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THE MODULATED OPTICAL ALARM SYSTEM

By

SAMUEL M. BAGNO, CONSULTANT

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PROCEEDINGS OF THE RADIO CLUB OF AMERICA

Volume 41 May, 1965 No. 1

THE MODULATED OPTICAL ALARM SYSTEM

M. O. S. T.

By

SAMUEL M. BAGNO, CONSULTANT

BELLEVILLE, NEW JERSEY

One important commercial use of electrical devices has been the protection of property against intrusion. The first electrical burglar alarm was invented in 1859 by Holmes, who found that he could protect the perimeter (walls, doors, floors and ceilings as well as windows) by setting up a mosaic of wires carrying an electric current. These wires were in series with each other and with a relay and battery. If any wire was broken the relay would drop out and give an alarm. Such a system was very effective and for almost a century was the only reliable means of signalling intrusion.

To completely protect an enclosure by perimeter protection, however, was too costly. In general the user compromised on partial protection. This meant it was possible for an intruder to get by the protection if he knew enough about the system. In order to supplement this partial perimeter protection various traps were devised, such as a dark thread within the protected enclosure that an intruder might brush up against and set off an alarm. These traps, although useful, proved to be too cumbersome, and since each had to be set individually they were generally supplemented by photo-electric and capacity type traps. Short circuiting mats were also used as traps.

The vacuum tube and the electronic photocell made these systems practical. The further development of solid-state devices helped make the optical beam and the capacity alarm common methods of protection. The optical method was limited to interrupting a beam of light, with the disadvantage that it was necessary to finely direct it. Although, in theory, it should have been possible to reflect the light back and forth by mirrors a number of times to fill a volume of space, in practice it proved impractical and the beam was limited to trap protection, that is, it was possible to trap an intruder with it if he inadvertently cut the beam of light. The capacity alarm was likewise limited by the necessity to confine the protection to the close proximity of an electrical conductor. These electronic systems were simply traps within a partially-protected enclosure.

In order to overcome the limitations of perimeter protection even when supplemented by traps, attempts were made to set up space protection, where the entire space within the protected area was sensitized to catch an intruder. In general, the attempt was made to catch an intruder by his motion. Several methods were tried. In the early 1930's Meissner attempted to use standing sound waves in air for the purpose. Shepard, Lindsey and others attempted to use standing sound waves in the electromagnetic spectrum. Each of these two systems had its disadvantages. The sonic standing waves in an enclosure varied with temperature, humidity and, most seriously of all, the thermal turbulences in the air itself. These turbulences closely simulated an intruder and caused countless false alarms.

The sonic system was later modified by the author to use the Doppler effect and turbulence compensation as well as an ultrasonic carrier to become a practical system. Turbulence compensation was possible because, on the average, it had a different Doppler spectrum than an intruder. The Doppler spectrum of turbulence, although statistically providing a stationary time series, tended to a constant average spectrum despite the fact that it varied from moment to moment. Therefore the spectrum could be averaged over time and could be separated from that generated by an intruder. In an alarm system two to three seconds were available for catching an intruder. This proved to be a sufficiently long averaging time to enable turbulence compensation to correct for all but the more severe types of turbulence such as were generated by blower systems or unit heaters. This made the system practical, and thousands are in use throughout the world.

The Radar system (standing wave) did not have this turbulence limitation but it had another that was even more serious. Electro-magnetic waves penetrated walls, detected what was beyond the walls. The system in general was subject to numerous false alarms.

To overcome these difficulties an attempt was made to devise an optical space alarm. In 1935 Alan Fitzgerald placed a checkerboard type mosaic in the focal plane of the camera. Alternate squares were transparent and the other squares opaque. A moving object that was projected on the focal plane of the camera from a moving intruder alternately traversed the transparent and opaque squares and generated a fluctuating light on a photocell that was placed just beyond the focal plane. The photocell in turn fed an amplifier which amplified its fluctuating signal and operated an AC relay. Thus movement within the view of the camera was detected and gave an alarm. This system, although excellent within an optically isolated enclosure such as a vault, was impractical in the normal enclosure where a variable light coming through a window such as a moving headlight or sunshine momentarily hidden by the clouds could set off false alarms. In order to overcome these disadvantages, the author devised the Modulated Optical Space Transducer.

This alarm system is an optical device, designed to indicate motion in any given area by means of near infra-red, pretty much as the Ultrasonic or Radar alarm systems indicate such motion. However, in common with the Ultrasonic alarm, its signal is confined within the protected premises. Likewise, in common with the radar type detectors, it is unaffected by air turbulences. Neither motion outside of the protected area nor air turbulence can give false alarms. It also has the advantage of being sufficiently insensitive to ambient light changes, because it sees only its own modulated light. Anything other than an external light shining directly into the lens of its camera and focused on its focal plane does not affect it. It, therefore, becomes insensitive to such changes as might occur when a headlight shines in through a window or a cloud passes beneath the sun.

The alarm is capable of monitoring a large or small area against the possible intruder. There are three basic parts to this system.

1. The modulated lights and its power source.
2. The camera or cameras (more than one camera can be used with each control unit).
3. The control unit which senses the alarm and operates a self-contained relay.

A block diagram for the system is shown in Fig. I. The camera looks into the area to be protected. When a person moves within this protected area, his movement causes a change in the light pattern at the focal point of the camera. However, the camera is only sensitive to the modulated light provided for this system, because that modulation carries a signal which the camera recognizes. Other ambient lights do not carry such a signal and the camera does not recog-

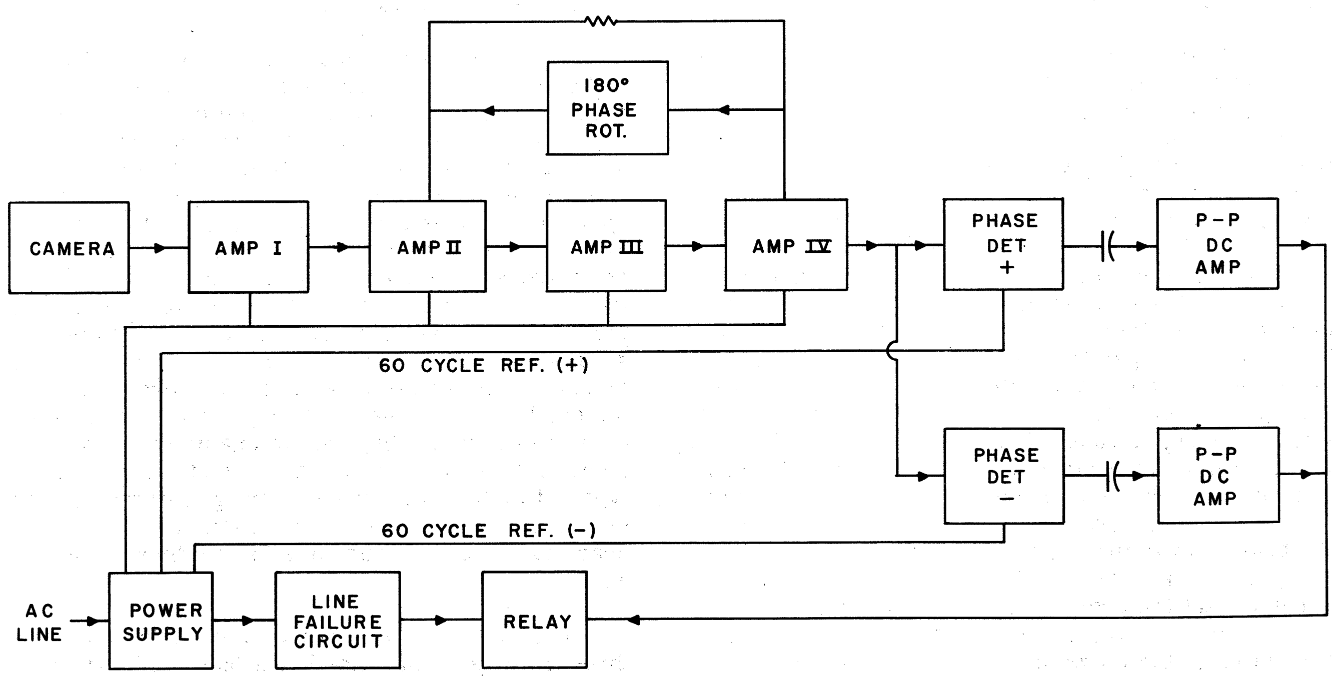


Figure I - A block diagram of the Modulated Optical Space Transducer nize their existence. The output of the cameras is fed to the control unit. The control unit causes a relay to drop out and give an alarm when there is motion in the area.

LIGHT SOURCE

The light source for the cameras is powered directly by 60 cycle AC. This can be the 120 volt source, or if the system is provided with lower voltage lamps they can be fed from a step-down transformer. A diode rectifier, placed in series with the lamps, provides a 60 cycle half-wave voltage across each filament. This causes the filaments to heat and cool 60 times a second, modulating their light output approximately 40%, depending on the thermal inertia of the filament. Without such a rectifier the filaments would heat and cool on every alternate half wave, or 120 times a second, providing a modulated light of 120 cycles per second. In this system only a 60 cycle modulated light is effective in detecting an intruder, and is insensitive to 120 cycles.

The lamps should not be in the line of sight of the cameras because too much light coming from a single point may saturate the system. All that is necessary for proper protection is light that has been diffused by reflection from the walls and other objects in the protected area, Fig. 2. As an example, a single rectifier operating three 6 watt 24 volt

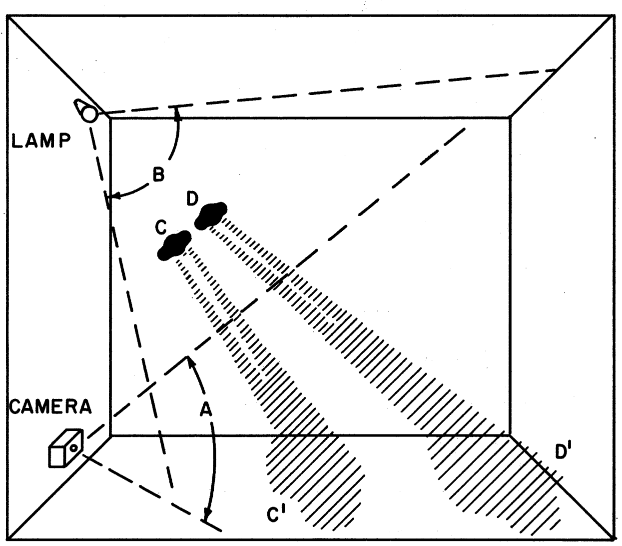


Figure II - Here the Projector lamp (about 30 watt) has a Projection angle "A". The camera view angle (about 70^{o}) is shown as "A". As intruder moves from point C to D the camera notes the moving shadow moving from C' to D' and sounds an alarm.

lamps from a 24 volt a-c source was sufficient illumination to provide one step sensitivity anywhere in a protected area having walnut-colored wood paneled walls. The area was 25 feet long by 16 feet wide. The specific light and camera locations for best protection depend on the area to be protected. In general, however, it is best to illuminate a far wall with the modulated light and look at it with the cameras from the other side of the enclosure, or protected area. A moving shadow, shadowing a 60 cycle light likewise can protect an area beyond the line of sight of the camera.

CAMERA

The camera consists of a lens which focuses the image of the protected area on six voltaic photo cells. These photocells form a solid angle of 70^{o} in width and 15^{o} in height with the lenses providing a 70^{o} by 15^{o} field of view. These photo cells are arranged so that the outputs of alternate sets of cells are 180 degrees out of phase, and thereby tend to cancel each other. The series voltage output of three cells is balanced against the other three by means of a 3 K ohm variable potentiometer. The resultant output, or unbalance, of the system is fed through a shielded cable to the control cabinet. In order to linearize the system, each photo cell is shunted individually by a resistor. Linearizing the system keeps the sensitivity independent of variations in ambient light intensity.

CONTROL UNIT

The control unit, housed within the control cabinet, as shown in block diagram Fig. I, consists of an input stage (low noise), a 60 cycle tuned amplifier, a pushpull phase detector stage which senses the variations in phase and amplitude of the incoming signal and converts it into a corresponding direct current. A pushpull amplifier (very low frequency) amplifies the fluctuation of this direct current, and converts these fluctuations into a signal to de-energize a normally energized relay.

There is also a circuit to protect against false alarm in case of momentary power failure. This power failure circuit makes use of the sudden charge and discharge of the capacitors in the power supply circuit on momentary power failure to transfer the energizing power for the relay from the motion-sensitive circuit to a capacitive circuit that holds the relay energized for a few seconds after the power failure. When the power has been restored, it keeps the relay energized until all transients due to the power failure are dissipated out of the amplifier circuit. The relay is then switched back to the sensing system. In that way momentary power failures do not cause false alarms.

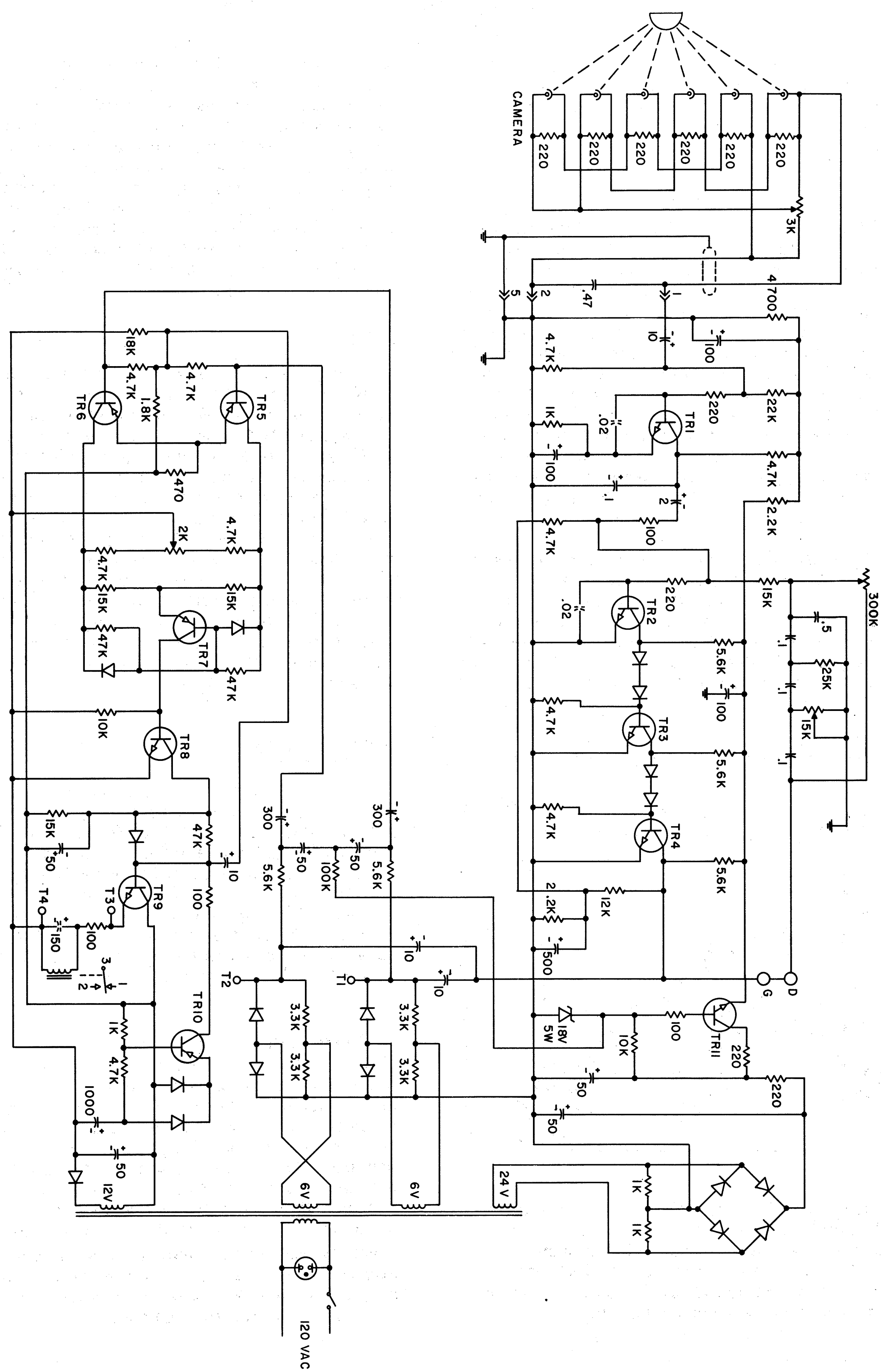


Figure III - Circuit Diagram

Referring to the circuit diagram, Fig. 3, the camera is shown as six photo cells in a series-bucking arrangement balanced by a 3 K potentiometer. The output of the camera is capacity-coupled through a 10 mfd capacitor into the first amplifier stage. The first amplifier stage consists of a noise-selected silicon planar NPN transistor in a conventional grounded emitter amplifier circuit. Its output is by-passed by a 0.1 mfd capacitor, to eliminate higher frequency components, and capacity-coupled by a means of a 2 mfd coupling capacitor and 100 ohm resistance into a three stage selective direct-coupled amplifier. This amplifier is selective to 60 cycles. Its input section also consists of an NPN silicon noise selected Planar transistor. The output of the third stage of this amplifier is fed back through a 180 degree phase shift network to the base of the first of the three stages. The network consists of the three 0.1 mfd condensers and the 15 K resistor and the variable 25 K resistors. This phase shift network is shunted by a resistance which feeds back the same signal in phase. The value of this variable resistance is so adjusted that at 60 cycles its signal completely blocks out the signal from the phase shift network which had been shifted 180 degrees. At 60 cycles therefore, there is complete cancellation in the feed-back network and no amplifier degeneration results. However, at frequencies different than 60 cycles this cancellation does not occur. There is negative feed-back which greatly decreases the amplification. The amplifier is thereby made 60 cycles selective by some 20 db per octave.

This amplifier also has a temperature stabilizing feed-back network consisting of the 12 K and 2.2 K voltage divider resistances which supply the bias to the first stage of the amplifier through a 4.7 K base resistor. The voltage drop across the 2.2 K resistor is by-passed by a 500 mfd condenser so that only the very low frequencies associated with temperature changes are fed back. This stabilizes the amplifier against such temperature changes. The connections marked 'D' and 'G' are normally soldered together but are broken for the initial adjustment of the shunted phase shift network to cancel the 60 cycles, and then re-connected. The variable resistance is then fixed in position. The output of this amplifier, basically 60 cycles, is then fed to a phase detector system. This consists of two phase detectors, each coupled by a 10 mfd condenser, one providing a positive DC voltage when there is a 60 cycle input in phase with its control signal and the other negative DC voltage under the same conditions. This provides a pushpull DC output which follows the amplitude and phase of the signals provided by the camera. (60 cycles). Specifically each phase detector works as follows: the two 3K resistors and the two diodes form a bridge circuit. The diodes are so connected that unless there is a voltage from the synchronous 6 volt transformer source the diodes are non-conducting and there is no DC output. When there is an AC voltage applied from the six volt source, the diodes become conducting every other half-cycle although, because of the bridge circuit, none of the 6 volts is reflected into the opposite legs (input side) of the bridge. However, during the half-wave that the diodes are conducting the input signal from the 10 mfd condenser is short circuited. During the other half wave of that same input no short circuit exists because the diodes are non-conducting, the voltages from the 6 volt source having reversed itself. Thus, either the positive or negative phase of the input signal remains and gives a resulting DC voltage dependent on its phase relative to the six volt driving voltage. This results in a positive or negative DC output from the phase detector.

The phase detector will properly detect only 60 cycle signals. All even harmonics are not detected at all. The normal 120 cycle flicker in lighting systems or lamps outside of the protected area therefore is not detected by the phase detector even if some of the 120 cycles gets through the selective amplifier.

The output of the 2 phase detectors is connected through the two 5.6 K resistors and 50 mfd filter to filter out any of the remaining 60 cycles and the resulting slow DC fluctuations. It is capacitive-coupled by means of the two 200 mfd condensers into a pushpull amplifier stage consisting of TR 5 and TR 6. The power supply of this amplifier stage floats with respect to the power supply of the previous amplifier. Any low frequency signal not being detected by this phase detector stage comes through to both bases alike. Because of this floating power supply, TR 5 and TR 6 will only respond to a differential signal. Low frequency pulses not coming in differentially do not get into the pushpull stage. However, because of the nature of the phase detectors any modulations of the 60 cycle input on the camera are detected differentially (in a pushpull manner). The modulation envelope (the slow fluctuations in the 60 cycles from the camera due to a moving intruder) is fed through the 200 mfd condensers, and is amplified differentially by TR 5 and TR 6. The DC output of TR 5 and TR 6 is balanced by means of the 2 K potentiometer in their collector supply circuit so that with no input signal there is no voltage difference between the collectors of TR 5 and TR 6. The 2 K potentiometer is then locked. The output (pushpull) of the 2 collectors is then fed to a bridge circuit consisting of two 15 K resistors and two diodes each shunted by a 47 K resistor. The output of this bridge is connected between the base and emitter of the PNP transistor TR 7, in such a way that any unbalanced signal between the collectors in either direction (plus or minus) makes the base negative in respect to the emitter and a collector current in TR 7 is generated.

The TR 7 collector current provides a base current for TR 8 which in turn gives an amplified collector current. The collector current through TR 8 produces a voltage drop in the 15 K resistor in series with it. Thus, if TR 8 is fully conducting almost the entire voltage is across the 15 K and only about .1 volts across TR 8. The voltage drop across TR 8 supplies the bias for the emitter follower transistor TR 9 whose emitter, in series with the 100 ohm protective resistor, supplies the output relay. The relay in turn is shunted by a 150 mfd 25 volt condenser to bypass instantaneous surges. The collector resistor (15 K) in series with TR 8 is also shunted by a 50 mfd condenser to hold over during a polarity reversal on the bases of TR 5 and TR 6. Such polarity reversals occur because the 200 mfd condensers feeding TR 5 and TR 6 can only pass AC fluctuations which must have polarity reversals.

In order to protect against false alarms due to momentary interruptions in the power line, the circuit provided by transistor TR 10 is included. This circuit is in the power supply for the relay circuit and partially consists of the normal power supply circuit containing the 12 volt secondary, a rectifying diode and a 50 mfd filter condenser. Under normal conditions this circuit supplies the power for the pushpull amplifier and relay. However, it also charges a 1000 mfd condenser through a bridge circuit consisting of 1 K and 4.7 K legs in series as well as 2 diodes in a series bucking arrangement to provide the other two legs of the bridge. The junction of the two resistors is connected to the base of TR 10 and the junction of the two diodes (silicon) to its emitter.

Any change in the line potential causes a change in the DC across the 50 mfd condenser in the power supply, tending to charge or discharge the 1000 mfd condenser. During the charging or discharging of this condenser there is a potential drop across the aforementioned bridge feeding the condenser. When this potential drop exceeds the voltage necessary for one of the diodes to conduct, it provides a base current for TR 10. This occurs, for instance, during a line failure or the instant the power comes on again, but does not occur during normal line voltage fluctuations. When TR 10 conducts, it provides base current for TR 9, keeping the relay energized during the transient condition caused by the power failure and keeping it energized long enough until all signals generated in the amplifier by the failure have dissipated themselves. The diode between TR 8 and TR 9 effectively disconnects TR 9 from TR 8 when TR 10 is supplying the base voltage to TR 9. At all other times the diode conducts causing TR 9 to respond to the intruder. Thus the relay is normally energized during no alarm and becomes de-energized and drops out during an alarm condition.

INSTALLATION INSTRUCTIONS

Whenever possible the cameras are mounted on the side of an enclosure not facing windows. The wall or walls opposite the cameras are illuminated by the light source. In general tungsten filament lamps connected in parallel and having filaments whose filament current should not exceed .7 amperes. The lamps are then connected to a power source in series with a silicon rectifier rated for the proper current. This power source can be the AC line or a stepdown transformer of the same voltage as the rated voltage of the lamps.

In general there are three methods of illuminating the protected area, although any combination of these three may be used.

(1) The far wall that the camera views may be illuminated directly by an array of modulated lights. A desirable intensity of lighting for distances less than sixty (60) feet is approximately 1/10th watt of incandescent lighting per square foot. The lamps should not be in the direct view of the camera.

(2) The walls may be illuminated by lamps placed strategically in the protected area so that movement outside of the angle of view of the camera will throw a moving shadow on one or both of the viewed walls (see Fig. 2).

(3) The camera may look directly at an array of reflector lamps at a distance of between a hundred and three hundred feet from the camera. Alternate lamps may be phased 180 degrees from each other by means of series rectifiers oppositely poled. Such a system may be used to provide a fence of light that an intruder cannot penetrate without giving an alarm. The fence may be completed by having a camera and an array of lights at each end of a protected corridor, each camera looking at the other end.

A number of cameras may be connected in parallel or in series parallel. Since each camera has an impedance of 1200 ohms, the camera should be so connected as to provide an impedance of between 400 and 1200 ohms looking into the amplifier circuit. A remote test may be provided by momentarily extinguishing one of the modulated lamps by means of a relay.

CONCLUSION:

Although this system is only a few months old, all installations so far indicate that it accomplishes all the functions for which it was intended.

DR. JOHN A. PIERCE, GUEST SPEAKER
AT THE 55TH ANNUAL BANQUET

Left to Right: Dr. Harold A. Wheeler, Armstrong Medal winner; Ralph Batcher, President of the Club; Dr. Pierce and Robert Finlay, Master of Ceremonies

DR. JOHN R. PIERCE SPEAKER AT RADIO CLUB'S 55TH ANNUAL BANQUET

Reflecting the good fellowship of many decades of association, the 55th Annual Banquet of the Radio Club of America was held at the Seventh Regiment Armory on November 20th, 1964. The highlights of the evening were Dr. John R. Pierce's address on the place of the amateur in today's technology, the presentation of the Armstrong Medal to Dr. Harold A. Wheeler by Professor John H. Bose and the award of Honorary Memberships to Paul F. Godley and Raymond A. Heising.

Mr. Robert Finlay, who acted as Master of Ceremonies, introduced President Ralph Batcher and his greetings to the members of the club and their guests, starting off a pleasant and significant evening, with every seat in the Appleton Grill filled. The speaker's remarks were heard clearly and effectively, thanks to a public address system furnished and installed by Mr. Finlay, who thereby cured the only possible criticism of our choice of the last few years for our banquet hall.

Dr. Pierce, who is Director of the Bell Telephone Laboratories, summarized the objective of his address with a characteristic clarity, as follows: "What I have meant to bring to the Radio Club of America on its 55th anniversary is something of a new challenge and inspiration in fields outside of, but in some way related to radio. I have tried to illustrate this challenge in concrete terms, but in doing so, I have indicated only a few possible opportunities. The broad message which I want to convey is that of searching out human needs and showing how they can be effectively met."

This purpose, Dr. Pierce met by presenting a series of practical examples, largely drawn from the medical field. He acknowledged the contributions of the amateur scientist in the radio field but pointed out that the amateur cannot effectively turn his thoughts to very popular or very abtruse fields, which are best served by the professional supported by facilities and information.

"Radio has a proud record of amateur discovery and invention, including the usefulness of short waves, which has proved greater than that of frequencies out of which amateur radio experimentation was crowded, and the first utilization of grounded grid amplifiers. Thus, it is natural for those who have been long connected with radio to wonder what they can do to further our accomplishments in science and technology.

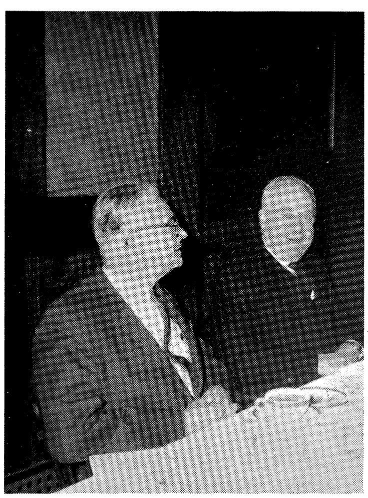
"I ask you to consider your daily lives, your homes, your offices, your problems, in the light of your knowledge of electronics and of science in general. Isn't there something that you could do which would be good for man and which hasn't yet been done effectively and economically?"

With practical insight, Dr. Pierce warned against efforts which cannot be effectively served by amateur scientists. "Popular fields are overrun with highly trained and highly competitive men. Very abtruse fields require a high degree of training as well as high intelligence," said Dr. Pierce. ... "It is that the challenges of science and technology are so great that there seems not to be enough highly informed ingenuity to go around in bringing new benefits to mankind, even when things appear to be understood in principle."

Speaking of the kind of opportunity open to the technically experienced radio technician and scientist, Dr. Pierce said, "Almost a decade ago, I became acquainted with certain neurological and other research in a large New York City hospital. It was being carried out under the direction of an extremely busy, though highly intelligent, group of physicians. But the electronic gear that was used was primitive in the extreme. Sixty-cycle currents were being used to stimulate nerves. I was intrigued and horrified, and I had a nerve stimulator built for the use of these people. It didn't require equipment or knowledge which most of you don't have, but the people connected with these physicians didn't have that equipment or knowledge, and they were making do with the most primitive sorts of devices.

"I didn't just want to speak about the challenge of medical apparatus - electrical or mechanical. I used this as an example. What I am telling you in more general terms is that I am sure that in many, many departments of our lives, the application of science technology in an economical and practical way has lagged far beyond our inherent ability to do."

Dr. John H. Bose, Chairman of the Club's Medals and Awards Committee made the award presentation for the Armstring Medal to Dr. Harold A. Wheeler. The citation appears elsewhere in this issue.



Ed Felix, Banquet Committee Chairman, talks to Harry W. Houck, Chairman of the Archives Committee

Thomas J. Styles, Secretary of the Armstrong Memorial Research Foundation, comments favorably on quantity and quality of banquet

Francis Shepard says "C'est ci bon," upon discovering the benefits of Vichy.

DR. HAROLD A. WHEELER ACCEPTS THE ARMSTRONG MEDAL FROM PRESIDENT BATCHER

(Professor John H. Bose, at left, made the presentation)

RADIO CLUB AWARDS ARMSTRONG MEDAL TO HAROLD A. WHEELER

A feature of the 1964 Radio Club Annual Banquet was the award of the Armstrong Medal to Dr. Harold A. Wheeler, in recognition of his outstanding contributions to radio communications. The citation presented with the medal is as follows:

"Although his contributions have been recognized by his professional colleagues in numerous pre-eminent awards, it is particularly appropriate that this year, which marks the 25th Anniversary of F. M. broadcasting, the Armstrong Medal is awarded to one who also pioneered in the field of frequency modulation. His theoretical analyses of frequency modulated signals helped outline the boundaries of this new discipline.

"In forty years devoted to the radio art, Harold Wheeler has made substantial contributions by the theory of television systems, wide band amplifiers, transmission lines, antennas, microwave elements, circuits and receivers. The awarding of this medal is in recognition of his rare talent in reducing to practice, for the good of all, the results of individual research."

RAYMOND A. HEISING, INVENTOR OF MODULATION SYSTEMS, DIES AT 75

Raymond A. Heising, distinguished inventor and scientist, died at his home in Summit, New Jersey, on January 16th at the age of 75. Since his retirement from the Bell System in 1953, he served as consulting engineer and patent advisor. Mr. Heising's invention of a practical modulation system provided significant impetus to the radio broadcasting boom of the early twenties because it made possible the radiation of high power radio telephone signals of adequate field strength for good home reception in large cities and eliminated the necessity for short-lived and elaborately cooled banks of carbon microphones which hampered broadcasting pioneers prior to World War I.

Mr. Heising also contributed materially to the design and construction of the first experimental transatlantic radio telephone transmitter shortly after World War I, using the NAA Arlington transmitting tower loaned by the U. S. Navy for the purpose. In his forty years of service with the Bell Telephone Laboratories, Mr. Heising played a leading role in the development of all forms of radio telephony, including world-wide single side-band systems, aircraft, tank and submarine voice communications. He was granted over 120 patents in his lifetime of service to the radio communications art.

Active for many years in the affairs of the Radio Club of America, Mr. Heising served as a director for several terms. In 1953, he was awarded the Club's Armstrong Medal in recognition of his outstanding contributions to radio communications. He was elected an Honorary Member of the Club in 1964.

He was a past president and a Fellow of the Institute of Radio Engineers, winner of its Liebmann Memorial Prize in 1921. Among his many contributions to the growth and expansion of the Institute was his support and ultimate supervision of the acquisition of its former headquarters at 1 West 79th Street in New York and his outstanding part in creating the professional group system. He was also an active member of the American Association for the Advancement of Science, the American Physical Society and the Broadcast Pioneers.

Born in Albert Lee, Minn., Mr. Heising received an electrical engineering degree at the University of Notre Dame in 1912 and his Master of Science Degree in 1947 from the University of Wisconsin. He was the author of a book on "Quartz Crystals for Electrical Circuits," and of numerous technical papers dealing with radio communications.

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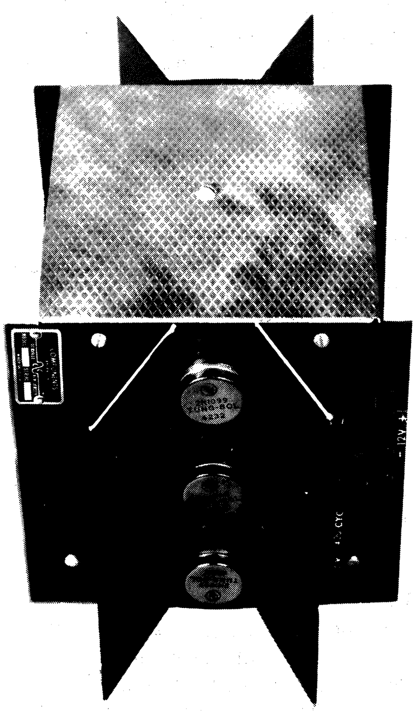

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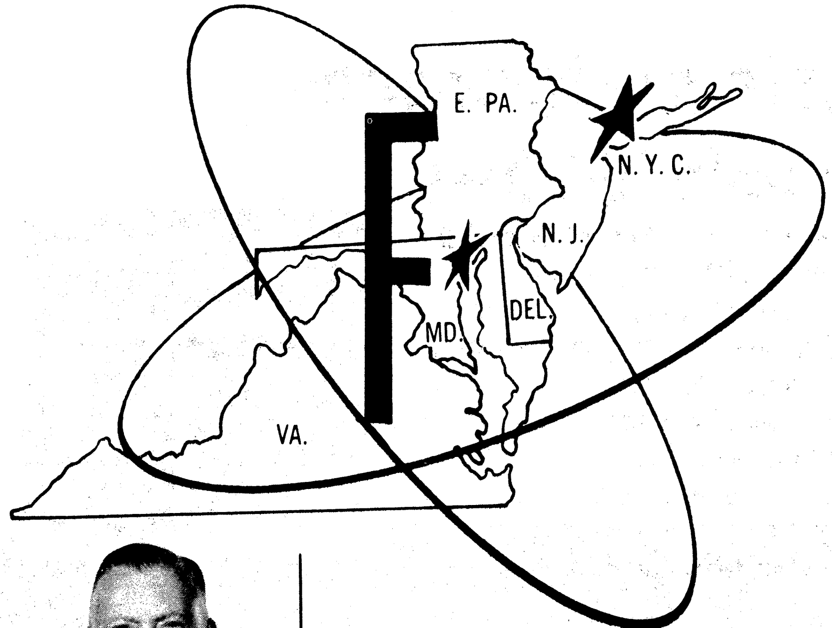

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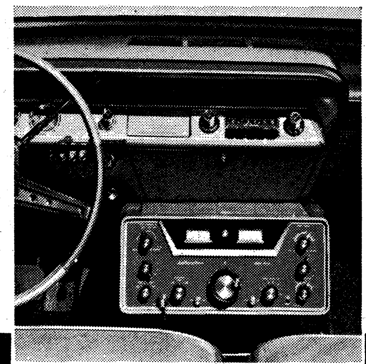
Full amateur band coverage, 80 through 10 meters • Hallicrafters exclusive new R.I.T. (Receiver Incremental Tuning) for ± 2 kc. adjustment of receiver frequency independent of transmitter, and AALC (Amplified Automatic Level Control) • Receiver AF gain and RF gain controls • SSB operation, VOX or PTT . . . CW operation, manual or break-in • 1650 kc. crystal filter . . .



SPECIFICATIONS

Frequency coverage: Eight-band capability — full coverage provided for 80, 40, 20, 15 meters; 10M crystals furnished for operation on 28.5 – 29.0 Mc. Other crystals may be added for full 10 meter coverage without adjustment. Available for operation on specified non-amateur frequencies by special order.

Front panel controls: Tuning; Band Selector; Final Tuning; RF Level; Mic. Gain; Pre-Selector; R.I.T.; Rec. RF Gain; AF Gain; Operation (Off/Standby/MOX/VOX.); Function (CW/USB/LSB); Cal.

General: Dial cal., 5 kc.; 100 kc. crystal cal.; VFO tunes 500 kc.; 18 tubes plus volt. reg., 10 diodes, one varicap. Rugged, lightweight aluminum construction (only 17½ lb.); size—6½" x 15" x 13".

Transmitter Section: (2) 12DQ6B output tubes. Fixed, 50-ohm Pi network. Power input—150W P.E.P. SSB; 125W CW. Carrier and unwanted sideband suppression 50 db.; distortion prod., 30 db. Audio: 400-2800 c.p.s. @ 3 db.

Receiver Section: Sensitivity less than 1 uv for 20 db. signal-to-noise ratio. Audio output 2W; overall gain, 1 uv for ½ W output. 6.0 – 6.5 1st I.F. (tunes with VFO). 1650 kc. 2nd I.F.

Accessories: P-150AC, AC power supply, $99.50. P-150DC, DC power supply, $109.50. MR-150 mounting rack, $39.95.

New **SR-150** Fixed/Mobile Transceiver ***hallicrafters***

Overseas sales: Export Division, Hallicrafters • Canada: Gould Sales Co., Montreal, P.Q. 5th and Kostner Aves., Chicago 24, Ill.

Laboratory Standards

MEASUREMENTS

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