ITEM No. 1 & 6
FILE No. XXVIII—41

INSTITUT FUR PHYSIKALISCHE FORSCHUNG

NEU DROSSENFELD

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COMBINED INTELLIGENCE OBJECTIVES
SUB-COMMITTEE

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INSTITUT FUR PHYSIKALISCHE FORSCHUNG
NEU DROSSENFELD

30 June 1945

Reported by:

Mr. WALTER HAUZ, U. S. Ord.

CIOS Target Nos. 1/725 & 6/109
Radar
Directed Missiles

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE
G-2 Division, SHAEF (Rear) APO 413

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INSTITUT FUR PHYSIKALISCHE FORSCHUNG
NEU DROSSENFELD

Target No. - Target of Opportunity

I. SUMMARY

This institurte worked on a television type homing device before American occupation, and tested it successfully. They are continuing now so a demonstration may be given to Allied representatives. The leader of the group and inventor of the device is Dr. Werner Rambauske. The Institut was attached to the Gesellschaft fur Forschung und Entwicklung (Berlin), which was chiefly sponsored by the Luftwaffe.

II. EXPLOITATION OF THE TARGET

The target was assed on 1-2 June 1945 by Capt. R. A. Wright and Lt. G. E. Gross, a CAFT Group II team. They visited the spinning mill to the North of Bayreuth in which the subject institute of this report had occupied a wing. The leader of the group, Dr. Werner Rambauske, was there. He was interrogated and revealed the dispersal at Neu Drossenfeld (North of Bayreuth) where, in a small shop on the second floor of a Gasthof, his group was repairing radios and continuing work on the device. A description of the device (in German) and a short biography of his life (in German) were prepared by Dr. Rambauske, and the device was discussed with the assessors with the aid of Mr. Burghoff, a friend of Dr. Rambauske who spoke some English. The assessors were sufficiently interested in the device to encourage such further work on it as might be necessary for a demonstration. One safe, containing technical documents, was dynamited and the documents evacuated. Another, partly covered by a wrecked roof, was left for the later investigaters. A military guard was posted at Neu Drossenfeld but the spinning mill was left under German civilian guard.

The writer of this report, requested to investigate the target by G-2 T Branch, 12 AG Hq., interrogated these men on 19 and 20 June. The demonstration was not yet ready, but some schematic diagrams, used as illustrations in this report, had been prepared. The spinning mill site was visited, and it was found that the second safe had been blown in the interim and looted by unknown persons. As the spinning mill was only under German civilian guard it could not be ascertained who had done this. However, this second safe is said to have chiefly contained personnel records, stamps, and material records, and not technical information.

The writer, believing that the device justified some investment, urged that the demonstration plans be continued. Means for sponsoring the work to prevent disintegration of the organization before a demonstration can be given were discussed with the commanding officer of G-2, Ninth Armored Division at Bayreuth. He was very willing to cooperate with all means in his power, but was unable to authorize subsistence wages for the employees on the project. Third Army Forward and Rear, G-5 were also unable to authorise this, so action must originate on a higher level (see Recommendations).

III. HISTORY OF THE TELEVISION HOMING DEVICE

Dr. Rambauske apparently became interested in an "automatic electric eye" in connection with his astronomical and electron optical work in 1939. The Luftwaffe were mildly interested and some patents were taken out. During his employ by Gollnow and Sohn, 1939-41, he did some work on it with the cooperation of Firma Fernseh GmbH on the iconoscopes. No immediate success was met so Gollnow let it drop. In 1941, he became employed by Askania A.G. as scientific consultant and head of a small department for high frequency work. At this time he took up the project again because of general progress in the field.

He worked at the Berlin plant of Askania until it was bombed out in 1943. The project then moved to a branch plant at Stargard/Pomerania. Dr. Gerlich of Zeiss-Ikon Dresden was now doing the work on the iconoscopes. Some government decision removed electronic work from Askania, which was primarily a mechanical device manufacturer (gyroscopes). It was proposed to transfer the project to Zeiss-Ikon, but this could not be arranged, so a separate organization was created, with Dr. Rambauske as leader and was named the Institut fur Physikalische Forschung. This organization received its money and men from the RLM and the Arbeitsfront, and was, along with many other similar small institutes, under the supervision of the Gesellschaft fur Forschung und Entwicklung. The latter had headquarters in Berlin and was headed by Dr. Lafferentz. Figure 1 shows an organization chart as prepared by Rambauske.

The new organization occupied one wing of the Neue Baumwollspinneri (spinning mill) at Bayreuth. When this was caved in by bombing early in 1945, work was continued in a second floor workshop above a Gasthof in Neu Drossenfeld. Some space for storage and eventually work was engaged in Kulmbach, also North of Bayreuth. When the Americans occupied the towns, Rambauske destroyed completed models as ordered by the Germans, but retained incomplete apparatus and some iconoscopes.

The device had allegedly been successfully tested on the Madusee near Stargard/Pomerania in the autumn of 1944. The tests consisted of putting the device on one motor boat and having it track another motor boat under various maneuvers. Another method of testing consisted of an illuminated screen across which simulated targets were moved by fine wires. This type of demonstration was also successful.

IV. HISTORY OF DR. RAMBAUSKE

Born 18 March 1911 in Breslau, moved in 1923 to near Stettin, where all his family except his sister now are. Attended a Gymnasium, then the Universities of Wurzburg, Munich, Gottingen and Berlin, where he studied mathematics, physics, astronomy and music. He stayed for a year at the astrophysical Observatory at Potsdam and took his doctorate under Professors Grotrian and Guthnick in 1938.

Employed by Gollnow and Sohn in Stettin, he applied his electron-optical interests to X-Ray inspection of welded joints. He claims to have practically completed an electron optical fluoroscope which would permit direct visual observation without lengthy photographic procedures of materials that transmitted far too little X-Rays for the use of ordinary fluoroscopes. The principle was a thin screen covered with bismuth needles like crystals. A few electrons are emitted under the influence of X-rays, and a simple electro-optical system accelerates these electrons to 80,000 volts before they impinge on a fluorescent screen. Chief troubles were field emission from the bismuth needles, but shaping of the electrodes and proper treatment of the screen allegedly cured this. The device then was a X-ray-electron-optical amplifier. It was patented and working models were made, but then the war came and other work had to be undertaken.

The Postamt was very interested in building a super-radio station for propaganda use near Dresden. They were having trouble with their antenna construction, although everything else was coming along on schedule. Therefore, they offered a prize of five million Reichsmarks to the company that would submit the best design of antenna. Rambauske claims that Gollnow and Sohn won the prize through his efforts. Twenty two patents were taken out on his design, which involved many new features in insulators, guy wire construction and tower construction. He would not reveal many details, saying he would like to talk to an expert on low frequency antennas. The specifications required that the antenna be for a 1400 meter, 20,000 KW transmitter. R-f voltages up to 200,000 volts were involved. Ten towers in a ring, each about 320 meters high and tapped by a huge capacitor were required for proper load distribution and direction control. Although the prize was awarded, after tests on submitted insulators and samples of construction the antenna was never built because of insufficient allotted funds.

After this, the television homing device project received the most attention, as described in "History of the Television Homing Device". Rambauske now lives at Neu Drossenfeld, with his sister, near his shop.

V. TECHNICAL DESCRIPTION OF TELEVISION HOMING DEVICE

(a) General

Two forms of the device were under development and construction; a large form was to be used in missiles where weight and size specifications were not very restrictive, such as the BV 243 missile and the LT 950 air-launched torpedo; and a small compact form for use where specifications of weight and size were confining, such as the HS 296 and Enzian missiles. Both forms were identical in principle, but the larger form could contain several refinements, more tubes, and a larger iconoscope, increasing the accuracy and reliability. The smaller unit weighs about 5.5 lbs. and has a size of about 8" diameter and 8" length.

A block diagram of the device is shown in Figure 2. The device is essentially an eye, a brain, and muscles only for directing the eyeball. The muscular, or servo, system to direct the missile in the direction that the eye is looking (or some derived path) is left to the designers of the individual missiles. Stability troubles due to this separation of function may not be serious since the moving parts of the homing device are extremely light and time constants involved are much shorter than those present in the aerodynamic control.

As the block diagram indicates, an image of the target is focused on the screen of an iconoscope by a mirror and lens system. Device AT (Abtast gerat) produces voltages to scan the iconoscope mosaic spirally. The iconoscope output signal is amplified by the IV (Impuls verstarker) then delivered to the IW (Impuls wandler) which changes the signal into a square wave pulse of a duration corresponding to the direction of required correction. Device AS (Abschalt gerat) resolves this, with the aid of a synchronizing signal from the spiral scan generator, into two d-c signals proportional to the required correction on the two axes. Each d-c signal is applied to a bridge circuit (MS) where it changes the inductance of two saturable reactors, thus shifting the phase of the bridge output. A multi-winding simple induction motor rotates in a direction determined by the phase shift and, through a worm and gear, drives a light mirror supported on two gimbals in the direction required to bring the target back to the center of the iconoscope screen.

(b) Iconoscope

The iconoscope used in both the small and the large units was specially developed by Zeiss Ikon (Dresden) by a Dr. Gerlich, to specifications and suggestions made by Dr. Rambauske. Under Gerlich, a chemist named Dr. Krohs worked on the screen materials.

The iconoscope combines some of the features of the Farnsworth and the Zworykin types. The image is focused on a photocathode, which gives off photoelectrons that are accelerated by an electric field and are focused by a magnetic field onto a mosaic designed to have a high secondary emission ratio. The mosaic globules charge in proportion to light density, and a scanning beam excites a response dependent on the charge at that point. See Figure 3.

The photocathode screen can be made, as desired, to have a particular spectral response that is best for the application. The units available have a photoscreen of antimony and caesium oxide, lightly coated with silver for conduction. (A type known before the war, says Dr. Rambauske). One advantage of this type of iconoscope is that more than one focal point is available by proper choice of accelerating voltage and focusing current, giving different sized images simply. At least two combinations gave a sharp image, said Dr. Rambauske. The accelerating voltage used in units already made is 1000 volts.

The mosaic consists of a material of high secondary emissivity sputtered on a thin insulating sheet backed up by a silver conducting layer. A ten to one amplification by secondary emission was claimed. The material contains caesium and other components worked out by Dr. Krohs. The sputtering density is 10,000 per mm^2. The insulating base used in the units available is TiO_2 (dielectric constant 80) of 0,4 mm thickness. It was made by Hermsdorf Schomburg A.G. (Hescho). This company was working on a similar base of a material with dielectric constant 200. Another place (Prof Guddin of Prague) was attempting to use a thin cuprous oxide coating as a base which would have lower resistance but higher capacity.

The electron gun accelerates a 25 microampere beam to 1000 volt potential. Electrostatic focusing and electrostatic deflection are used. Shading signals are claimed to be no source of trouble in this device, because they include only such low frequencies as the fundamental rotary frequency of scan and can easily be removed by proper amplifier characteristics.

(c) AT...Scanning Voltages

The deflection voltages and related voltages are obtained from the Abtastgerat (literally sampling or scanning) as shown in Figure 4. Three tubes are used, a sine wave generator, a sawtooth wave generator, and a mixer which modulates the amplitude of the sine wave in sawtooth fashion. The output of the mixer contains a phasing network to give the required ninety degree phase difference between the horizontal and vertical deflecting voltages.

The lower left tube is the sine wave generator consisting of an EF12 pentode. A conventional oscillator circuit is formed by the cathode, control and screen grid circuits, the latter being the grounded electrode. The plate load circuit is electronically coupled to this 5000 cycle per second oscillator. Inductively coupled to the plate circuit are windings delivering this sine voltage to the mixer tube and to the high voltage chassis described later.

The sawtooth generator is a one tube blocking oscillator, with a fairly high oscillation frequency (order of ten MC). A short period of oscillation charges the 0,1 mfd capacitor in its cathode circuit sufficiently to throw it out of oscillation. The capacitor (or the cathode) voltage then decays exponentially until a point is reached at which oscillations again occur. The repetition period of this sawtooth voltage is 100 cps. Some synchronizing voltage from the sine wave oscillator makes the sawtooth always occur at about the same phase. A capacitor-resistor combination in the plate circuit, of fairly short time constant, provides a short reference pulse for a use described later.

The mixer is also an Ef12 with the sine wave connected to the screen grid and the sawtooth to the control grid. The output, fed to a resonant plate circuit, consists of a sine wave varying in amplitude from maximum down to nearly zero, then returning abruptly to maximum amplitude. Two coupled potentiometers control the size of the voltage delivered to one pair of deflecting plates, and another pair of coupled potentiometers is connected to the other pair of deflecting plates through two resistor-capacitor circuits. Both sets of deflection voltages are balanced to ground.

A proposed modification would incorporate in the iconoscope the function of the mixing tube for the spiral scan. A polar electrode would be used in addition to the two pairs of deflecting plates. This polar electrode would consist of a central road and a concentric tube. The beam, caused to scan a small circle by the voltages on the deflecting plates, could be moved to any radius by the proper potential difference on the polar electrode. A sawtooth voltage applied to this electrode would result in a spiral scan if sinusoidal voltages are on the regular plates. It was further proposed to make this electrode trigger a small glow tube or thyratron when the spiral decreased till the electron beam touched the central rod. This would cause the spiral to again jump to its outermost position.

(d) HG...High Voltage Supply

The high voltage supply (Hochspannung Gerat) includes a single tube - an EBF11. See Figure 5. The a-c (5000 cycles) supplied by the AT device described above is amplified by the pentode section, stepped up by a transformer, and rectified by the two diode sections of this tube. After filtering, a supply of -1000 volts is available for use on the iconoscope cathode. The pentode output is also used to supply two quadrature phases of reference sine waves (uniform amplitude) to the Abschalt Gerat. Batteries are used for the 300-volt supply and planet supply.

For short flight missiles a capacitor, charged by an external source before flight, could replace the above as a 1000-volt source.

(e) <u>IV...Amplifier</u>

The amplifier for the iconoscope output signal (Impuls verstarker--IV) consists of three EF14 tubes all RC coupled and with cathode bias. (Fig. 6) The last stage has, however, a transformer for a plate load, and, since it is a pentode, the output picture impulse (Bildimpuls ausgang) is the derivative of the input signal. Slow changes of light intensity are eliminated in this amplifier; only sudden contrasts produce an output. The response is made low below about 75 KC and is peak between about 150 and 250 KC.

(f) <u>IW...Impulse Changer</u>

The Impulswandler (IW) or signal changer is one of the key ideas of this project. Two forms are presented in Figures 7 and 8. The simplest form, shown in Figure 7, uses only one tube and was used at first in the small version of the device. It is inferior in versatility, so Dr. Rambauske believes the more complex circuit of Figure 8 will be used always. The basic function of this section of the device is to convert a small pulse, indicating a change of contrast--or the target--, into a square pulse of definite length, 1/20,000 second, and constant amplitude, which can be resolved into control signals on two axes.

In the simple circuit of Figure 7, an EF12 is used as a blocking oscillator at a frequency of about eight megacycles. A potentiometer connected to a twenty volt bias battery is adjusted so that oscillations cannot occur unless a trigger signal of more than a definite size is received. When such an impulse is received, oscillations begin quite quickly and continue until a 5000 picofarad condenser in the grid circuit becomes sufficiently charged by grid current to make oscillations unstable. The time constant of the circuit associated with this capacitor is rather long so that any normal trigger signal will not key the oscillator again until nearly one "frame" (1/100 sec) later. Thus, only one impulse per frame is received, and not one each "line" or circle of the spiral. The square pulse in the plate circuit is transformer coupled to a center-tapped winding to give both a positive and a negative pulse simultaneously.

The more complex circuit of Figure 8 cures certain disadvantages of the one-tube circuit. The exponential decay of the grid bias in Figure 7 would permit a larger or brighter target in the field of view to steal the attention of the homing device by supplying sufficient trigger to start oscillation before the inward-going spiral has reached the target. This drawback is particularly bad when the range is great so the target angle is so small that it frequently is wholly in the small dead spot in the very center of the spiral. To give better control of the blocked period, a separate tube is used. To permit making just a certain adjustable ring on the screen "alive", a third tube is used.

Tube 1 is virtually the same as before except that a shorter time constant can be used in its grid circuit. Tube 2 has a circuit identical to tube 1, except that no output transformer is needed and the source of trigger is the pulse derived from the sawtooth generator, or a phase shifted voltage derived from it. Tube 3 is also a blocking oscillator which can be triggered by either of the other two, and which prevents either of the others from oscillating for about 80% of a "frame" period after it has been triggered. It oscillates for a large portion of the "frame" time so the time constant of the circuit biasing the other tubes can be made short. Thus, there is only a relatively narrow ring in which even a very large signal will cause a response.

One method of use for the device would be as follows. For, say, an air-to-air weapon, the operator observes in an auxiliary cathode ray scope the field of view of the iconoscope in the missile before firing. He can thus steer the plane or the mirror system of the missile until the desired target is centered and can maintain this while withholding fire until close approach if desired. Intensification of the spiral intensity over a narrow ring is provided to show the sensitive ring. If the pulse voltage derived from the sawtooth generator is used directly, the bright sensitive ring will consist of about the inner 20% of the spiral. If means are provided for shifting the phase of this pulse signal, the sensitive ring can be manually adjusted to just span the target immediately prior to firing. The circuits for this would be external to the missile since they are not used during flight. Particularly when the target is far away, and the angle subtended is within the central deadspot, this system will keep the sensitive ring at the center where it will not respond to other targets in the field of view but will respond to the target whenever it leaves the dead spot.

From this method of use, it can be seen that when there is no target in the sensitive ring, the trigger voltage from the sawtooth generator when applied to tube 2 maintains the sensitive ring in a constant place, but does not give any output steering signal because the output transformer is only affected by tube 1. When, however, a target signal occurs before the trigger on tube 2, tube 1 oscillates instead of tube 2, an output steering signal is caused, and the mirror system is moved to bring the target back to the center. As the target angle gets large enough to more than span the central dead spot, the sensitive ring will automatically move out to just circumscribe the target.

Tube 1 is triggered by only a positive pulse. However, either a light target on a dark background or a dark target on a light background cause proper operation. The insensitivity to low frequencies makes any large target appear as a sequence of contrast pulses, positive and negative. The differentiation changes each pulse to both a positive and a negative pulse in rapid succession, and of these the positive pulse acts as trigger.

(g) AS...Electronic Switch

The Abschaltgerat or electronic switch, shown in Figure 9, essentially consists of four gate tubes, each of which is maintained open in turn for ¼ of the reference 5000 cycle frequency. If a signal arrives that coincides with one of the ninety degree periods, a response goes through on only one channel, otherwise the response divides between two channels since the ¼ cycle output of the IW will overlap two channels. Time constant storage circuits lengthen the effect of the short signal, so that the effect is prolonged for a good portion of the 1/100 second frame interval. Two output tubes are provided, one for up-down control, the other for right-left control. Each operates with about four milliamperes output for no signal with increase and decrease of this causing contrary effects in the servo system.

The gate tube system, as explained by Rambauske, has four input circuits, two fed by phi 1 and two by phi 2 (quadrature components of the reference sine frequency). A self bias circuit in each lead, comprising a 1000pf capacitor and a 10 Mohm resistor and a set of four copper oxide or selenium rectifiers, cause a shifting of the sine wave with respect to ground potential, and a clipping of the tops of the sine wave at ground potential. As shown in Figure 10, each line is then at zero potential for exactly ¼ cycle. An output signal ¼ cycle long, square, and opposite in polarity at terminals I_1 and I_2 will permit the voltage on one or more of the four lines to rise above zero so one or more of the four gate tubes (EA50) will pass current, charging its time constant circuit. The presentation of Figure 10 is schematic in that since half the gate tubes conduct in one direction and half in the other direction, two of the clipped sine waves must be above the ground potential and two below.

(h) MS...Bridge Circuit

The d-c output of each of the two tubes of the AS gerat, which is normally about four milliamperes but varies from two to six for extreme signals, is delivered to the bridge circuits of Figure 11. Two resistors and two inductances comprise each bridge. If the impedance of the resistors is about the same as that of the reactors, then the midpoint of one pair of bridge arms lags and the other leads the input voltage by 45 degrees. Thus, the voltage across the two midpoints, or the bridge output, differs from the input voltage by about 90 degrees. Changes of inductance, caused by changing the d-c saturating currents from the AS gerat will for a limited range shift the phase of output without appreciable effect on amplitude. A reference voltage is derived also from the voltage source. This is shifted about 90 degrees by a series capacitor, so is approximately in phase with the bridge outputs. The bridge adjustments are such that it is accurately in phase with the bridge output when no steering signal is received.

(i) Servo Motors

The motors used are a very simple form of induction motor, or "Ferraris" motor. The reference winding and the control winding are spatially at right angles. A stationary induction motor will have no torque when both windings are in phase but will tend to rotate in the direction of phase rotation if the phase of the windings differs. Thus, a decrease in As output causing, say, a lag in bridge output phase will cause one direction of motor rotation, and an increase of AS output cause the reverse rotation.

The motor, specially designed to have a low moment of inertia, consists of a stationary iron cylinder slotted for windings and supported by an aluminum frame. Surrounding this stator is a thin aluminum cup (thickness o,1 mm, diameter 1 cm.) which is attached at one end to a shaft passing loosely through the center of the iron stator. The bearing points for this shaft are in an aluminum cover for the motor and at the opposite end of the aluminum frame. Pivot bearings are used since Swiss small ball-bearings were no longer available. The aluminum frame has a long milled slot in which a worm gear is attached to the shaft. This drives a gear segment which operates the mirror on its gimbals.

No electrical feedback is used. There is claimed to be sufficient damping and small enough delays in the mirror system to minimize oscillation. The mirror experimentally vibrated about one degree, and it was felt that the accuracy of the midpoint of this oscillation was better than 1/10 degree. The central dead spot, which is of course only important when the target is so far away that it does not subtend that much angle, is about 1/5 degree.

(j) Mirror and Optical System

The mirror may be silvered, but is preferably rhodium coated. Heraeus in Hanau did this rhodium plating. As shown in Figure 13, the mirror is mounted on two gimbals, at right angles to each other. The outer gimbal is directly driven by one motor via a worm and segment gear as shown. This could not be done on the inner gimbal without carrying the mass of one motor on the outer gimbal, thus increasing the moment of inertia, so the construction shown in the detail is used. The inner mirror gimbal carries an arm terminated in two small wheels. A separate U frame is rotatable about a fixed axis by means of the second motor, worm and segment gear. This U frame moves the mirror about its axis by means of a thin attached tab that fits between the two wheels mentioned. Motion of the mirror about the axis of the outer gimbal merely moves the wheels to a new point on the tab.

The mirror normally deflects the light through 90° into a lens system of 20 cm focal length, f 3.5 aperture. Mirror motion through ± 20° is possible.

(k) Performance Figures

It is claimed that in tests on the Madu See in the fall of 1944, it was determined that the device was capable of tracking under all light conditions from early morning to dusk, covering light intensities from below 500 lux to above 10,000 lux (higher with filters). It could operate on contrasts as low as 8%; that is, say, background 100 and target 92. It could follow angular velocities of up to twenty degrees per second, and it succeeded in tracking one motor boat while mounted on another at distances up to 800 meters. Minimum target size on which this operation was expected was 3 x 3 meters.

(l) Uses

Dr. Rambauske visualized use of his device not only as a homing device for missiles but as a servo device or eye and brain which could be kept pointed at any source of light or shade for any application. Artillery or flak guns could be informed of the present position of moving targets, and by computers of the predicted position. The device could be used in navigation on sea or in the air to automatically point at a lighthouse, or the sun, or a star, and supply corrections to an automatic pilot.

VI. CONCLUSIONS AND RECOMMENDATIONS

Other groups, both in Germany and in Allied countries, have worked on homing devices, some on television types. This particular group did not have a high priority assigned to them by the German Government, who did not regard their project as a key one, evidently. It was apparently continued chiefly because of the enthusiasm and continued pressure by Dr. Rambauske, the inventor, and leader of the group.

He seems to be a sound engineer, and the device appears to be in a late stage of development. The investment required of the Allied military forces or Control Commission to continue the work to the point of a demonstration is small. Such a demonstration would consist of completion of one sample of the device and illustration of its ability to follow illuminated targets on a screen with varying degrees of contrast from 100% down to zero. It is estimated that this test could be made on or after August 5. A test of larger scope such as use of the device on a missile or a plane or boat would require more time and facilities from us.

It is, therefore, recommended that this group be encouraged to continue work until this simple demonstration is ready, that necessary sponsorship be provided to facilitate this work, and that personnel familiar with Allied and German homing devices of similar nature be alerted to attend such demonstration and decide whether the man or device should be further exploited.

The extent of sponsorship recommended to assure continuance of the work until a demonstration is, as a minimum:

a. Subsistence wages for his engineers and mechanics to prevent disintegration of his organization.

b. Liaison with the G-2 section of the local troops so contact may be arranged, the demonstration date may be corroborated, and needed parts such as tubes and batteries may be supplied from local stocks of captured enemy materiel, if possible.

c. A minimum of transport for the group so that material may be moved from one dispersal point to another for efficient work.

VII. ACKNOWLEDGMENTS

The cooperation of the G-2 section of the Ninth Armored Division which is in charge of the target area, is gratefully acknowledged. The source of some of the material on the history of the organization, and of Dr. Rambauske, is the German statements written by Rambauske and attached to the excellent assessment report prepared by Capt. R.A. Wright, A.C., and Lt. G. E. Gross, Ord.

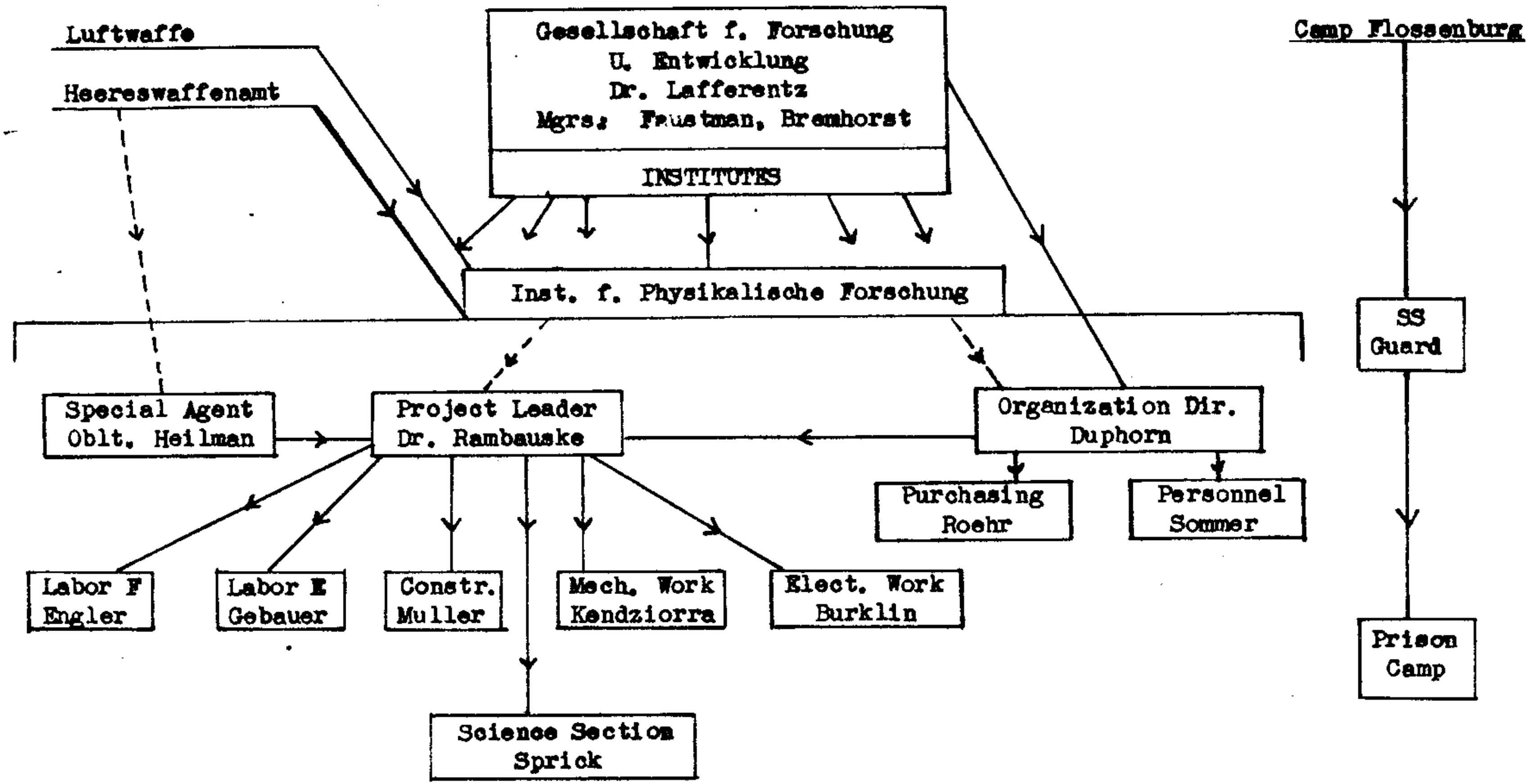
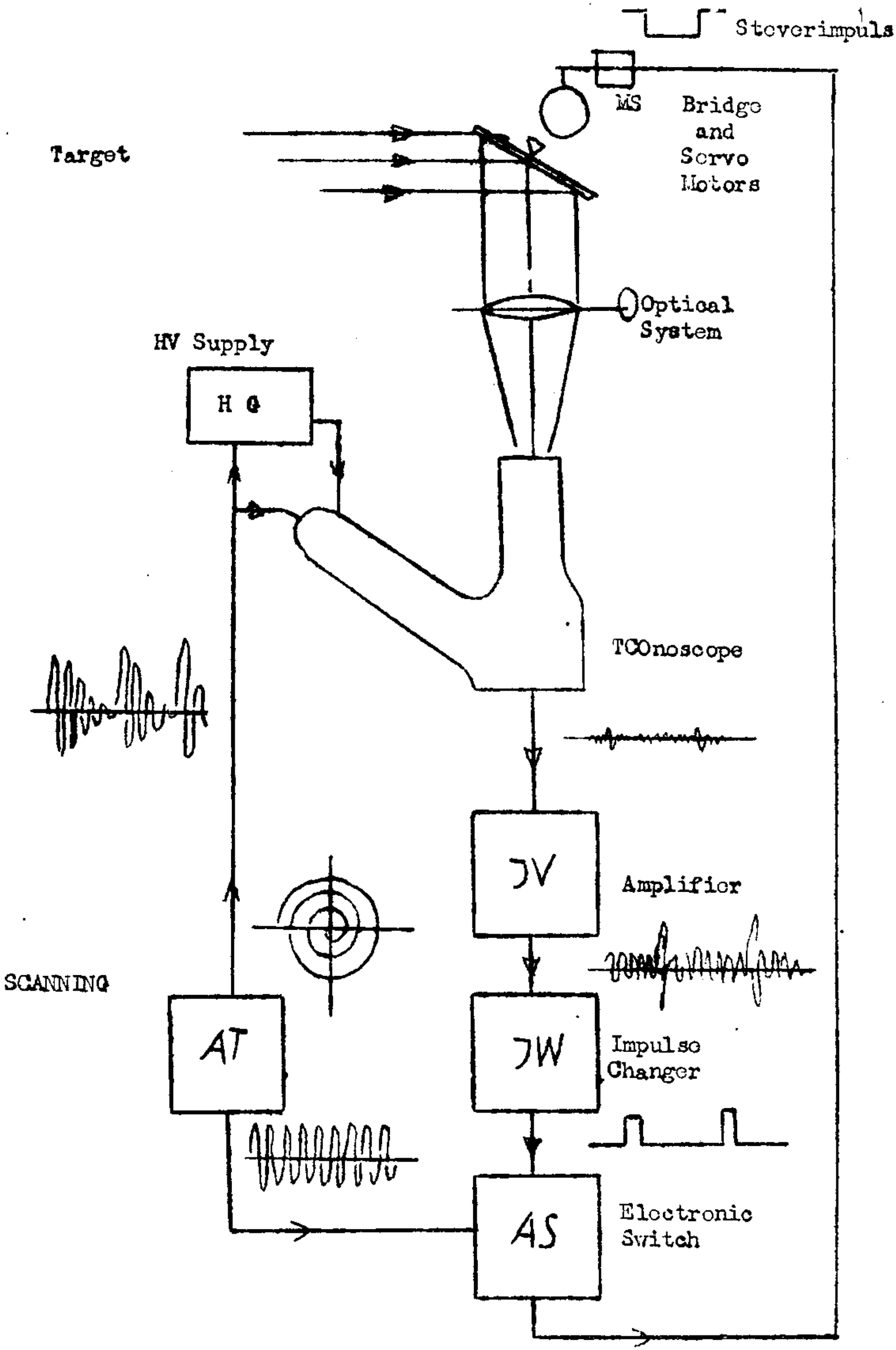


Fig. 1

Organization Chart



BLOCK-SCHEMATIC FIG. 2

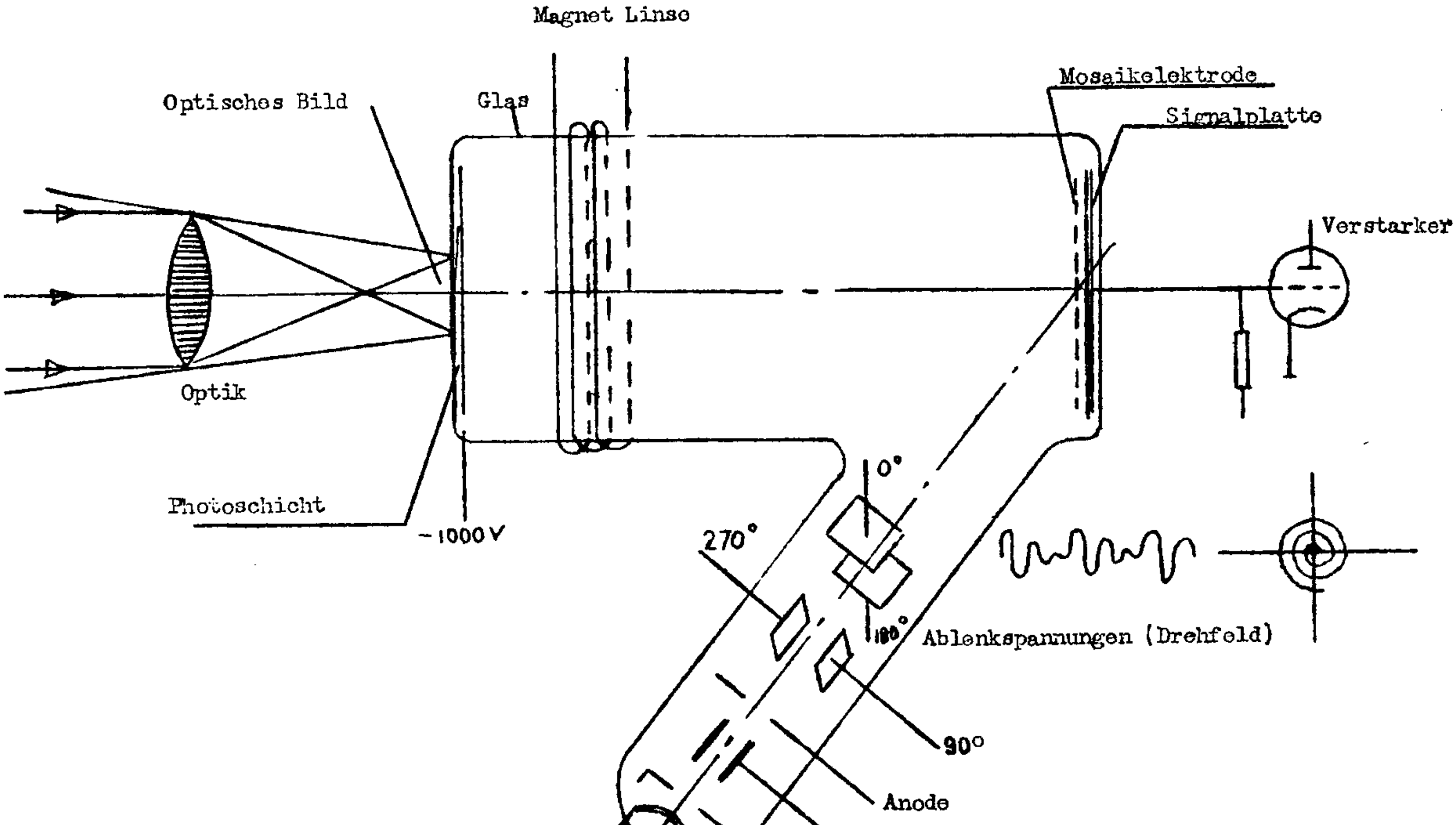


FIGURE 3
ICONOSCOPE (About Full Scale for Small Unit)

FIGURE 4

SCANNING VOLTAGE GENERATOR

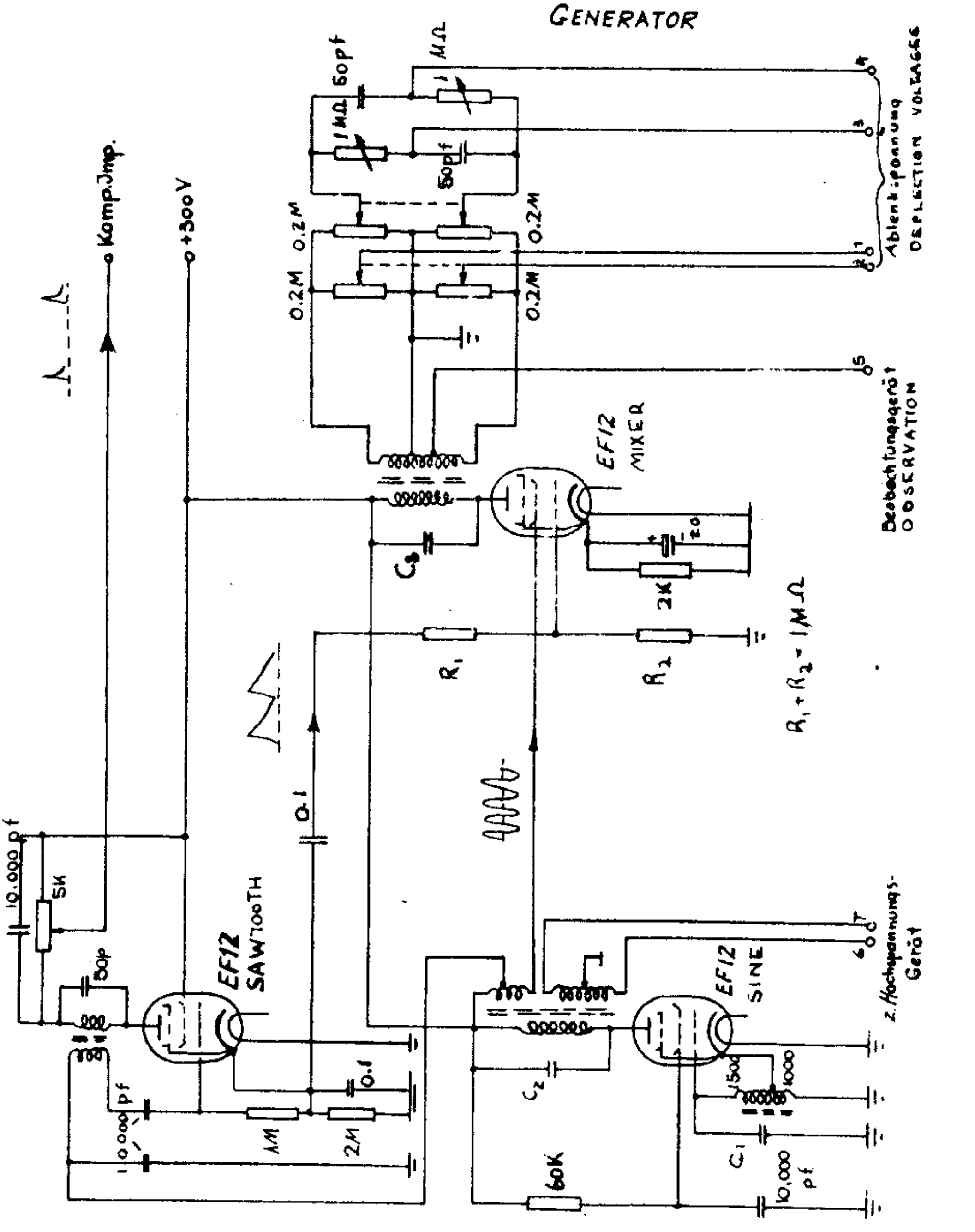
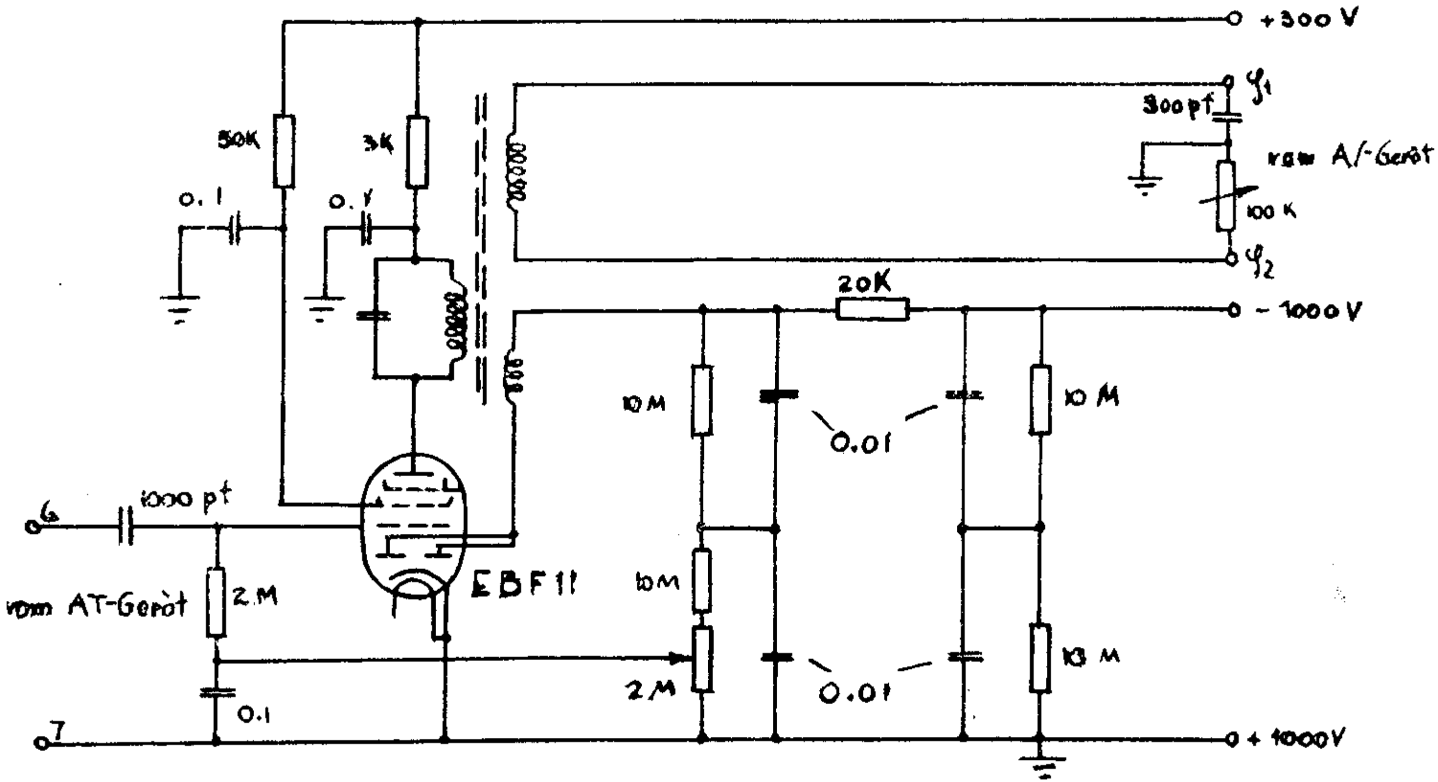


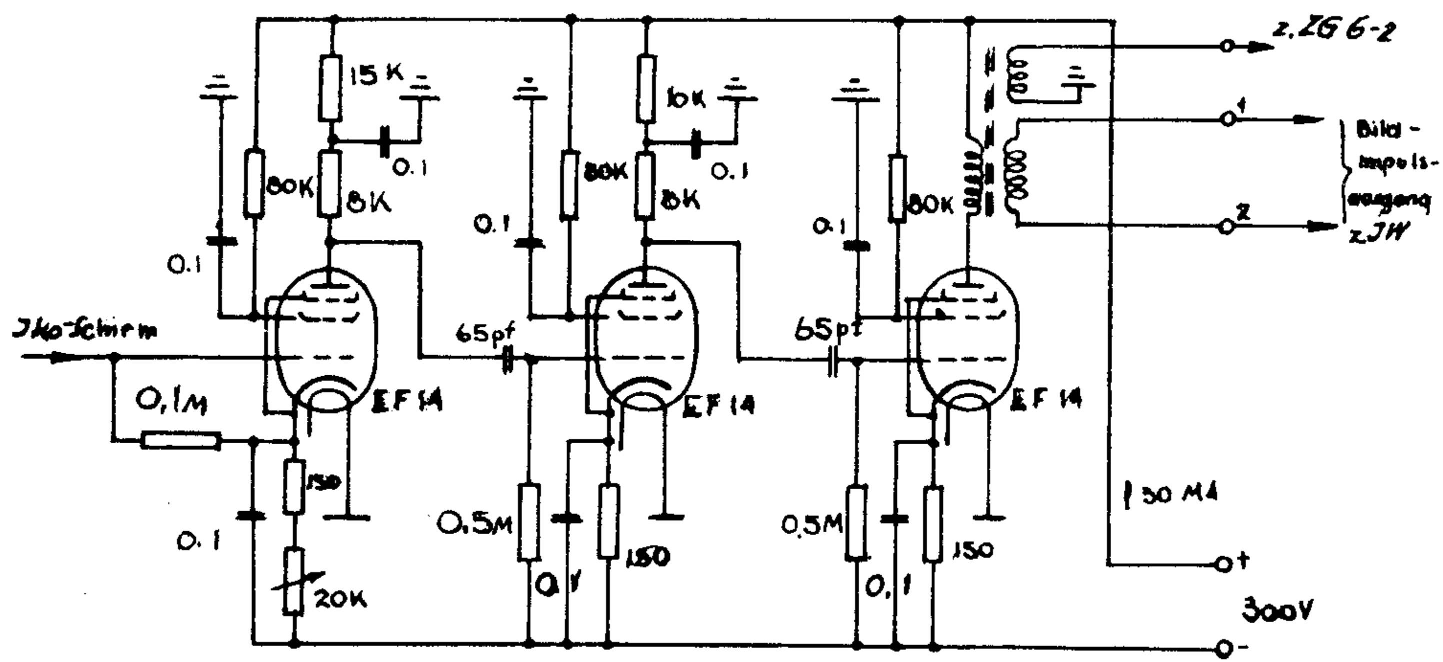
FIGURE 5
HIGH VOLTAGE SUPPLY

HG 1-Z



JV 1-2

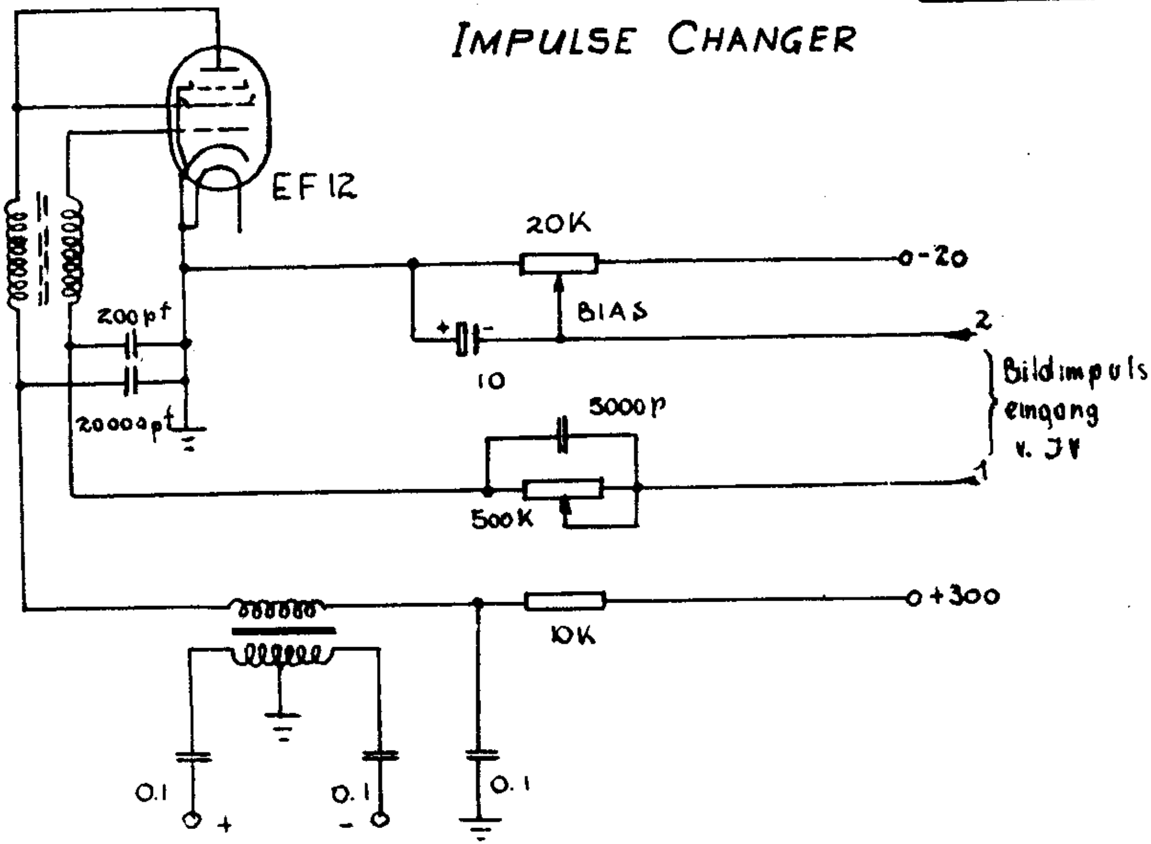
FIGURE 6
AMPLIFIER



JW 1-2

FIGURE 7

IMPULSE CHANGER



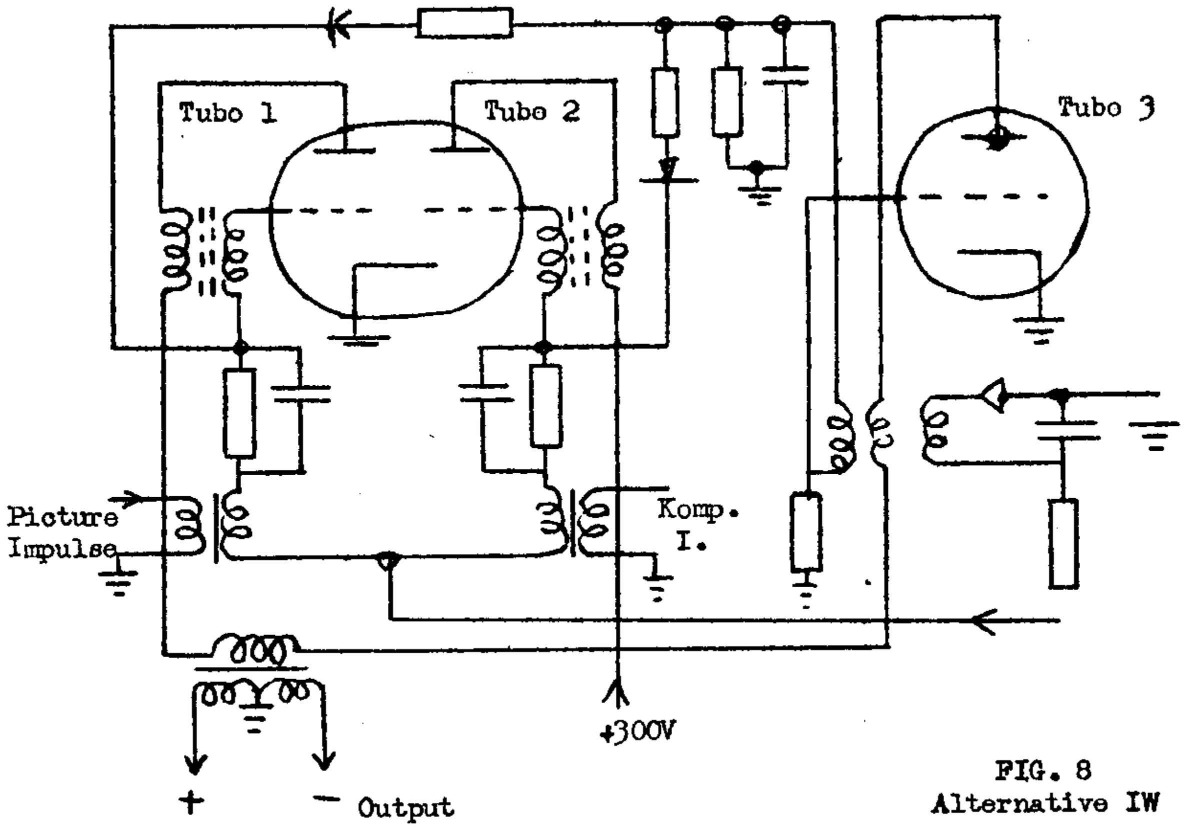


FIG. 8
Alternative IW

FIGURE 9
ELECTRONIC SWITCH

AS I-2
ABSCHALT

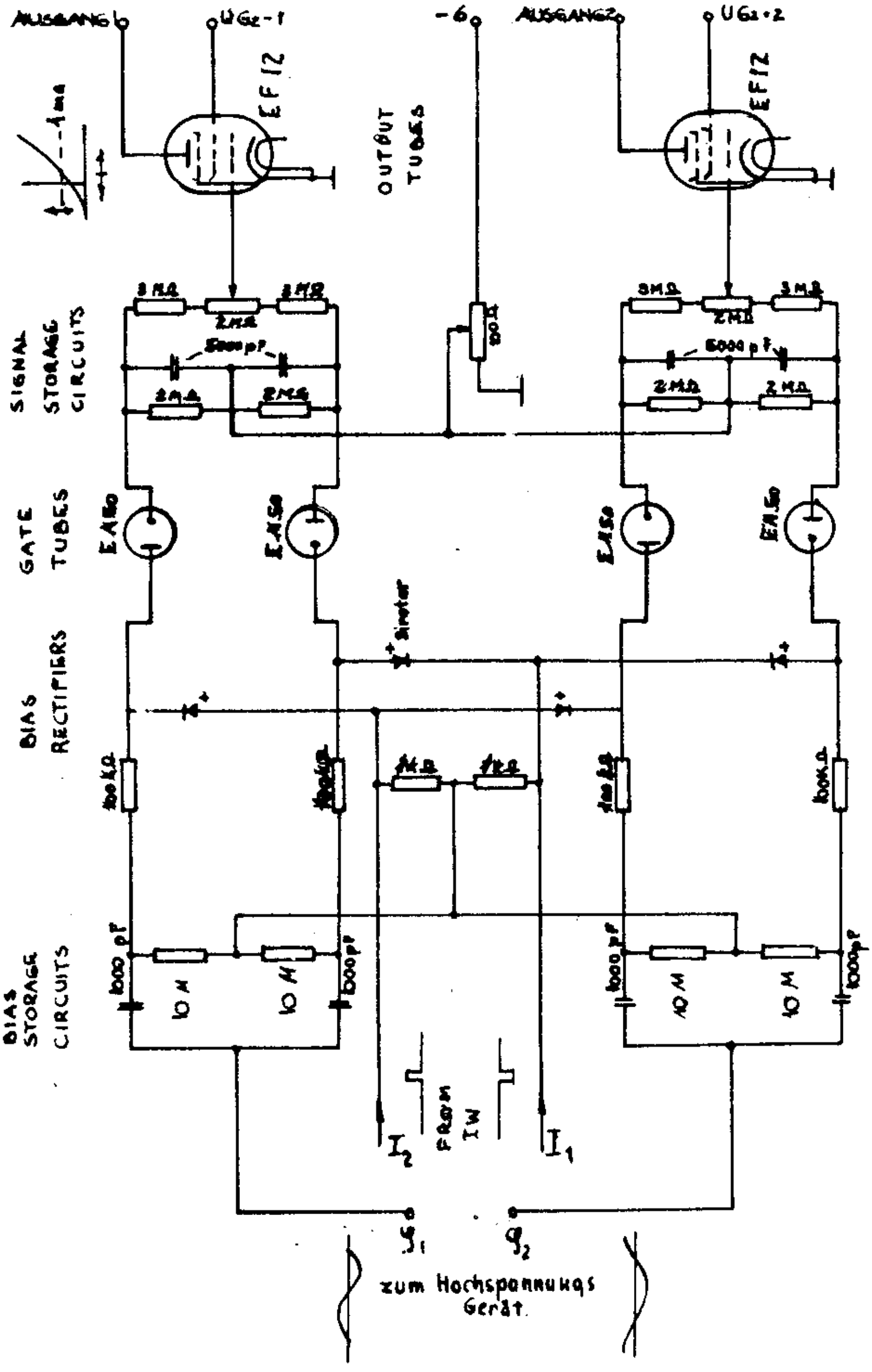
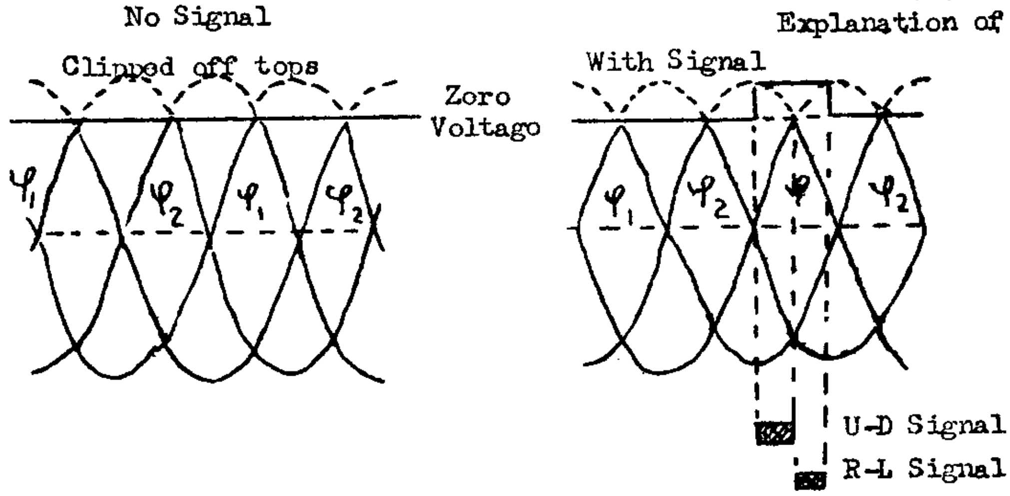
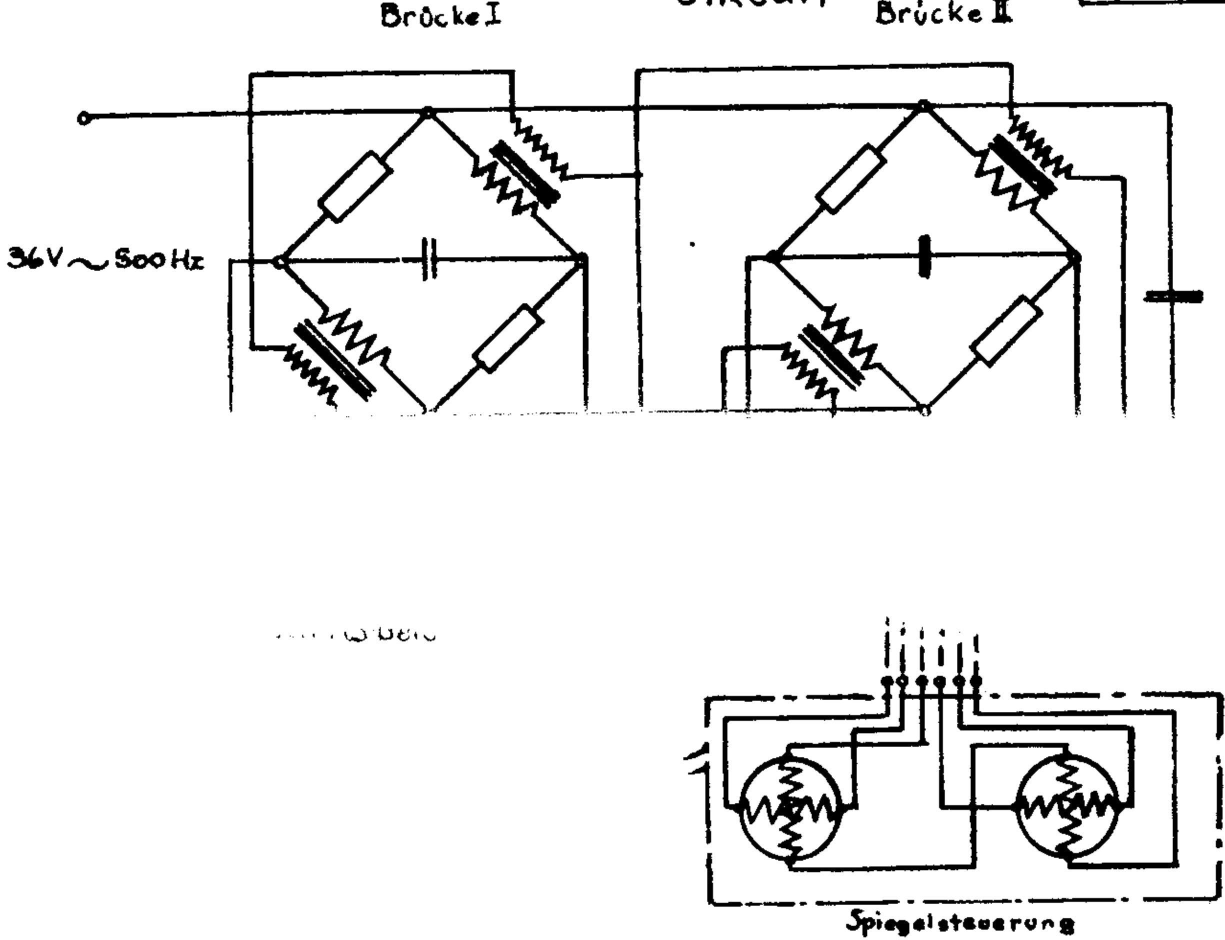


FIG. 10
Explanation of AS



MS1-2

FIGURE 11
BRIDGE & MOTOR CIRCUIT



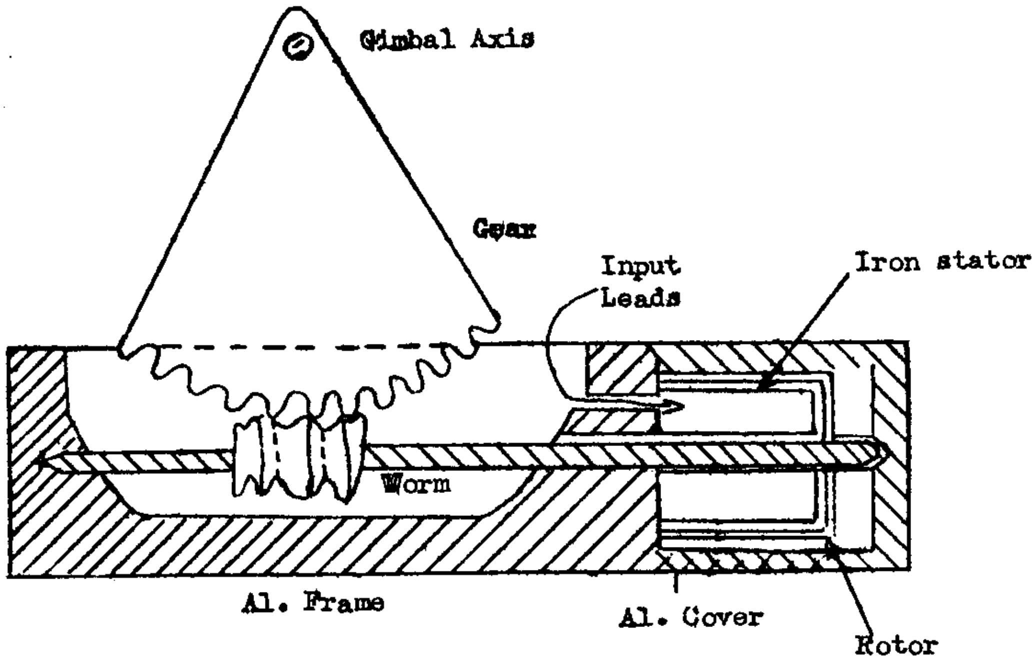


FIG. 12
Section of Servo Motor

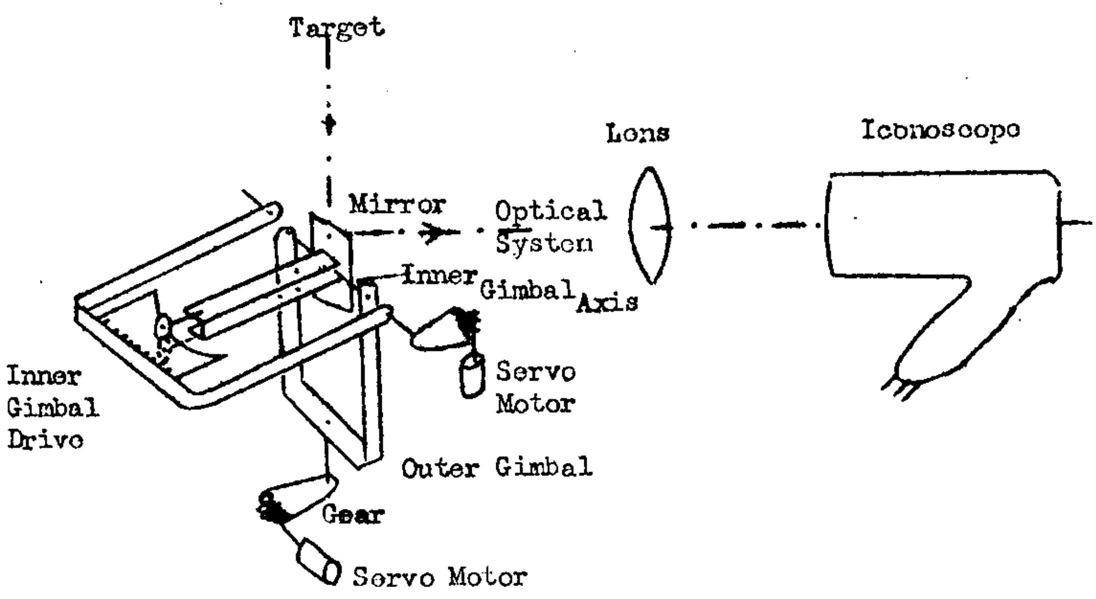


FIG. 13

Mirror and Optical System