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VARACTOR DIODE PART 1

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ELECTRO-QUOTE

DISPLAY SYSTEM

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Data Card Transmitter

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BOMB ALARM

Display System 210-A

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Patents Recently Issued to Western Union

Volume 17

Number 1

THE WESTERN UNION TELEGRAPH CO.

60 HUDSON ST., NEW YORK 13, N. Y.

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C. R. Deibert and W. D. Buckingham, Electronics Division

BOMB ALARM

Display System 210-A

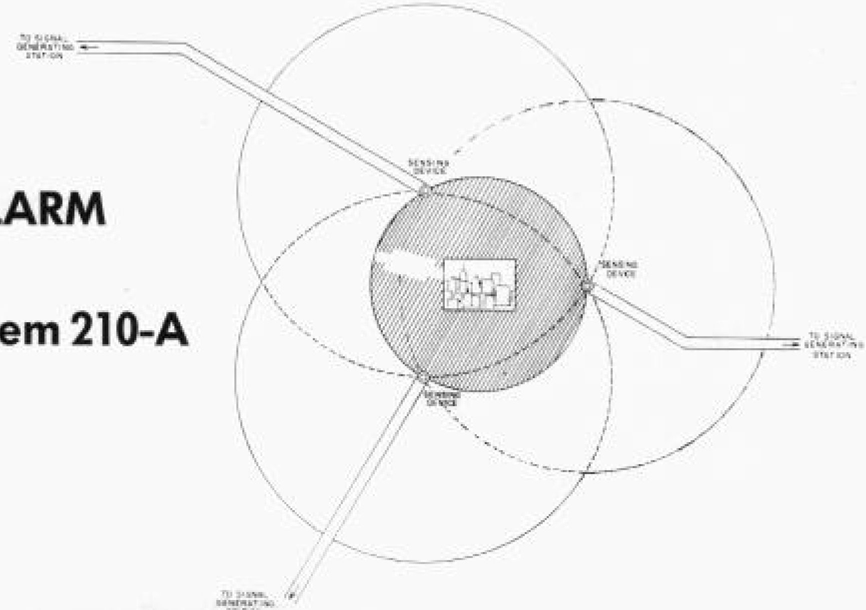


Figure 1. Configuration of Sensing Devices

THE prime requisite of any alarm system is maximum reliability coupled with safeguards which insure that the system "fail safe" in event of trouble. A nuclear-bomb alarm system has the added special requirement that it never send a false alarm. The Western Union Display System is designed to these specifications.

Energy Produced by Bomb

A nuclear bomb produces three main types of energy which might be used as a basis for detecting a blast. About one third of the total energy is emitted in the form of light and heat,—generally referred to as "thermal radiation." This intense radiation travels almost instantaneously and can start fires or cause skin burns at considerable distances from the point of detonation.

The second type of energy known as "initial nuclear radiation" consists of gamma rays and neutrons. This comprises only three percent of the total energy and its intensity decreases sharply with distance. At a distance from the blast where exposure to thermal radiation could produce serious skin burns, initial nuclear radiation would not cause any obvious injury.

The third type of energy, and that which is responsible for the largest part of the destructive action of the bomb, is the "blast wave." While this is intense, it is relatively slow, and its arrival time depends upon the energy yield of the explosion and the distance involved. At a distance of one mile from a one-megaton blast, the blast wave will arrive about four seconds after the thermal radiation.

Any one of these three forms of energy could be used as basis for detection; but, considering available methods, the high intensity and the high speed of transmission of the thermal radiation energy make it best suited to operate a bomb-explosion detecting device. In addition, the thermal radiation from a nuclear blast has a unique wave shape which distinguishes it from all natural sources of thermal radiation. The nuclear flash wave consists of two pulses of thermal energy, a fast-rising short-duration pulse followed by a comparatively slow-rising long-duration pulse.

Western Union Design

Detectors or sensing devices used in the Western Union Bomb Alarm System are designed to detect the thermal radiation from nuclear blasts. They have an adequate foggy weather range and observe a field extending from 0 to 360° in azimuth. They are used in groups of three, spaced at intervals 120° apart and several miles distant from the center of the area under observation. Figure 1 illustrates an ideal configuration of three sensors.

If a blast occurs near the center of the area, it is reported by all three detectors, since there is ample time for each detector to report the event before the arrival of the blast wave, which might destroy the detector or its connecting wires. The connecting wires and other system elements are located outside the central area. If the blast occurs sufficiently close to one of the three detectors to destroy it before it can report, then the other two detectors in the group will send the alarm. While all events are reported to central information points, simultaneous reports from at least two detectors will normally be required to record a bomb alarm on the system display map, at each central information point.

The detector, which is transistorized, receives its operating power from the telegraph signal generating station, over a pair of telegraph wires. Signals from the detector to the signal generating station pass over the same wires as audio-frequency tones. Three tones are used: one indicating the normal or "green" condition, the other two, used in sequence, indicate an alarm or "red" condition. The detector may be located some distance away from the signal generating station, depending on the line resistance and the permissible line voltage.

The detector, shown in Figure 2, is housed in a heavy, air-tight, aluminum, cylindrical container, about 9 inches in diameter and one foot high, which is surmounted by a cylindrical Fresnel-type marine lens. Within the lens is a cylindrical perforated-metal shield, which has a light-attenuation factor of 100; within the shield are the photocells, mounted at the focal point of the lens.

■ Western Union was asked, in May of 1959, to submit a proposal to the Air Force for a nuclear-bomb alarm system. It was required that this system should observe a group of about one hundred selected possible target areas in the United States and continuously report their condition on display boards located at a number of different military command centers. Plans for such a system were presented to the Air Force in June 1959, Western Union was given instructions to proceed early in August 1959, and a prototype system was developed and in operation by March of 1960.

■ This prototype display system observed fourteen potential target areas in the eastern portion of the United States. It consisted of thirty-seven Detectors and Signal Generating Stations, one Master Control Center, and one Display Center located in the Pentagon. After a series of engineering tests, the U.S. Air Force accepted the prototype system on February 10, 1961. From that date until February 6, 1962 when the prototype was integrated into a nationwide system, performance was satisfactory, with no false alarms and with 98.1 percent normal responses out of a total of 18,600,000 responses.

■ Nationwide expansion of the system was completed early in 1962. Following a series of tests, which included the successful reporting of an actual nuclear detonation, the system was declared "fully operational" by the Air Force. This system is known as Western Union Bomb Alarm—Display System 210-A.

Figure 2. The Detector

Operation of the Detector

The photocells are the silicon "sun battery" type. The individual cells are thin plates 1 by 2 centimeters. Three plates are mounted in a triangular structure, 2 cm high and 1 cm on a side, with the sensitive surface on the outer face. These photovoltaic cells respond to the visible and infrared energy produced by a nuclear flash. Their response time is only a few microseconds.

A double-peaked electrical pulse, illustrated in Figure 3, is generated in the photocells by a nuclear blast. This pulse is amplified by two separate amplifiers and fed into two separate discriminating circuits. The first discriminator requires a fast-rising, high-amplitude pulse to cause it to trigger and shift the oscillator in the detector to its intermediate warning frequency. The second discriminating circuit is designed to respond only to pulses of sufficient magnitude and of a shape unique to a nuclear blast.

Thus a series of tests is applied, to assure that an alarm will be given only in the event of a nuclear flash and not because of lightning or other natural causes.

Lightning does have a fast rise time, but its intensity is low and its spectral distribution is such that much of its energy falls outside the acceptance range of the photocell. Lightning also does not last long enough to produce sufficient energy to satisfy the discriminator. Even multiple lightning flashes fall far short of satisfying the energy requirement of the alarm system.

Environmental Conditions

A desiccant is mounted in the sealed aluminum container to maintain a low-humidity atmosphere for the detector components.

The aluminum can is painted white on the outside to reflect solar heat. The detector circuits are designed to operate over a wide temperature range.

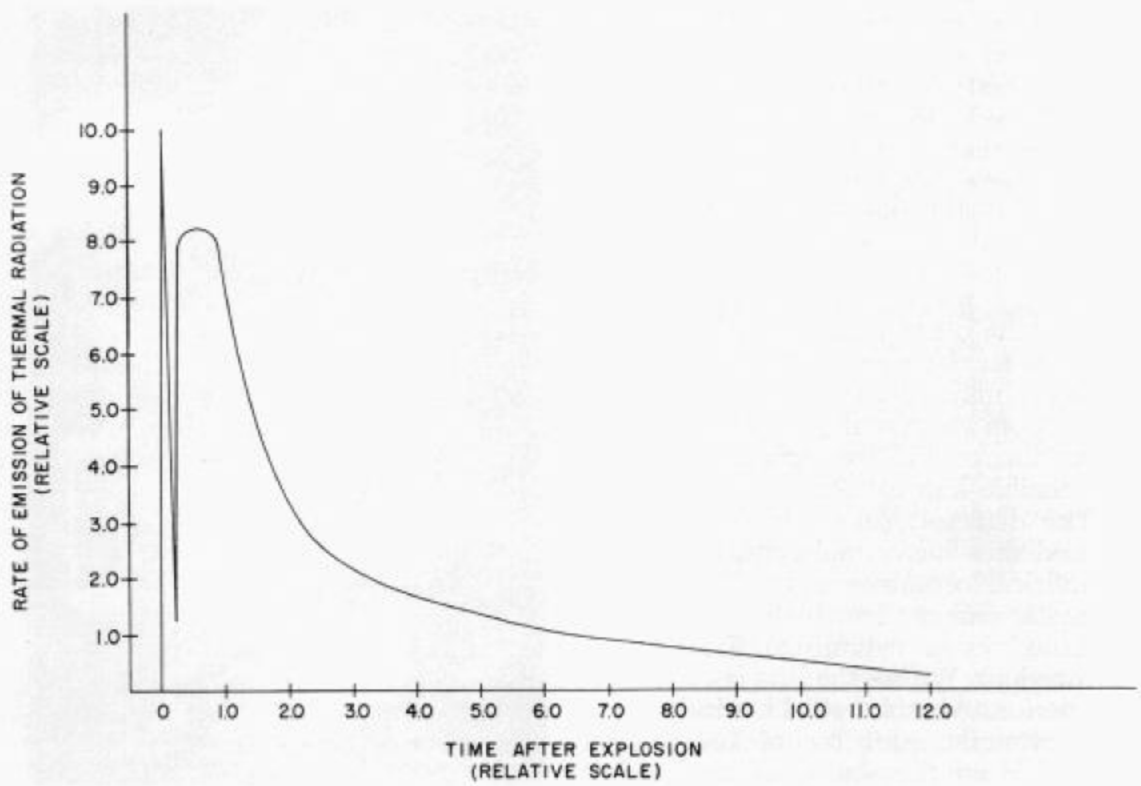


Figure 3. Emission of Thermal Radiation

Remote Control Tests

The detector includes a built-in test simulator which can be triggered remotely. It operates to produce a flash from a group of small neon and tungsten filament lamps which are mounted inside the attenuating metal screen and around the photocells. This flash is similar in shape to a nuclear flash. The detector will report an alarm upon the receipt of such a test flash.

A test of the complete system is possible from the photocell and the detector, the signal generating station, the Master Control Center, and all the interconnecting telegraph network to the Display Centers.

Signal Generating Station

The signal generating station shown in Figures 4 and 5, is located at some convenient point within approximately twenty miles of the detector. It supplies power to the detector and receives signals from the detector as a steady "green" or all-clear-and-operating signal or as the "red" sequence of two tones which constitutes the nuclear alarm.

The signal generating stations, connected in series loops, together form a system for reporting the status of detectors. When queried, each signal generating station will report "green" or not report at all. The "green" report indicates that the normal tone is being received from the detector and that the signal generating station is in working order. No report indicates trouble; either a detector is not

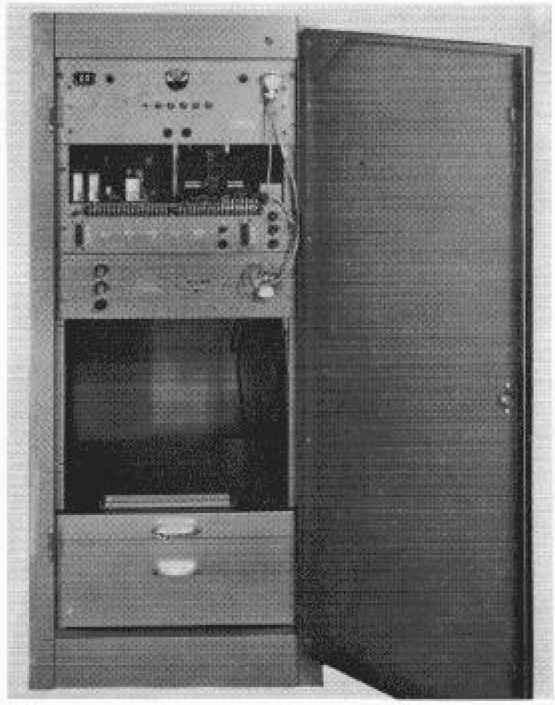
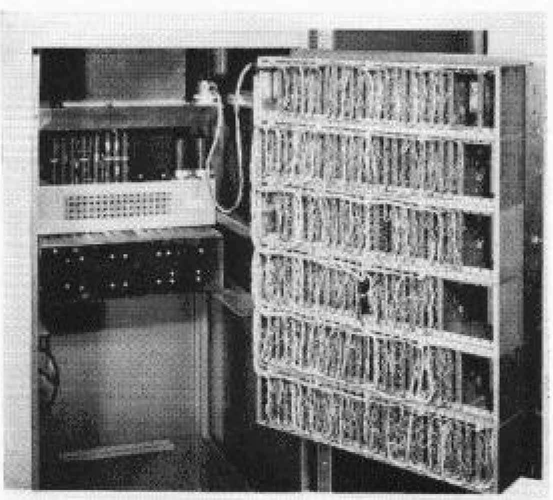
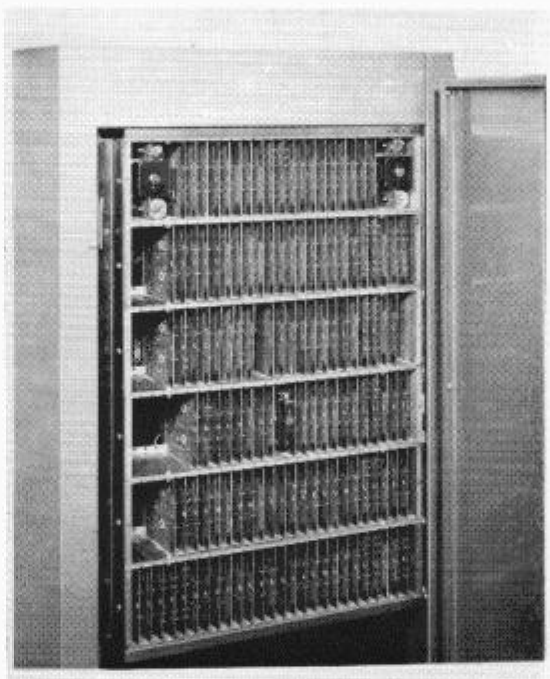


Figure 4. Signal Generating Station—Front View



a) Logic Assembly Swung Open



b) Back Door Opened showing Logic Assembly

Figure 5. Signal Generating Station—Rear View

working, the line to the detector is faulty, or the signal generating station itself is not in perfect working order.

Message Transmission

Each signal generating station is a regenerative repeater and is capable of retransmitting perfectly, even badly distorted signals. Each station can receive only from the next preceding station and can send only to the next succeeding one. Each such loop is under the direct control and supervision of a Master Control Center. Under normal conditions the Master Control Center will periodically send to all loops connected to it a polling signal in the form of five-letter word. The first signal generating station on each loop receives this signal and repeats it to the following station with an 11 millisecond delay. At the same time the message is decoded within the signal generating station and, on decoding, causes a probe to be made on the detector line. If the green tone is present, the signal generating station will transmit its green report directly following the poll message. If no green tone is found, no local report will be made.

The second signal generating station will receive and repeat the poll request and, on decoding the poll message, will prepare to send its answer as the first station did with the exception, that now there is further traffic on the line in the form of the reply of the first station. The second station will have to wait until it sees an idle incoming line before it inserts its reply. This procedure is followed all the way down the line, each station relaying all incoming traffic and appending its report at the end. The last station on a loop will relay back to the Master Control Station, the original poll request and the reports of all the other previous stations and append its own report as the last message.

If the signal generating station fails to receive a polling message for an interval of 2½ minutes, it will send its green report automatically. This feature aids attending personnel to locate breaks in the series loops, if they occur, and informs them as to the number of stations still capable of reporting red alarms under such conditions.

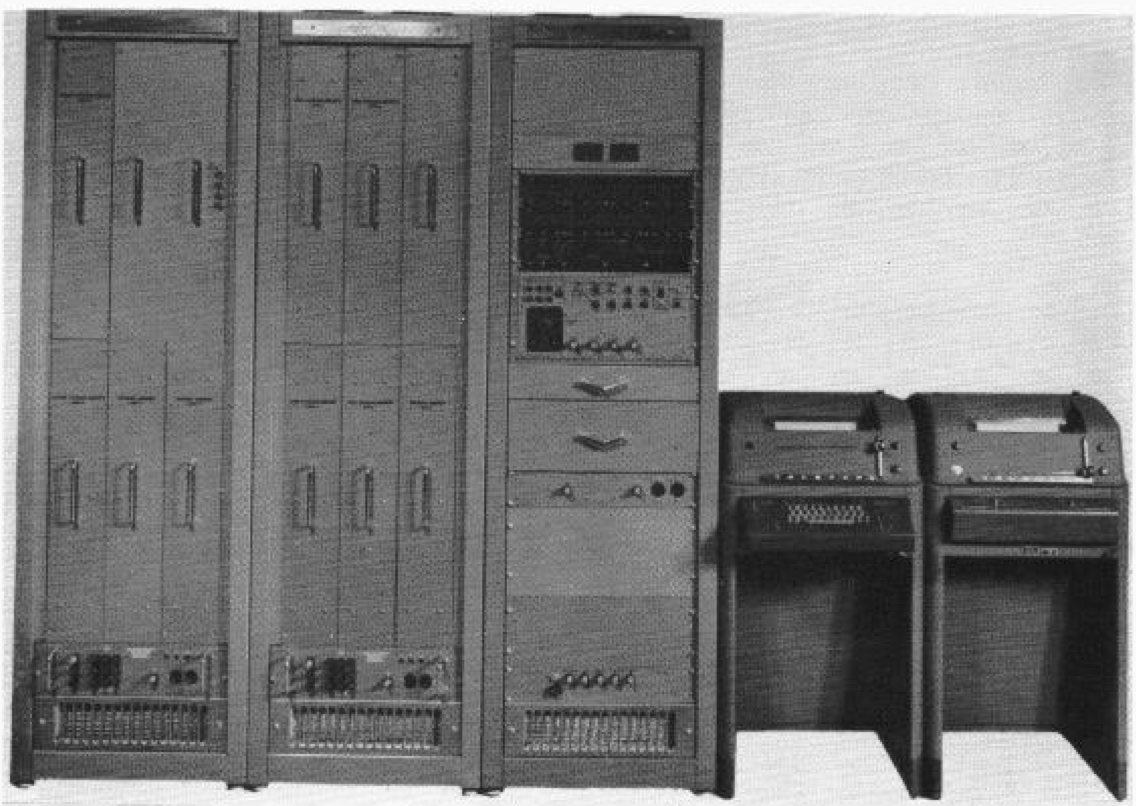


Figure 6. Master Control Center

Should the incoming tone from the detector shift to the alarm sequence, the signal generating station will generate its characteristic alarm signal and, if the line is idle, immediately transmit it down the line. Should the signal generating station be busy when an alarm is detected, the transmission of the alarm is delayed until the end of the message then being relayed.

After receiving an alarm from the detector, the signal generating station then inserts the alarm message and shunts any further incoming traffic into storage. The traffic in storage is retransmitted directly following the local alarm report. Handling traffic in this manner assures that an alarm can be handled with a minimum of delay and that no traffic is lost. It is important that the incoming traffic, which is stored when the local alarm is inserted, be preserved and retransmitted, for it, too, may be an alarm message.

Master Control Center

The Master Control Center, shown in Figure 6, is the automatic control center for the system. All the signal generating station loops begin and end in Master Control Centers. Loop polls are initiated from this point and all answers are received here. The Master Control Center knows the number of signal generating stations which should report and recognizes their call letters. On completion of a poll, all the stations reporting are checked off and the "green" reports are relayed to the Display Centers. The Master Control Center generates an out-of-order or "yellow" report for any station not reporting. On completion of the report to the Display Centers, the poll request is again sent out to all signal generating station loops, thus beginning a new cycle. Figure 7 is a functional block diagram of a Master Control Center.

On receipt of an alarm message the Master Control Center immediately ceases all normal functions. All "green" reports in storage are erased making the storage register available for recording "red" reports as they are received. At the same time the function of the storage register is changed, the Center begins a high speed scan of the register and within a millisecond it begins the transmission of the "red" reports to the Display Centers. After all "red" reports have been cleared out of the storage register and all incoming traffic has ceased, the Master Control Center initiates a poll. On completion of this poll the storage register is scanned for "yellow" reports only and a corresponding report is made to the Display Centers. At the end of this report the Master Control Center reverts to a normal status and initiates a normal polling sequence.

"Red" Test

In addition to the continual testing and reporting program which the Master

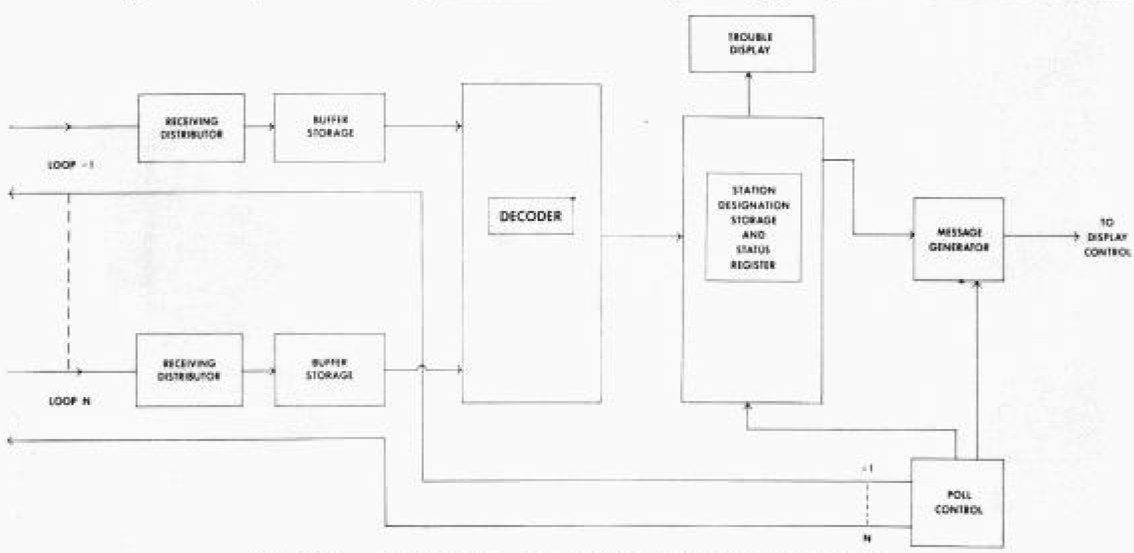


Figure 7. Functional Block Diagram of Master Control Center

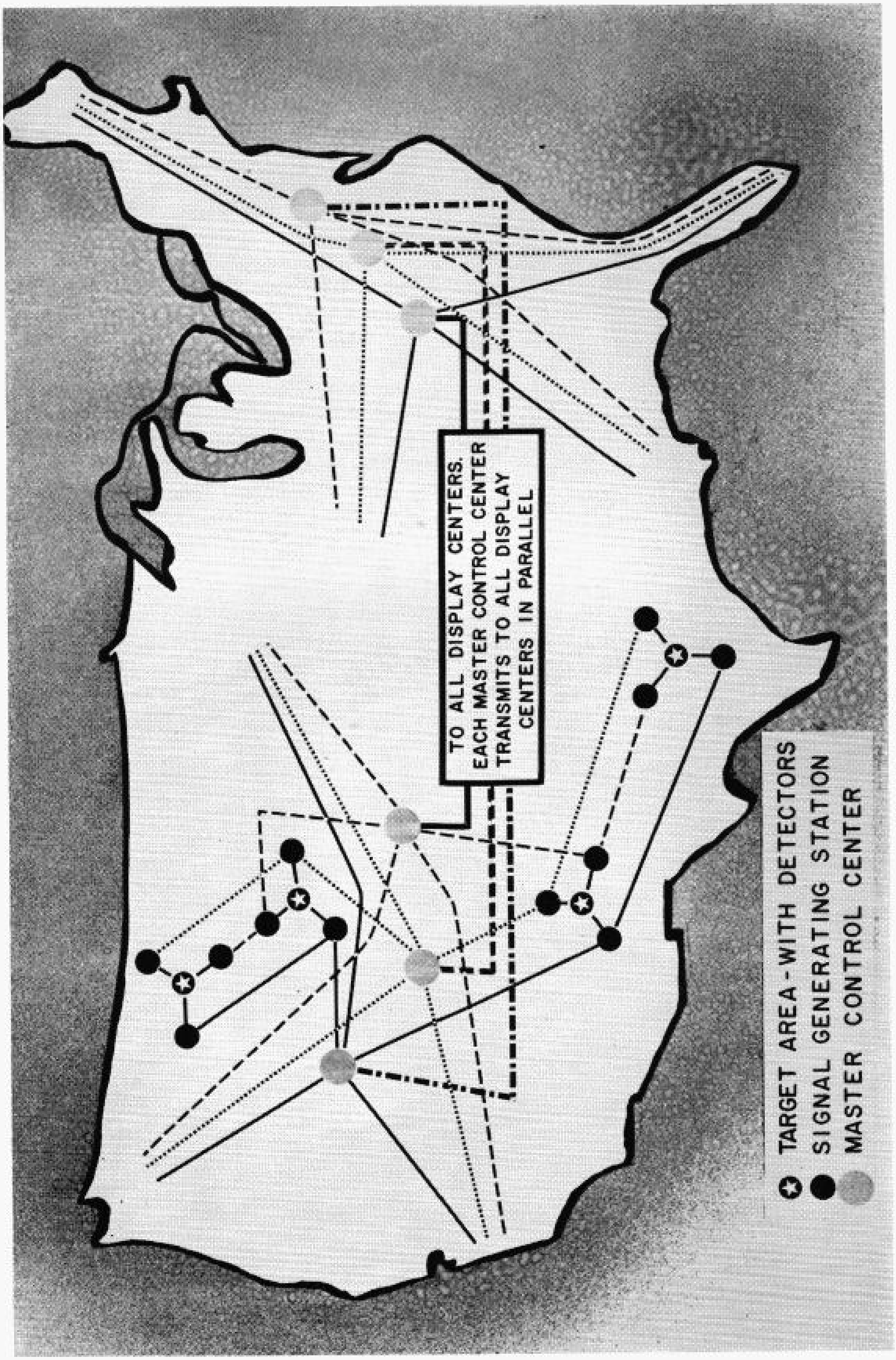


Figure 8. Theoretical System Layout

Control Center performs automatically, provision is made for the attendant at the Center to perform a complete test of the "red" reporting circuitry, loop by loop, or for the entire center at once. On insertion of the proper message on a loop, each signal generating station will trigger a built-in simulator in its associated detector and cause a "red" test to be made. Loops are normally taken out of service to make such tests and the "red" reports merely appear on a test printer and are not relayed to Display Centers. Messages originating in this manner are modified so they are easily identified as test messages and if inadvertently they are relayed to the Display Center, they will not be decoded as alarm messages. Full over-all tests can be made when properly authorized and initiated.

All trouble reports and "red" alarms are automatically printed out on a second printer at the Master Control Center. All maintenance functions can be initiated from this point immediately at the first appearance of trouble.

Regional Layout

The prototype system included only one Master Control Center. In the system covering the entire country, six such centers are employed in two groups of three; each group covering about one half the country. Figure 8 is a theoretical layout of the nationwide system. Each Master Control Center transmits to all Display Centers. The system is designed so that each of the three detectors, associated with a given target area, is tied into a separate Master Control Center by way of separate facilities. Reliability and continuity of coverage is improved by this triple diversification. Each Master Control Center polls all associated circuits every two minutes.

Display Center

The Display Center consists of the decoding equipment, shown in Figure 9 and two display panels illustrated in Figures 10 and 11. The decoding equipment decodes the telegraph traffic so that the designated lamps light up on the display panels. This equipment also keeps track of the mistakes it makes as well as those caused by a faulty circuit to the Display Center. Attendants are called in case of trouble. Figure 12 is a block diagram of the display control equipment.

The display panels consist of a map, shown in Figure 10 and a tabular listing of the target areas, shown in Figure 11. On the map display only the "red" status report can be made and this, only, if two or more Detectors in a given target area have sent in "red" reports, or if a single "red" report is received while the other two circuits, to a given target area, are inoperable or "yellow." A red lamp lights up behind a translucent panel, which has a map outlined on its front surface, so that the area under attack may be located. The locations of target areas are visible only when alarm situations exist or are simulated.

On the tabular listing, referred to as the communicator's panel in Figure 11, three lamps are provided for each detector; red, yellow and green. One of these lamps is lit at all times. Ideally, only "green" lights should appear indicating all equipment and circuits are in working order. A "yellow" light indicates that equipment or facilities associated with a particular de-

Figure 9. Display Control Cabinet and Printer

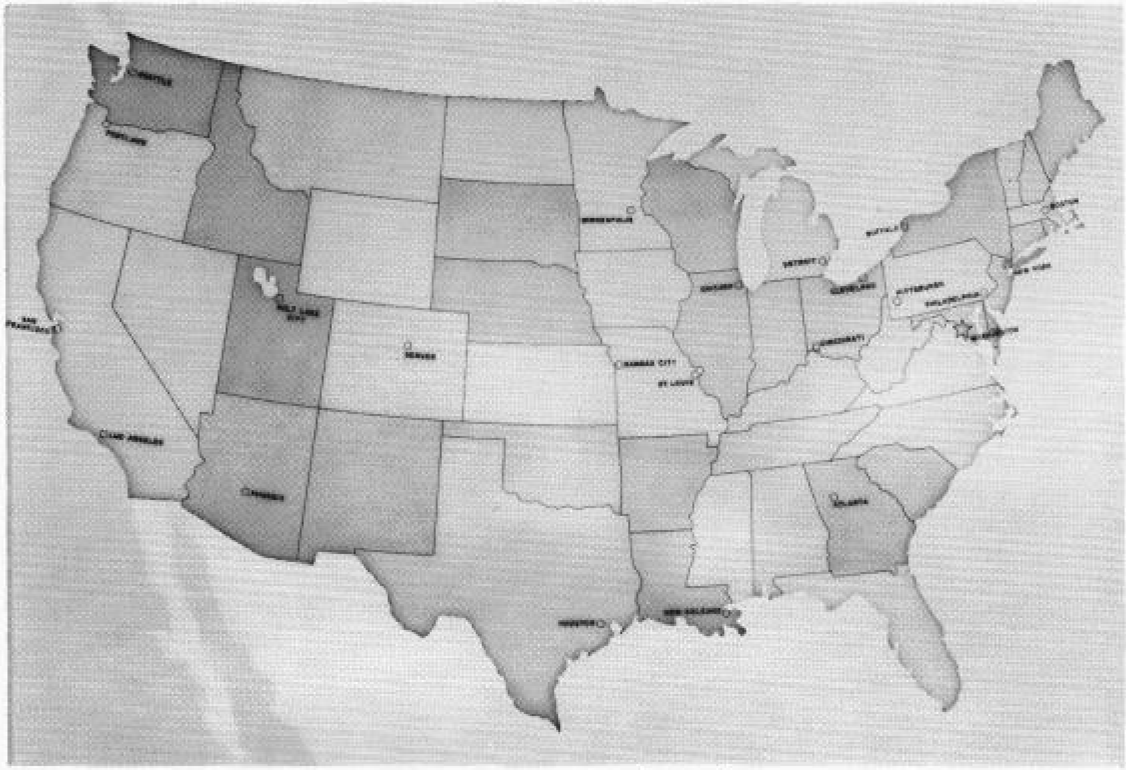


Figure 10. Map Display Panel

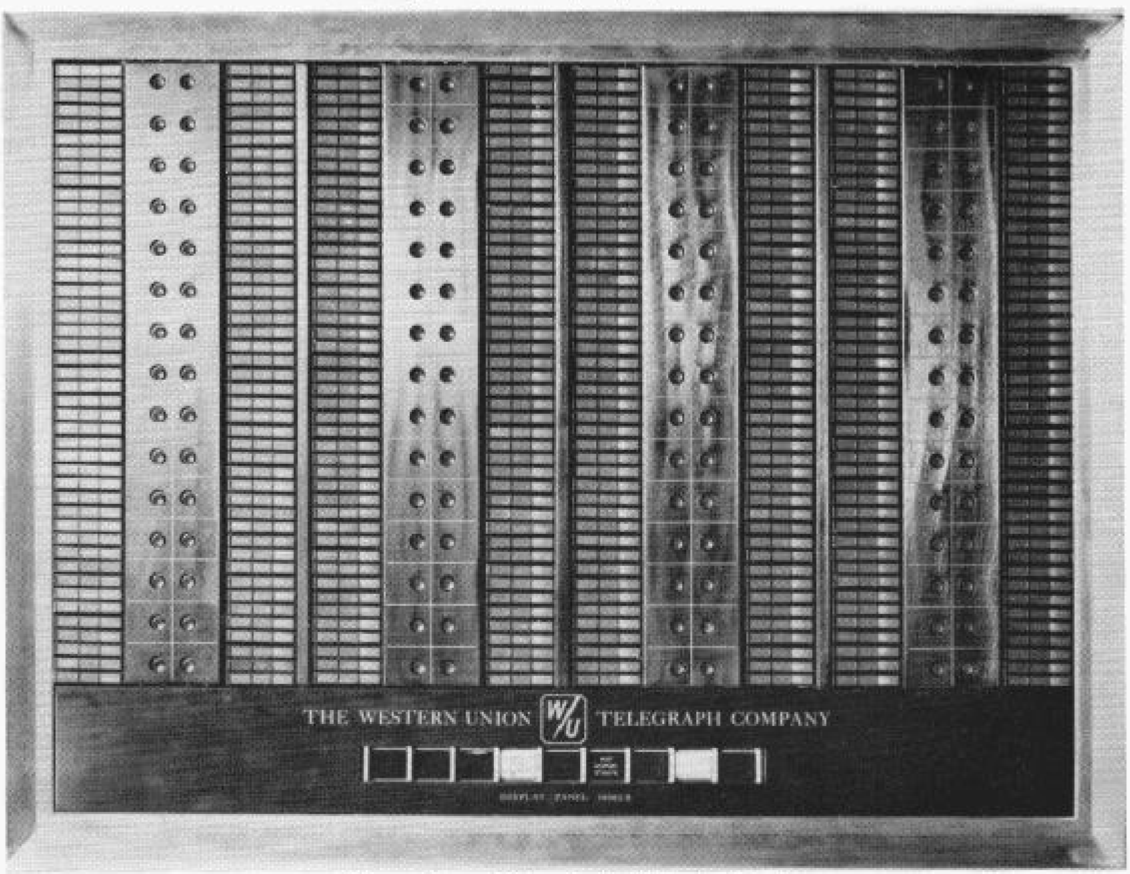


Figure 11. Communicator's Display Panel

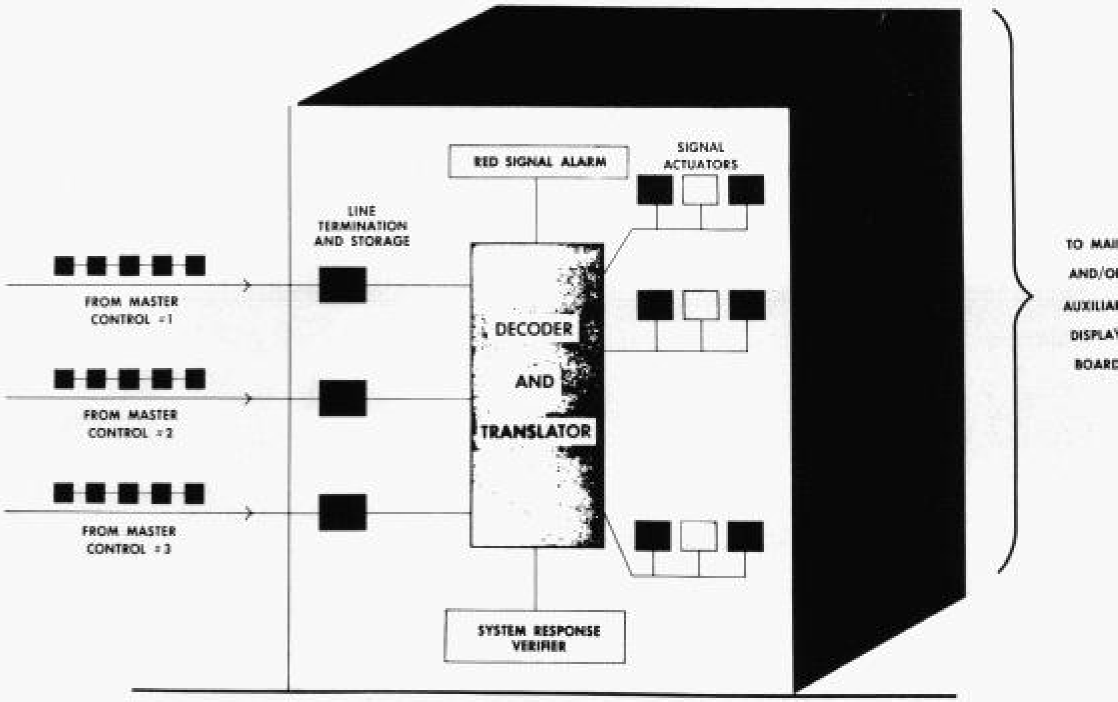


Figure 12. Display Center Control—Block Diagram

tector are faulty and are incapable of responding to the test sequence but may still be able to respond to an alarm sequence, depending on the type of fault. The "red" light indicates an alarm sequence has been detected. A target area name becomes readable only when an alarm situation exists or is simulated for that area. The attendant at the communicator's panel knows the status of all detectors at all times.

System Reliability

The Western Union Nuclear Bomb Alarm System has been designed with many safeguards to insure continuous operation. This system will maintain a constant watch over the selected locations with maximum reliability assured by continuous testing. If a nuclear explosion should occur within any of the observed areas, instant notice would be flashed to the important military posts.

MR. CLARENCE R. DEIBERT, Senior Engineer, is in charge of the Water Mill Laboratory Staff who designed and developed the component equipments of the Western Union Display System 210-A. He has been a member of the Water Mill engineering staff since 1941; was appointed Assistant to the Electronics Research Engineer in 1947.

On joining The Western Union Telegraph Company he was assigned to research in the field of infra-red signalling, first for Western Union, later under contract to the NDRC. Since 1947 he has directed the development of the High Speed Facsimile Terminal, of Telegraph Terminal AN/FGC-29, and most recently the design and development of the Bomb Alarm System.

Mr. Deibert is an Electrical Engineering graduate of Northeastern University. Before joining Western Union he was an employee of the General Radio Company and a research assistant in the nuclear physics laboratories at MIT. He is a co-inventor of the concentrated-arc lamp, holds several patents in the facsimile field, has contributed to the technical literature in both these fields and is a member of the IRE.

To a Western Union engineering, research, scientific or technical worker who has made a most significant contribution to the telegraph art

Mr. Buckingham receives the 1962 d'Humy Award from Mr. W. P. Marshall, President of The Western Union Telegraph Company

MR. WILLIAM D. BUCKINGHAM, Senior Engineer in the Electronics Laboratory at Water Mill, New York has had a major role in developing the sensor for the Bomb Alarm system. He received the 1962 D'Humy Award for "his original ideas, fruitful research and inventions in many areas of communications and national defense."

He joined Western Union in 1925 and since then has designed the optical system for a facsimile scanner, the concentrated arc-lamp, the depthometer, equipment for night fighter trainers, and character recognition equipment amongst others. He won the Franklin Institute Medal for his development of the Concentrated Arc-Lamp.

Mr. Buckingham is a graduate of Case Institute of Technology where he received his degree in Electrical Engineering. He is the author of numerous technical papers and is a member of the IRE.

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Varactors
Semiconductor Devices
Variable-Capacitance Diodes

Ernst, R. L. and Fitzpatrick, J. K.: Varactor Diode Part 1—Theory

Western Union TECHNICAL REVIEW, Vol. 17, No. 1 (Jan. 1963). pp 4 to 13

This is a tutorial article introducing the fundamental characteristics of varactor diodes. The Manley-Rowe power relations for nonlinear reactances are explained and illustrated with a practical example.

Part II will appear in the April, 1963 issue of the Western Union TECHNICAL REVIEW and will be concerned with the applications of this device.

Display Systems (Alpha-Numeric)
Data Communication Systems
Electro-Mechanical Devices

Burroughs, H. F.: Electro-Quote Display System

Western Union TECHNICAL REVIEW, Vol. 17, No. 1 (Jan. 1963). pp 14 to 19

Western Union developed and constructed ELECTRO-QUOTE for the Trans-Lux Corporation. This article describes the prototype system which translates telegraphic code into an alpha-numeric display of information received over telegraph facilities.

This method of data transmission has many potential applications such as brokerage houses, aircraft control centers or other places where a rapid automatic display of intelligence is required.

Data Transmission
Data Processing
Electro-Mechanical Devices

Recca, P. F.: Data Card Transmitter

Western Union TECHNICAL REVIEW, Vol. 17, No. 1 (Jan. 1963). pp 20 to 29

The Western Union DATA CARD TRANSMITTER 11313-A was designed to automate data transmission at the source. This article describes the problems in handling such data for telegraph transmission and suggests a few of the many applications of the unit such as: billing, shipping, stock trading, hotel reservations and others.

Data Communications Systems
Optical Sensors
Display Systems

Deibert, C. R. and Buckingham, W. D.: Bomb Alarm—Display System 210-A

Western Union TECHNICAL REVIEW, Vol. 17, No. 1 (Jan. 1963). pp 32 to 42

This article describes the system philosophy of Bomb Alarm—Display System 210-A and discusses, in general terms, the operation of the major units of equipment. A brief history of the development of the system by Western Union, in conjunction with the U.S. Air Force, is also included.

TECHNICAL REVIEW FOR '63

EDITORIAL

Perhaps you have noticed the changes in the cover and in the format of articles of the TECHNICAL REVIEW which occurred in 1962. Many of our readers have, and have commented favorably upon these changes. You may not know, however, that the magazine has had a new Editor for the past year and that, in large measure, the new Editor has been responsible for what has taken place.

The plans for 1963 include a series of special issues relating to particular subjects of interest, i.e., a Communications Switching issue, a Microwave issue, and others which will document Western Union's developments in advanced telecommunications.

Western Union's new services such as Private Wire Alternate Record Voice Service, Broadband Switching Service, AF DATACOM, TELEX, and others are subject matters to be reported and published in the near future. The advancing field of Data Communications is of continuing interest, also. We know that our readers—the employees of Western Union and our customers and friends in industry—are eager to keep abreast of the new developments in these fields.

Since this is a magazine primarily concerned with changes in the state of the art relating to fields in which the Telegraph Company is interested and particularly with Western Union accomplishments, most of our articles are prepared by members of the R&E Department and Plant Department on the solicitation of the Committee on Technical Publications, based upon the knowledge of committee members of current engineering projects and impending changes in our Public Message System or Private Wire Services. In addition to these solicited papers, articles in keeping with the objectives of the magazine are invited for consideration from all employees regardless of department.

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