK I receivers were used with both the BLOCK I and Orthicon transmitters. Several mechanical modifications were made to properly shock-mount the equipment and otherwise adapt it to the aircraft.

As a result of the tests, it was concluded that the operation of television equipment in an airplane for reconnaissance and observation purposes was practical. While the 20-watt power output of the television transmitter proved to be inadequate, the scene resolving capabilities of the system was sufficient to provide identification of medium-size buildings, bridges, roads, wharves, jetties, hangars, aircraft, reefs and breakers from high altitude in reasonably clear weather. The system was not a complete substitute for photography in detail capabilities, but it offered a service in scouting and observation not provided by other means.

Both the Iconoscope and the Orthicon showed serious limitations for the service. While the resolving capabilities of the Iconoscope were superior to those of the Orthicon, its sensitivity was somewhat lower. This was brought out when scenes were viewed on both systems while flying through a rain storm. In one test, the overall illumination on the ground was low, and the reflected light was further attenuated by the rain and mist between the camera and the scene. The Orthicon camera reproduced a good image of the earth below. On the BLOCK equipment, the scene as viewed on the Iconoscope camera was poor, and the location of objects on the terrain was a matter of guesswork.

The most serious limitation of the Iconoscope, however, was the "dark spot" spurious signal it produced. With the Orthicon, the "sticking" of the mosaic under conditions of bright illumination was the most disturbing characteristic. It was evident that completely new pickup equipment should be designed for reconnaissance applications.

<u>Image and Signal Multiplication</u>: For some time it had been known that the sensitivity of pickup tubes could be further increased by employing secondary emission in the tube in such a way as to increase its output. Secondary emission could be employed to "multiply" the electron emission caused by an image focused on the photocathode, or it could be applied, by the use of a series of electron multipliers, to multiply the number of electrons in the returning signal beam. In fact, RCA had constructed

several tubes embodying both "image multiplication" and "signal multiplication" in the same envelope.

Under the military contract, however, the prescribed dimensions of the pickup tube plus optical systems and focusing coils were not to exceed 17 inches in length and ten inches in outside diameter. Because of their size, therefore, these early RCA tubes were not used. It seemed logical to apply the principles to the two-inch Orthicon structure. What were the capabilities of this tube for military television?

Two-Inch Orthicon with Signal Multiplication: The use of a multistage signal multiplier was found to give difficulties from spurious signals and loss of resolution. Development was therefore begun using a one-stage multiplier of the form shown in Figure 112. The beam leaving the gun passes through aperture (A) in the multiplier plate, while the return beam is deflected away from this aperture by the signal electrode (Pl), which collects the secondary electrons.

While good pictures were obtained with this form of tube having multiplier gains of about six, operation of the multiplier was not as simple nor as consistent as desired. The return beam often struck the aperture or one of the plates, impairing focus. This led to a simplification of design, wherein the defining aperture was drilled or punched in the multiplier plate itself (Figure 113). A cylinder or box in front of the multiplier plate functioned as the collector. No precautions were taken to prevent the return beam from striking the defining aperture, because the spurious signal resulting from this was usually either absent or neglibibly small. Careful polishing of the multiplier plate, proper choice of rotation-ring potentials and precise adjustment of the beam focus, reduced spurious signals generated by the beam as it scanned irregularities in the multiplier plate.

The Orthicon Camera: Three Orthicon cameras were constructed f for field testing. These cameras were designed to be interchangeable with the BLOCK III camera. The Orthicon cameras incorporated the amplifying, synchronizing, deflection and high-voltage generating circuits required to deliver a "standard-level" video and blanking signal. The automatic iris, developed at the request of NDRC and the Navy, was used with these cameras.

Field tests showed that the sensitivity and resolution of the Orthicon with a single stage multiplier (signal multiplication) were satisfactory. Use of the iris, however, did not eliminate sticking of the mosaic when large area highlights were suddenly introduced in the scene, because the sticking occurred instantaneously, while the iris required a finite time for operation.

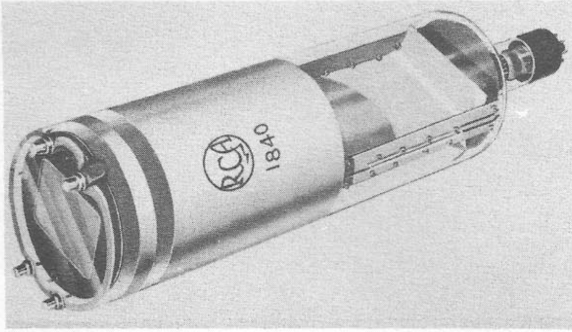

Figure 111. The Four-Inch RCA 1480 Orthicon Pickup Tube. This tube was too large to be adopted as standard military equipment.

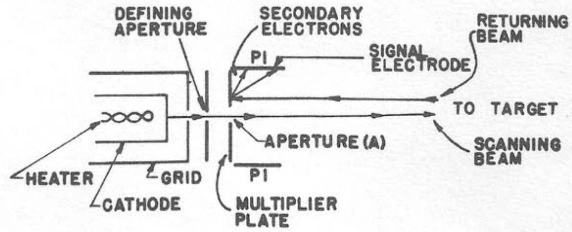

Figure 112. Schematic of An Early Two-Inch Orthicon with a Stage of Signal Multiplication.

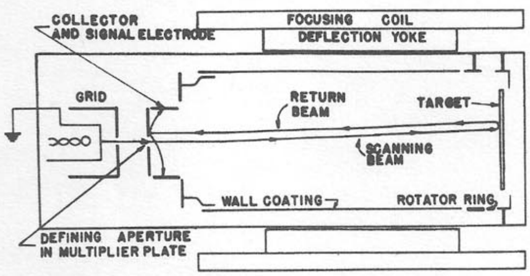

Figure 113. In this new design of the Orthicon with signal multiplication, the defining aperture was drilled in the multiplier plate itself.

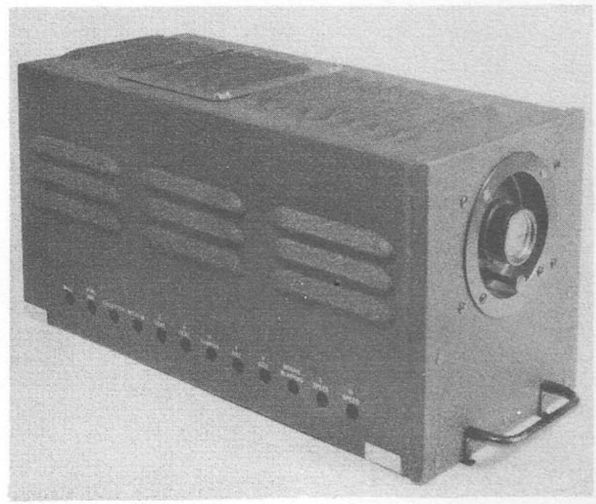

Figure 114. Three of these cameras using the two-inch Orthicon with a single multiplier stage were constructed for the National Defense Research Committee. A feature of the camera was the automatic iris which kept the average light on the mosaic constant under wide variations in outside illumination.

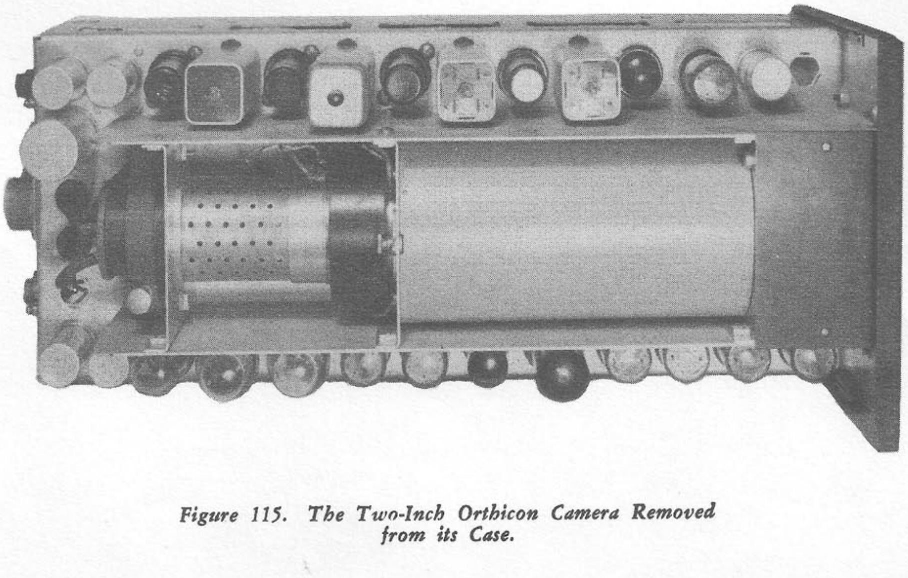

Figure 115. The Two-Inch Orthicon Camera Removed from its Case.

Nor was the sticking problem satisfactorily solved by the iris for scenes in which an appreciable area of sky appeared. In this case the iris, working on average overall illumination, would close down to such an extent that the level of illumination in the ground portion of the image was so low that useful detail was lost. These results confirmed the need for a pickup tube having the sensitivity of the Orthicon, but using a method of operation that would preclude sticking of the mosaic. The problem was solved with the development of the Image Orthicon, a pickup tube one hundred times more sensitive than the Iconoscope.

THE IMAGE ORTHICON: The Image Orthicon employs both image multiplication and signal multiplication in the same envelope. In operation, light from the scene being televised is picked up by an optical lens system and focused on the photosensitive face of the tube, which emits electrons from each illuminated area in proportion to the intensity of the light striking the area.

Streams of electrons, accelerated by a positive voltage applied to a grid directly behind the photosensitive face and held on parallel courses by an electromagnetic field, flow from the back of the sensitive face to a target. Secondary emission of electrons from the target, caused by the bombardment, leaves on the target a pattern of varying positive charges which corresponds to the pattern of light from the scene being televised. The back of the target is scanned by a beam of electrons emanating from an electron gun in the base of the tube, but the electrons making up this beam are slowed down so that they will stop just short of the target and return to the base of the tube except when they approach a section of the target carrying a positive charge. When this occurs, the beam will deposit enough electrons on the back of the target to neutralize the charge, after which it will again fall short of the target and turn back until it again approaches a positively-charged section.

The returning beam with picture information imposed upon it by the varying losses of electrons left behind on the target, is directed at the first of a series of dynodes near the base of the tube. Secondary electrons "knocked out" of this electrode by the bombardment, strike another dynode, and this process continues, with the strength of the signal multiplying at each stage until it reaches the signal plate and is carried out of the tube through an external connection.

Through the Image Orthicon, many of the major difficulties of illumination were solved. Its sensitivity permitted greater depth of field, including background that would otherwise be blurred. It extended the range of operations to include scenes in daylight, twilight or moonlight -- in good weather and in bad.

Improved stability in the tube protected images from interference due to sudden bursts of brilliant light. None of the "sticking" characteristics of the standard Orthicon mosaic were present in the Image Orthicon.

The Image Orthicon Camera: Early in 1943, development work was begun to utilize the new tube in a complete camera which would be interchangeable with the BLOCK III camera. The Image Orthicon would then be substituted where, due to low light conditions, it was impossible to obtain a satisfactory picture with the BLOCK III camera. Image Orthicon equipment is illustrated in Figures 116 to 121.

Many innovations in camera design came out of the development work, with a consequent saving in space, weight and power consumption. Because the Image Orthicon delivered a signal of higher level, two video amplifier stages were eliminated. The noise output was low and spurious signals such as dark spot and edge flare, so troublesome with the Iconoscope, were absent. Thus, the newly developed circuits for automatically regulating video gain and pickup tube beam current were employed to advantage. The Image Orthicon camera was built for unattended operation.

One of four cameras constructed by RCA Laboratories in Princeton was sent to the Advanced Development group of RCA Victor Division for redesign. With the completion of product design, new supersensitive cameras began rolling from production lines in the Camden plant. Two-hundred and fifty of these (Model PH-548/AXT-2) units, built for use with the BLOCK III transmitters, were procured by the Navy.

Like the earlier BLOCK III cameras, the Image Orthicon camera contained the necessary deflection and synchronizing circuits and picture-signal amplifiers. The picture signal from the Image Orthicon pickup tube was fed to a seven-stage video amplifier, using RCA 6AG5 miniature tubes. Very poor low-frequency response purposely introduced in the first five stages of the amplifier was regained between the fifth and sixth stages by the action of an RCA 6AL5 restorer, receiving its keying signals from the horizontal output transformer. A stable resistance-capacitance, phase-shift type vertical oscillator, wherein the signal from the plate of the oscillator is fed back to its grid, through a phase-shifting network, produced oscillation at 40 cycles per second. For the horizontal oscillator a stable sine wave oscillator with a resonant plate circuit was used. The normal frequency of this oscillator was line frequency, 14,000 cycles per second. A movable magnetite core in the primary winding of the oscillator transformer, however, permitted varying the resonant frequency over a range of 2000 cycles.

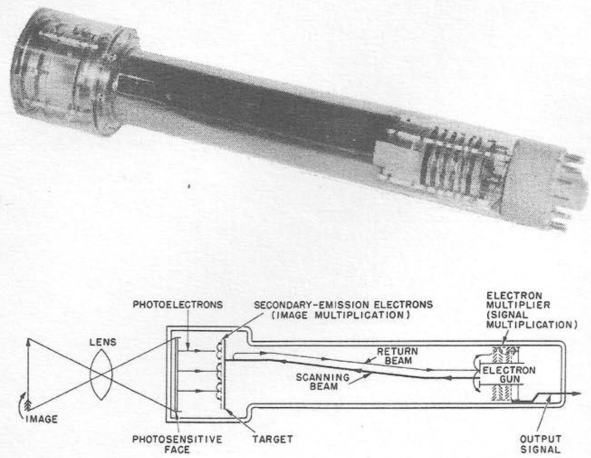

Figure 116. The RCA 2P21 Image Orthicon Pickup Tube.

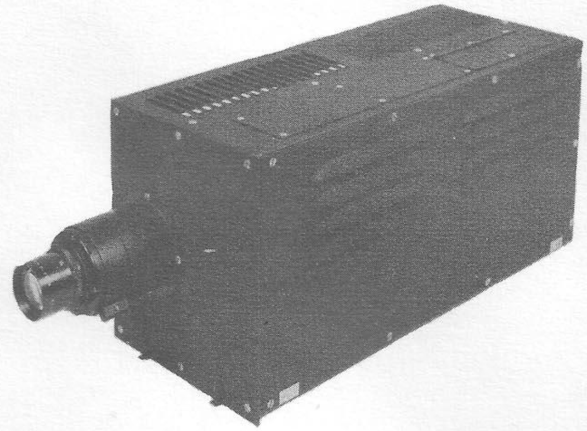

Figure 117. Final Development Model of the Image Orthicon Camera.

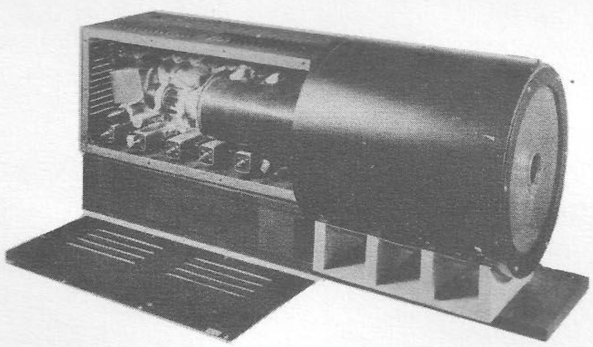

Figure 118. Image Orthicon Camera Using a Reflective Optical System.

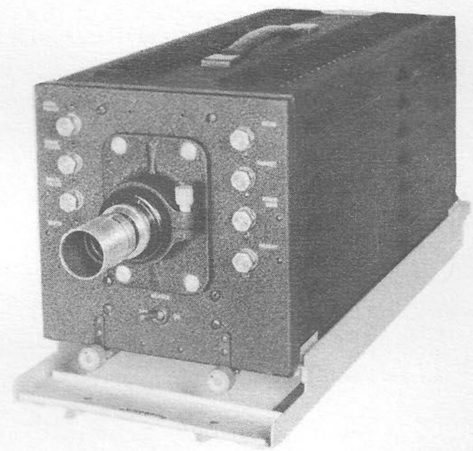

Figure 119. PH-548/AXT-2A Image Orthicon Camera Used with BLOCK III Transmitters.

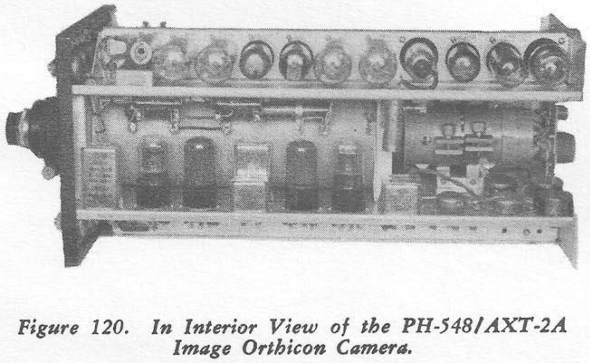

Figure 120. In Interior View of the PH-548/AXT-2A Image Orthicon Camera.

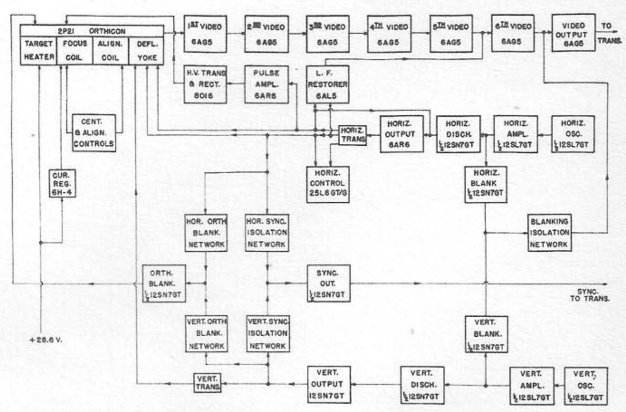

Figure 121. PH-548/AXT-2A Camera (block diagram).

If the scanning section of the Image Orthicon tube was allowed to operate during the vertical and horizontal retrace periods, the scanning beam would discharge all the image charges which it touched, producing dark retrace lines in the light portion of the picture. To avoid this, a method known as Orthicon blanking is employed, stopping the electrons of the beam before they reach the target. This is accomplished by applying the slightly peaked sawtooth voltage from the vertical output tube to the grid of an Orthicon Blanking tube through an isolation network which differentiates the sawtooth waveform to produce positive peaks at vertical frequency. Likewise, the horizontal blanking is effected through the use of pulses from the horizontal output circuit. Negative pulses of horizontal and vertical frequency, fed from the blanking tube, are applied through a coupling capacitor to the target.

The Image Orthicon camera represented the final step in development as far as BLOCK equipment was concerned. This camera made it possible to use BLOCK equipment on dark cloudy days or at twilight.

<u>BLOCK III Goes to the ETO and to the Pacific:</u> During June, 1944, a "Castor" glide-bomb group was sent to England. Castor was the code word for the use of "war-weary", television-equipped B-17 and B-23 bombers as guided missiles. The aircraft were to be loaded with tons of explosives and guided into targets by television and radio-control equipment. The television equipment used in these heavy bombers was identical to that used in the glide bombs, except that power was derived from the electrical system of the airplane, and a selsyn compass indicator was added to the camera. This compass projected a course-reading directly on the upper left-hand corner of the receiving Kinescope, superimposed on the picture information.

The first raids employing GB-4 glide bombs (Figures 122 to 132) were made against the rocket-launching sites at Calais, and against the German-held submarine pens at LeHavre and La Pallice, France. These targets were located in such a manner that it was necessary to approach them from over water. For tactical reasons the bombs were dropped from 20,000 feet. The total flying time of the bomb was about six minutes.

During the first two raids such heavy interference was encountered in the control plane that the picture was useless for all practical purposes, although occasional glimpses of the target were had. An observation plane, however, which stayed about 50 miles behind received an excellent picture during the entire flight. This suggested multipath reflection as affecting the picture in the control plane. Particular phenomena observed during the flight of one bomb indicated multipath reception as the cause for loss of synchronism. Reflections were finally reduced to a minimum by shifting the position of the

the television receiving antenna on the control plane. The experience, however, emphasized the need for a wide ratio between the strengths of direct and reflected signals.

It was in August in 1944, in the Northern Solomons near Bougainville, that the Navy first used a television-equipped guided missile, when TDR-1 drones were used against Japanese shipping. A mission about two months later resulted in the destruction of an important Jap radar station and anti-aircraft position -- a target that had come unscathed through many conventional bombing attacks.

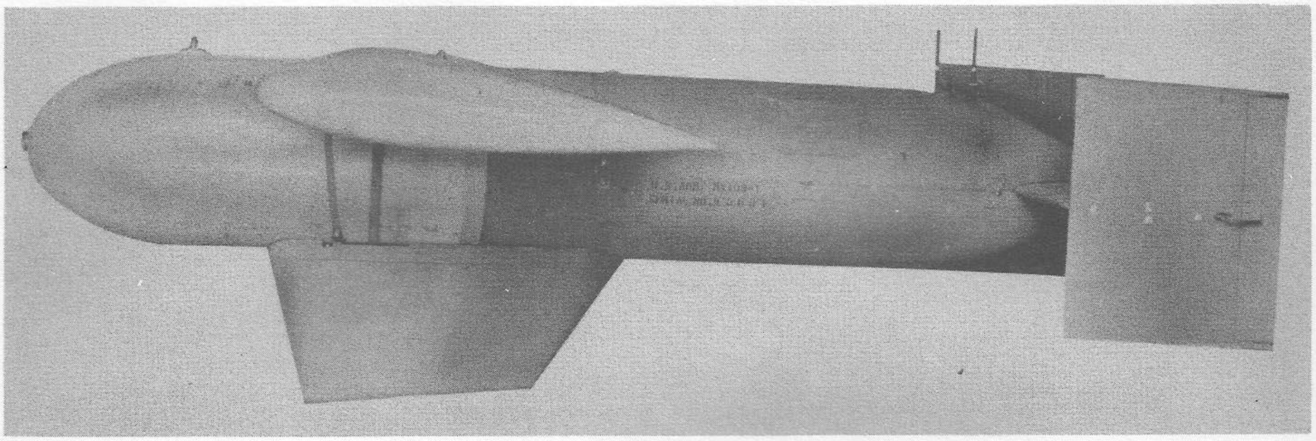

Figure 122. A Side View of the Army's GB-4 Radio-controlled, Television-equipped Glide Bomb. The light-colored front third of the cylindrical body was a 2000-pound demolition bomb. Contained in the after part were the television transmitter, radio-control receiver and the servo-control mechanism.

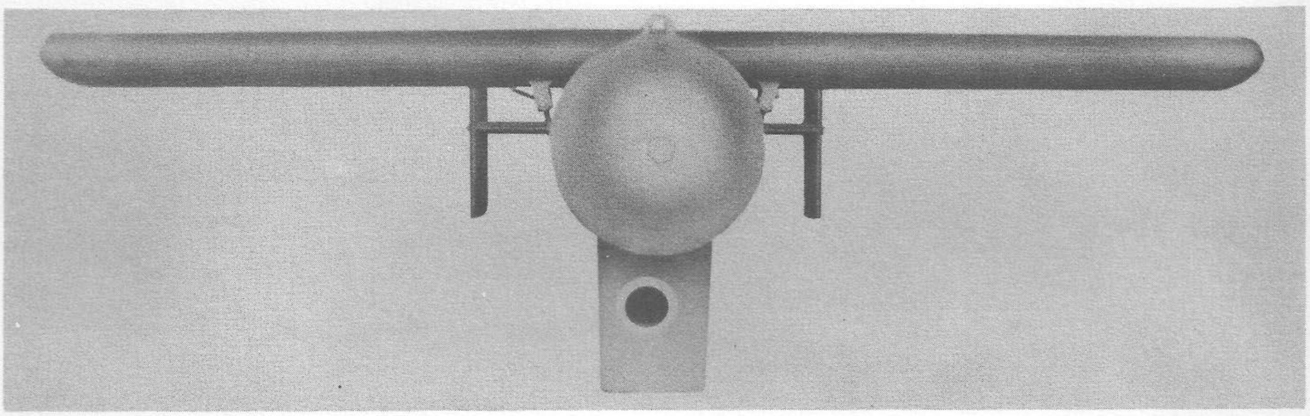

Figure 123. A Front View of the GB-4. The small wing surfaces gave the bomb an 8-to-1 glide angle, allowing it to be dropped at some distance, laterally from the target.

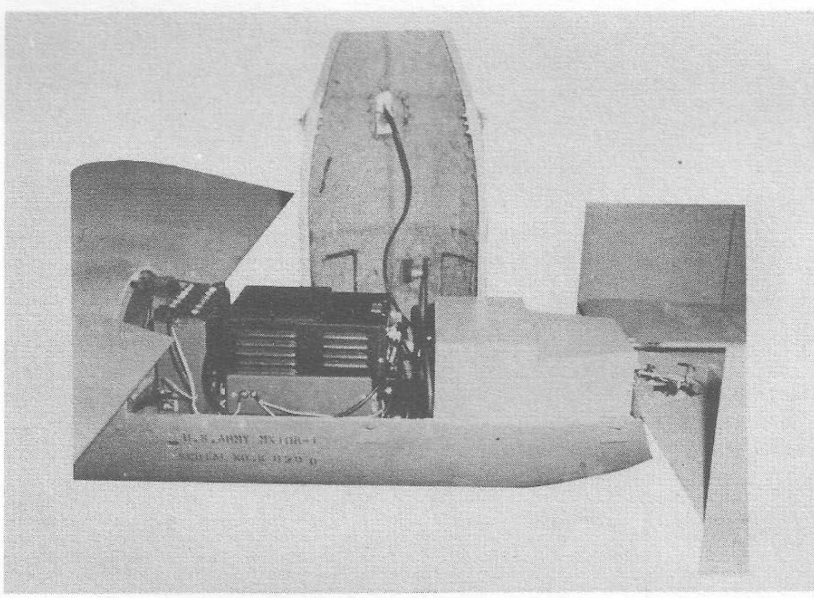

Figure 124. Rear Section of the GB-4 Glide Bomb with the Upper Half of the Fuselage Removed to Show the Transmitting and Control Equipment.

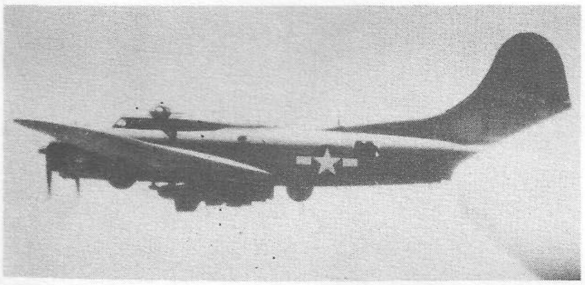

Figure 125. A B-17 Flying Fortress Equipped with Two GB-4 Bombs.

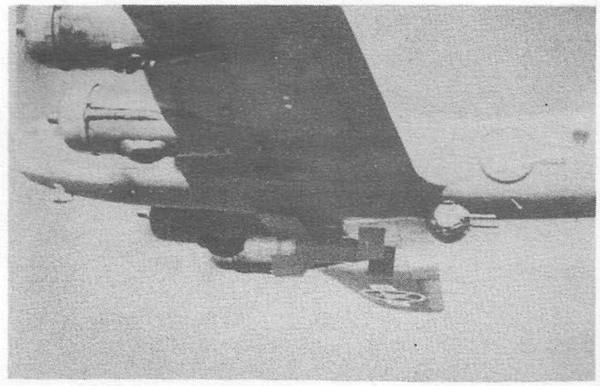

Figure 126. Within 10 to 15 miles from the target, the GB-4 is released from an external bomb rack.

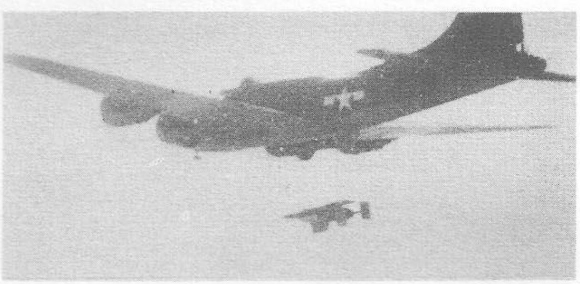

Figure 127. A GB-4 Glide Bomb just after being dropped from the mother plane. The mother plane can now circle at a safe distance from the target, while controlling the bomb to the target.

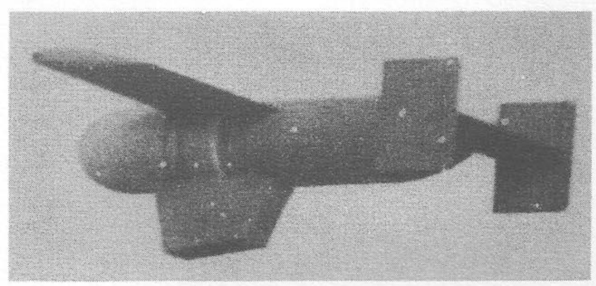

Figure 128. GB-4 Glide Bomb in Flight. The television camera in the nacelle is tilted slightly downward. In flight the direction of travel is always slightly downward from the fuselage centerline.

Figure 129. The target area at Elgin Field, Florida, as pictured by the television camera in the GB-4 Glide Bomb. The target is a small pyramid in the center of the white circle.

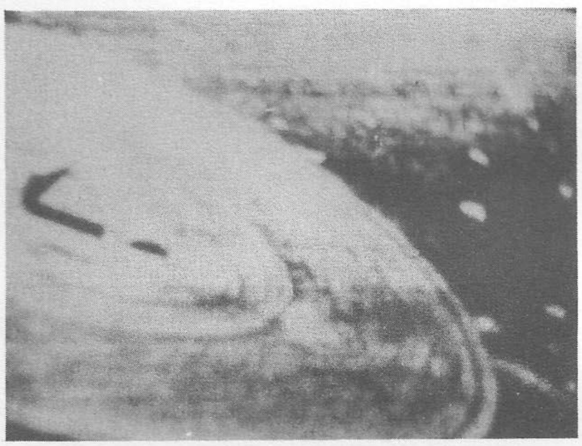

Figure 130. In this view the GB-4 has approached much closer to the target. The picture was tilted by applying course correction to the bomb.

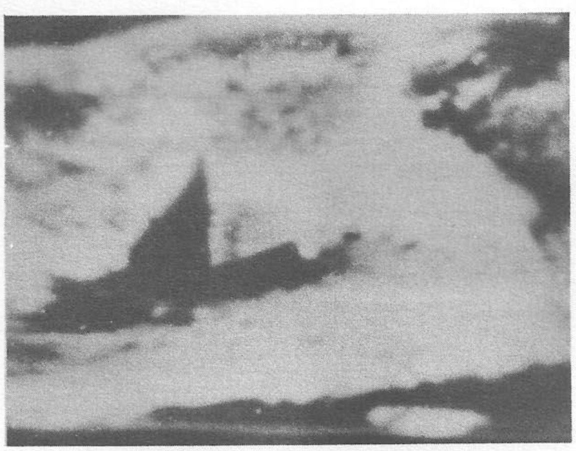

Figure 131. This view was recorded just before the bomb struck the target.

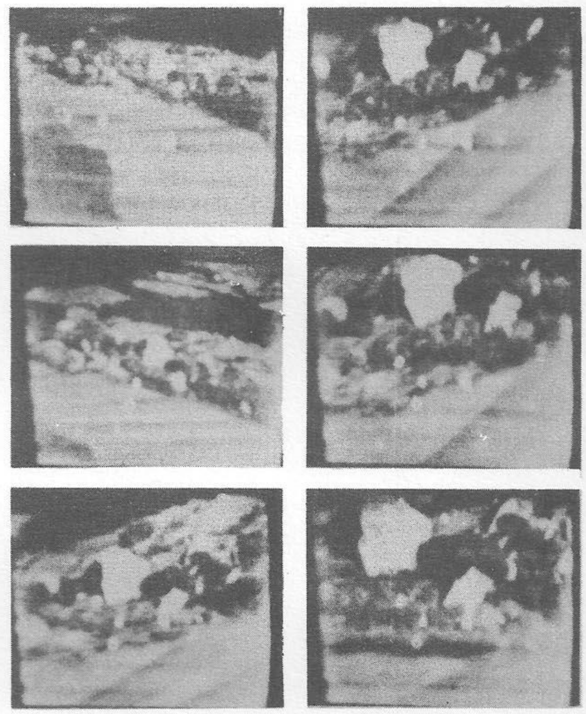

Figure 132. The series of pictures above are single frames enlarged from a 16 millimeter movie showing a GB-4 Glide Bomb approaching a target in Germany. The target is the white object in the center of each picture.

SECTION VI

MINIATURE IMAGE ORTHICON EQUIPMENT -- "MIMO"

Early in 1944 it became apparent that new military uses for television might be found if the equipment could be made smaller and lighter. A study was made by RCA Laboratories of miniature tubes and other components to determine whether they could be used in the wideband amplifiers, constant-current power supplies, blanking, deflecting, and other circuits peculiar to television. Based on this work, it seemed worthwhile to develop a miniature Image Orthicon camera and a correspondingly small transmitter.

A particular application for the proposed equipment was the "ROC" missile, a new, medium-angle bomb developed by a western aircraft company. The services requested that a miniature television set be developed specifically for this bomb.

By July, a general design for the television system was completed. The system was to consist of a small cylindrical camera placed in the nose of the missile, a small transmitter and power supply in the after part, and a dipole antenna on the rear of the missile. The first model, constructed in October of 1944, was sent to RCA's Advanced Development group in Camden. With the completion of design, eleven equipments were manufactured and delivered.

The entire MIMO equipment (Figures 133 to 139), including camera, transmitter, power supply and shock mounts weighed only 50 pounds -- half the weight of BLOCK III equipment. The Miniature Image Orthicon pickup tube developed for the project was patterned on the LM-15 Image Orthicon but was much smaller, measuring one and one-half inches in diameter and nine inches in length (Figure 133). The new tube, designated as LMS-15, was capable of resolution in excess of 200 lines per inch, but a BLOCK III receiver was to be used in the mother plane, so the MIMO deflection circuits were designed to produce pictures of 350 lines, sequentially scanned, at a frame frequency of 40 cycles per second.

The 300-megacycle MIMO transmitter utilized two 2C43 lighthouse tubes in a grounded-grid oscillator linked to two 2C43 tubes connected in push-pull as the grounded-grid power amplifier. Resonant lines were used in the plate and cathode circuits of the oscillator, and in the cathode and plate tank circuits of the power amplifier. The mixed video and sync output of two 6V6 beam tetrodes connected in parallel grid-modulated the amplifier. An RCA 9006 diode coupled to the antenna provided antenna tuning current to a plug-in meter.

At first, it was thought that provision should be made to adjust the antenna to any frequency within the MIMO band; therefore, an adjustable antenna was designed. Later, however, the design was revised and all variable adjustments were removed. The bandwidth of the fixed-tuned antenna proved to be adequate.

The radiator arms of a dipole were fastened to opposite halves of a split support tube. These halves of the support tube were insulated by filling the tube with solid dielectric. The inner conductor of the coaxial line was tied to one of the halves of the support tube.

The mother plane television antenna consisted of two dipoles identical to those used on the ROC missile. Mounted on the underside of the plane and oriented so that their extended axes intersected at 90 degrees, these dipoles were fed equally and in phase.

A cylindrical camera to fit snuggly in the ROC missile was constructed by mounting the tubes and other components on three disc-shaped chassis surrounding the pickup tube. The chassis, focusing coil, deflecting and alignment coils were assembled about a steel tube which also supported the lens mount. The camera case was airtight, providing normal atmospheric pressure for the circuits regardless of altitude. The required controls passed through special vacuum-tight bushings in the front of the case. The lens end of the case was covered with a flat optical glass treated on both sides with non-reflecting film.

The four-stage video amplifier, employing RCA 6AK5 tubes, was flat to four megacycles. A conventional high-peaking grid circuit in the third stage compensated for the high-frequency attenuation of the Image Orthicon output circuit. Reinsertion of the low-frequency components, lost in the small coupling capacitors of the preceding stage, was accomplished by clamping the grid of the fourth video amplifier stage to the black level. The clamping, which also removed amplifier microphonics, was performed by an RCA 6AL5 duo-diode tube. Pulses for the clamp circuit were obtained from the horizontal deflection coils. Video blanking was added in the plate circuit of the fourth picture stage. The cathode output stage operated as a clipper, setting a level of 0.3 volts, and tending to limit the video output to 0.6 volt, peak-to-peak.

MIMO FLIGHT TESTS: Several flight tests were made between December, 1944 and August, 1945, using the new MIMO equipment. Television-equipped, radio-controlled ROC "birds" were dropped over the bombing ranges at Santa Monica, California, Wendover, Utah, and Inyokern, California.

An account of one of the early tests emphasizes the disturbing effect multipath reception had on the received picture. On

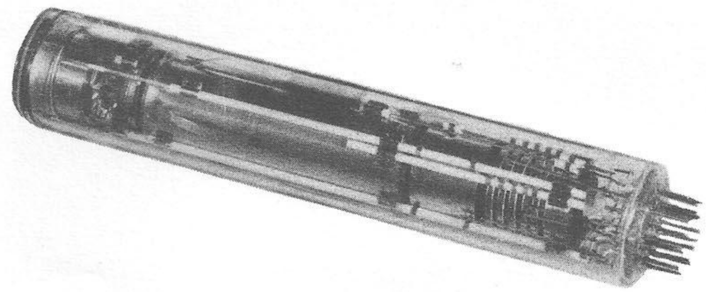

Figure 133. The Miniature Image Orthicon Pickup Tube, Type 2P22, which helped to make possible the small MIMO Television Equipment.

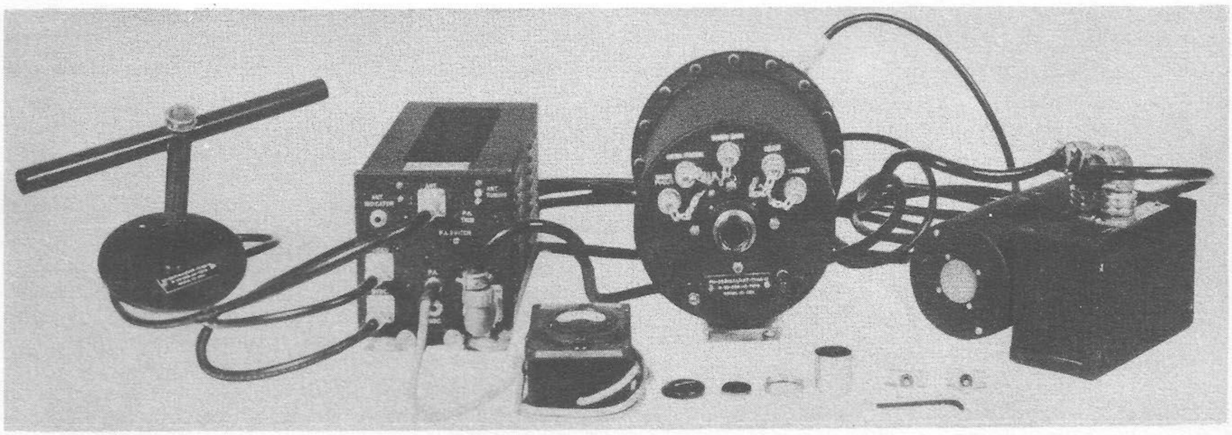

Figure 134. The Complete MIMO Equipment: Antenna, Transmitter, Camera, Dynamotor Power Supply and Transmitter Tuning Meter.

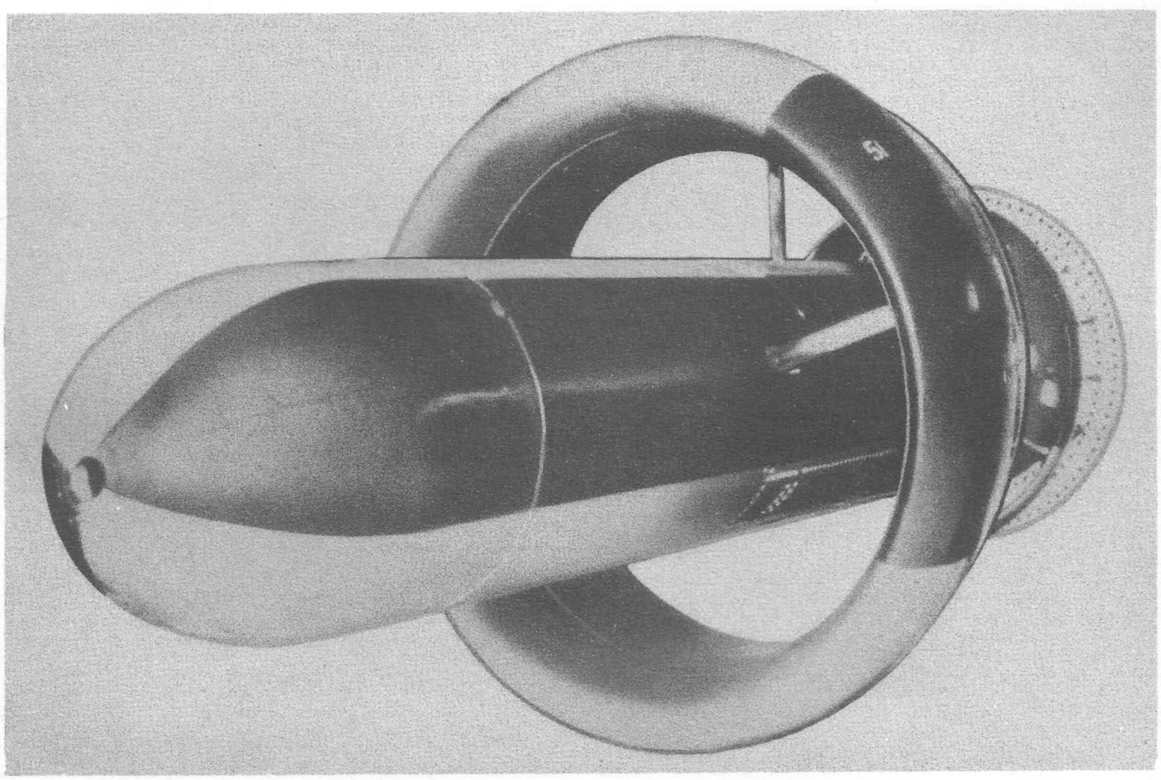

Figure 135. This is the "ROC," the High-Angle Bomb for which MIMO was designed.

April 25, 1945, a B-17G carrying in its bomb-racks two MIMO-equipped missiles (T2 and T3), flew at 15,000 feet above the target area at Wendover. Several "dry" runs were made with T2 operating, and an excellent picture was obtained. A bomb run was made and the missile released. The target came into view after about 12 seconds. The picture was excellent throughout the drop of the missile. Another dry run was then made with T3 operating. Again the target was seen, and the picture was satisfactory. Then T3 was dropped. The target came in to view and the picture was useful during all but the last ten seconds of the missile's flight. To compensate for gravity, some sail had been applied. This brought the missile over and past the target. Controls were then applied to bring it back. As the bird swung around to come back, severe multipath patterns, caused by relatively high groundward radiation from the MIMO antenna, nearly obscured the picture. The missile, after overshooting the target, was brought back too far and actually fell 108 feet short of the target.

In the course of further tests, improvements were made in the technique of releasing missiles. Also, the very fast a-v-c circuit developed for the BLOCK receiver was of great value in reducing interference from multipath Doppler effect. But results of the tests indicated that a still further reduction was necessary. This, it was thought, could be effected by better transmitter-antenna design and the use of a high carrier frequency.

The development of the high-sensitivity airborne television transmitting equipment and its application to the ROC missile was not completed in time to be of service before the war ended. This may be attributed partly to the complexity of the project and partly to the relatively abrupt termination of the war. Nevertheless, the project was successful in many respects.

A television camera was developed which was much smaller and lighter than previous cameras. It was sensitive enough for most outdoor, daytime applications with ordinary lenses. When fitted with a Schmidt optical system, its sensitivity approached that of the eye, and the camera could probably be used near dawn and dusk. The camera, sufficiently rugged mechanically, and in all respects suitable for operation in aircraft at practically any altitude, accommodated a wide range of light values without readjustment. It was easy to operate and its performance was reliable.

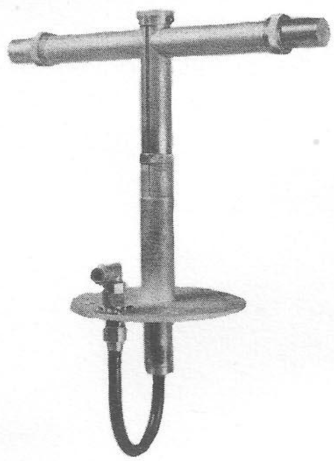

Figure 136. Closeup of MIMO Antenna Showing Basic Design. This is an early experimental model. The variable adjustments were removed in the production antennas.

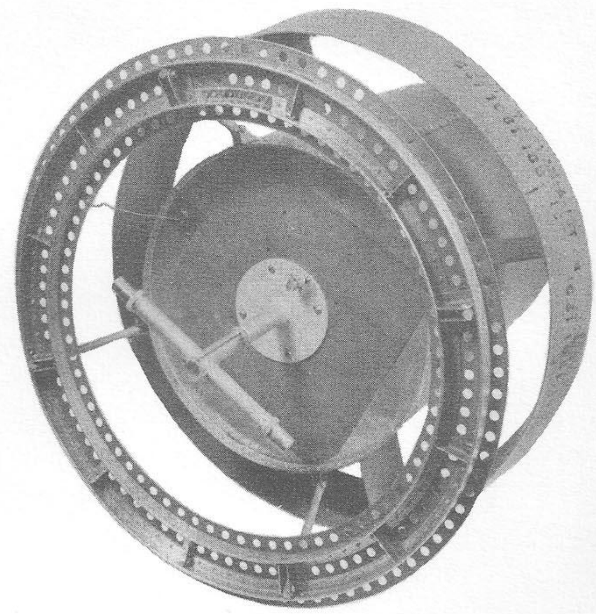

Figure 137. MIMO Antenna Mounted to Tail of ROC Missile. The outer "spoiler" ring of the missile was used as a receiving antenna for the radio-control signals.

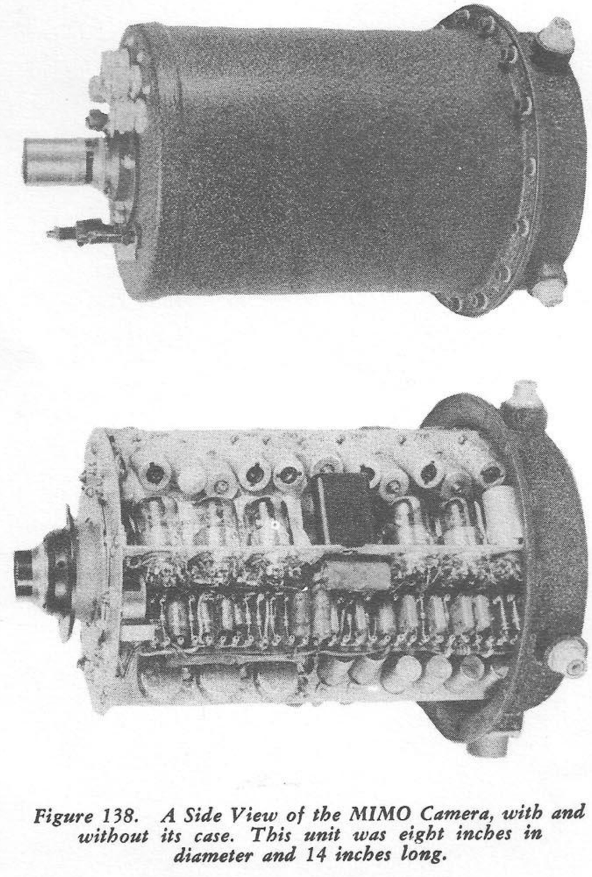

Figure 138. A Side View of the MIMO Camera, with and without its case. This unit was eight inches in diameter and 14 inches long.

Figure 139. The MIMO and BLOCK III Transmitters Compared in Size.

SECTION VII

"RING" -- A Deluxe Airborne Television Equipment

BLOCK and MIMO airborne television sets were designed for guided missiles, and therefore were made just as small and lightweight as ingenuity could make them. The 15 or 20 watts which they put out provided ranges up to 20 miles, and this was sufficient for the purpose. However, when television equipment of this type was mounted in reconnaissance planes, and used to transmit a picture back to headquarters, it was obvious that greater transmitter range was desirable. Since the weight and size requirements for this use were less critical, a transmitter of greater power was permitted. Such an equipment, named RING, was developed for a Navy project on which RCA was the contractor and the NBC Engineering department the subcontractor.

Two Image Orthicon cameras were provided, one to be used in the nose of the aircraft and the other in the fuselage near the tail. The receiver and monitor were generally similar to BLOCK equipment, but somewhat more elaborate. The most important difference was in the RING transmitter, which had a power output of approximately a kilowatt at 100 megacycles. This power, radiated from a non-directive antenna mounted on the underside of the fuselage, produced good pictures at a distance of 200 miles and at an altitude of 22,500 feet.

The RING transmitter is shown on the next page in Figures 140 and 141.

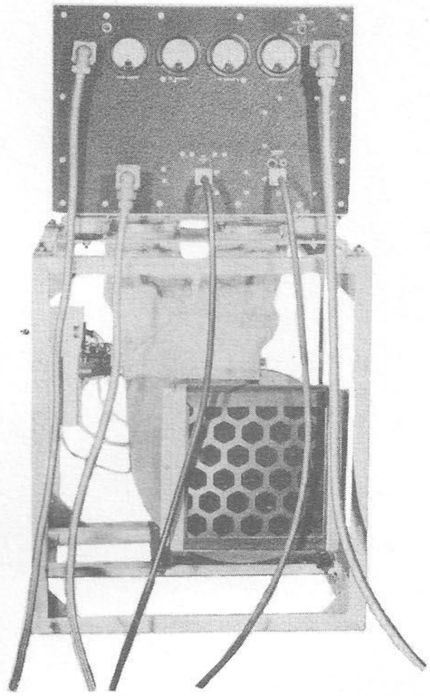

Figure 140. The One-Kilowatt, 100-Megacycle Transmitter and Associated Air Blower Used with the RING Equipment.

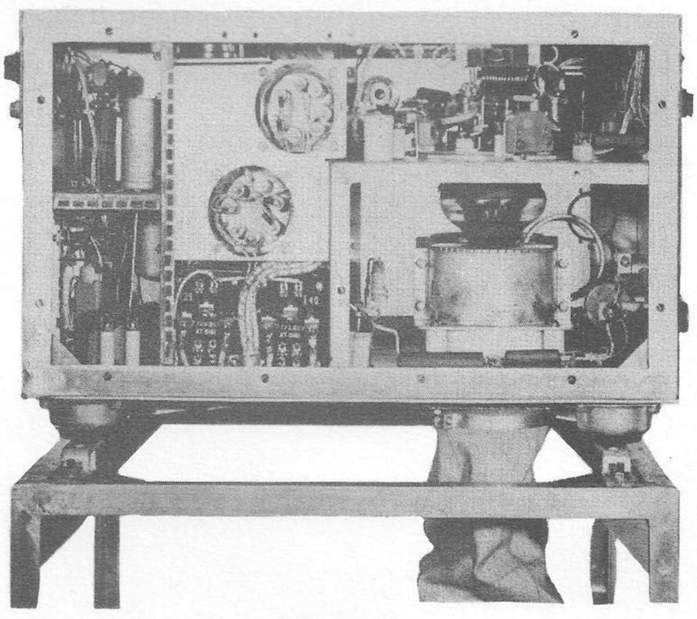

Figure 141. An Interior (Side View) of the Transmitter. Two RCA 827-R tubes in the output stage provided a power of one kilowatt at 100 megacycles.