COMMERCIAL RADIO

Feb.-Mar.
1935

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New WOR Transmitter

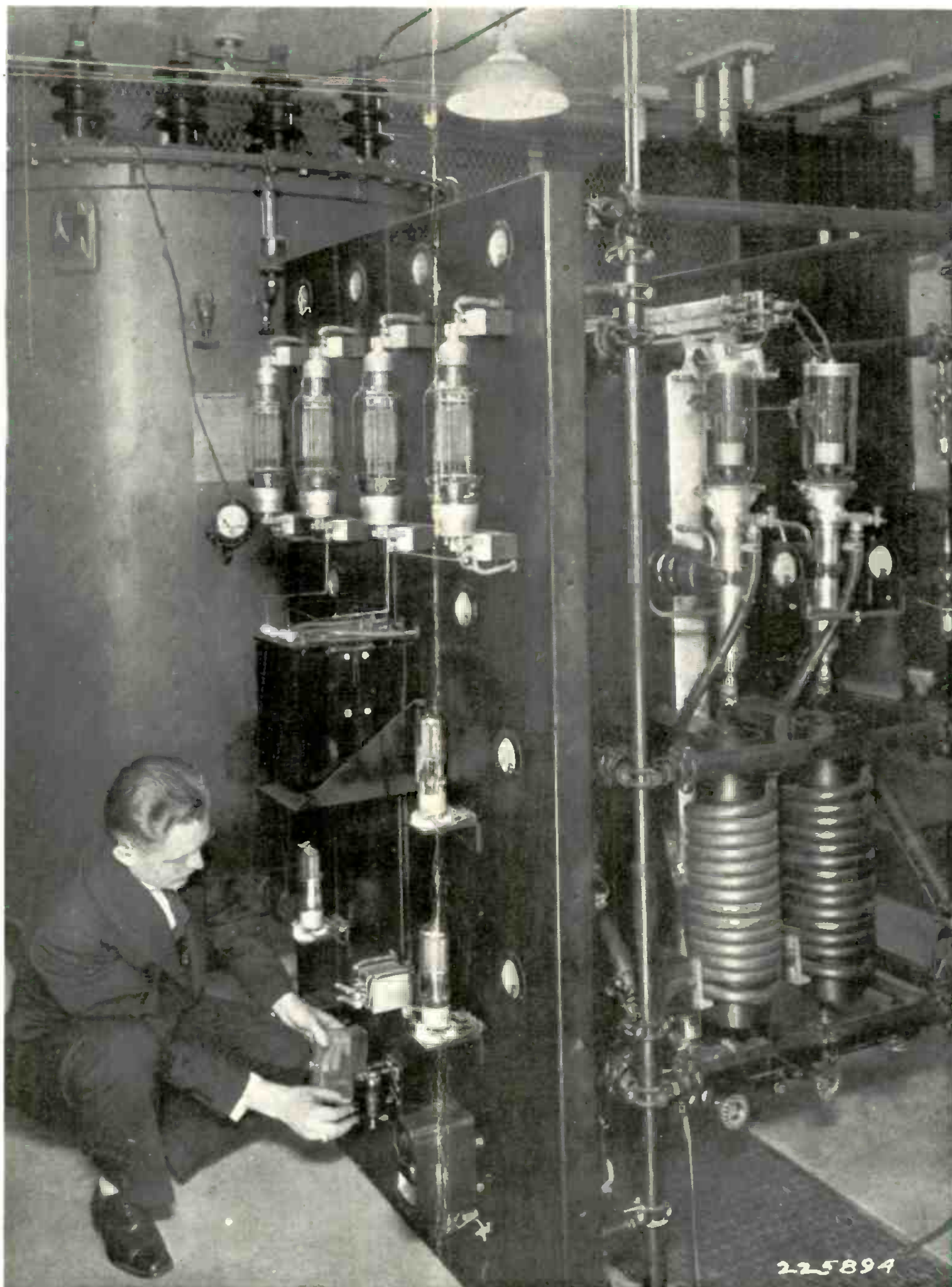
Telephotograph System

Transmission Disturbances

Aviation's Radio Compass

Assignments

Fiction



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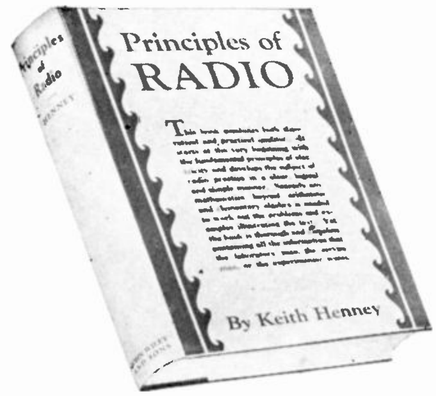

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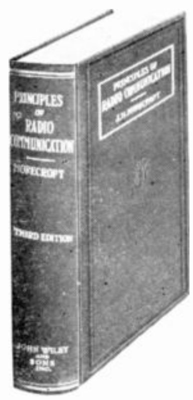

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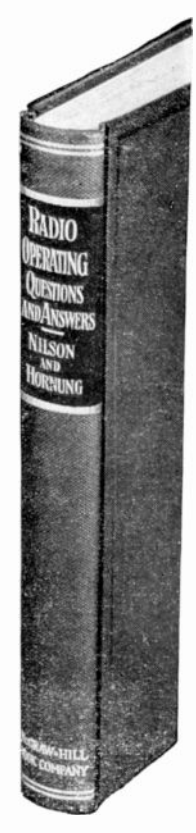

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VOLUME IV NO. 5

COMMERCIAL RADIO

(FORMERLY "C-Q")

The Only Magazine in America Devoted Entirely to the Commercial Radio Man

An action of wide interest to radio men was taken on January 24, 1935, when the Communications Commission reversing the recommendation of its examiner authorized a harbor to shore communication service by radio phone service in the Philadelphia harbor.

The Atlantic Communications Corporation was authorized to construct and operate a 50-watt transmitter with a remote control station in the main office of the Atlantic Refining Company, which is parent owner of the Atlantic Communications Corporation, on a frequency of 38.6 megacycles.

It is intended to arrange a direct telephone connection with the transmitter, so that by calling the number phone connection will be established with the transmitter and so to craft in the harbor with proper facilities of reception and transmission. There are to be five tugs equipped with 2 watt transmitters by the Atlantic Refining Company in the Philadelphia harbor.

While the permit is granted with complete reservation on the part of the Commission for revoking the same at will, and without hearing or notice, it is an action that may have far reaching importance to the development of radio facilities along this line of work.

The actual order authorizing construction of the 50-watt land station for operation during all hours, on 38600 kc. to station W3XAY, was issued January 17, and to become effective at 3 a. m. January 31st. Under the same date and effective time 2 watt licenses were issued to the tugs Van Dyke 1, Van Dyke 2, Van Dyke 3, Van Dyke 4, and the Atlantic also on 38600 kc.

Contents for February-March, 1935

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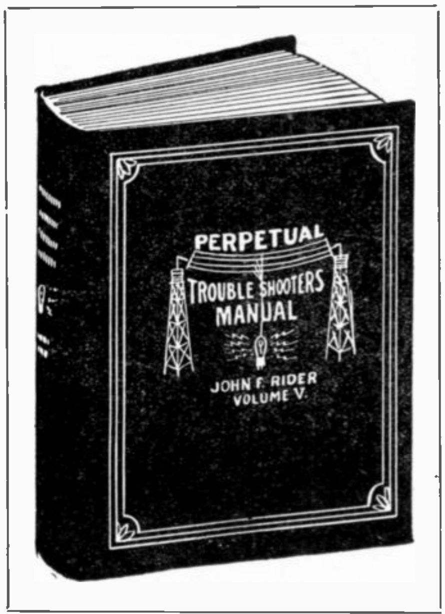

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Crosley	25
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Dewald	24
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Edison-Bell	7
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Horn	5
Hudson Ross	5
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Kingston	10
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Larkin	3
Lewol	5
Mission-Bell	6
Montgomery-Ward	13
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Philco	19
Pilot	10
Radolek	13
RCA-Victor	63
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Sears Roebuck	56
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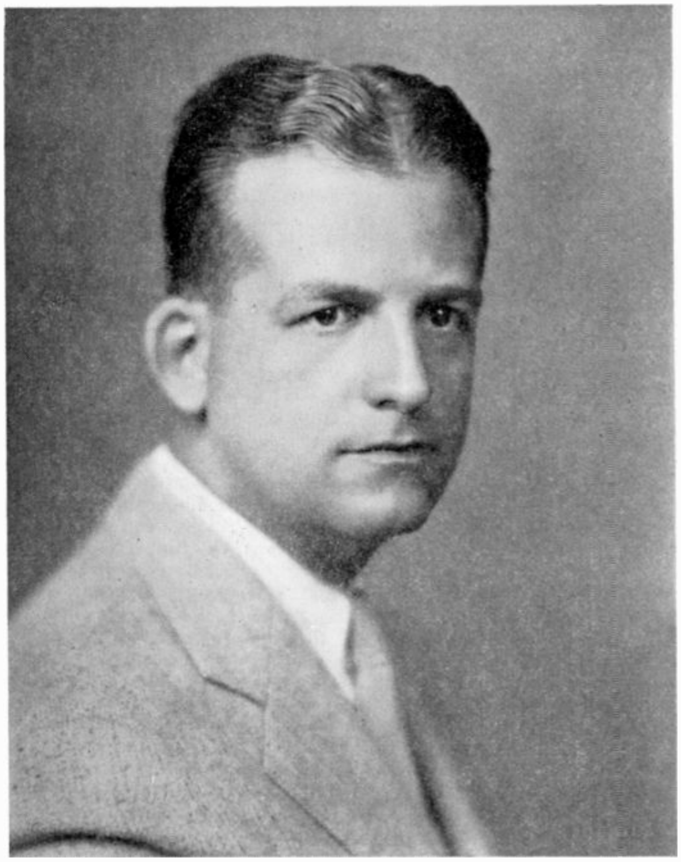
NEW YORK, N. Y.

The New WOR Transmitter

By H. W. FORSTER

TWO steel towers and a suspended cable emitting a pattern of radio waves that will concentrate on New York, Philadelphia and other cities, diminish over the Pocono Mountains and other thinly settled areas and re-occur beyond, are among the features of WOR's new broadcasting station at Carteret, New Jersey, scheduled to go on the air with regular programs the latter part of February.



J. R. Poppele, Chief Engineer WOR

This directional antenna system, first of its kind to be used by a commercial radio station, has been specially designed by Bell Telephone Laboratories to operate with the 50-kilowatt Western Electric transmitting equipment and to focus its power where the greatest number of listeners reside.

The importance of obtaining this focus of power lies in the fact that more electrical noises are produced in congested areas than in thinly populated sections. Electric trains, power lines, elevators, electrical appliances, all contribute to the "noise level" picked up by radio sets. For consistent reception the signal of a broadcasting station must be far above the noise levels. Consequently stronger signals are necessary in cities than in the suburbs or in the country.

In WOR's antenna system, the cable is suspended midway between the two towers, each 385 feet high and 790 feet apart. The three antennas are arrayed in a straight line and are spaced in accordance with wave length factors. Carteret itself is located on a line between New York and Philadelphia and the antennas run at right angles or broadside to this geographical line. Their broadside discharge of radiation is much more powerful than the lengthwise discharge. In fact, to secure on all sides a radiation equal to that which is trained on New York and Philadelphia would require 120 kilowatts in the antenna.

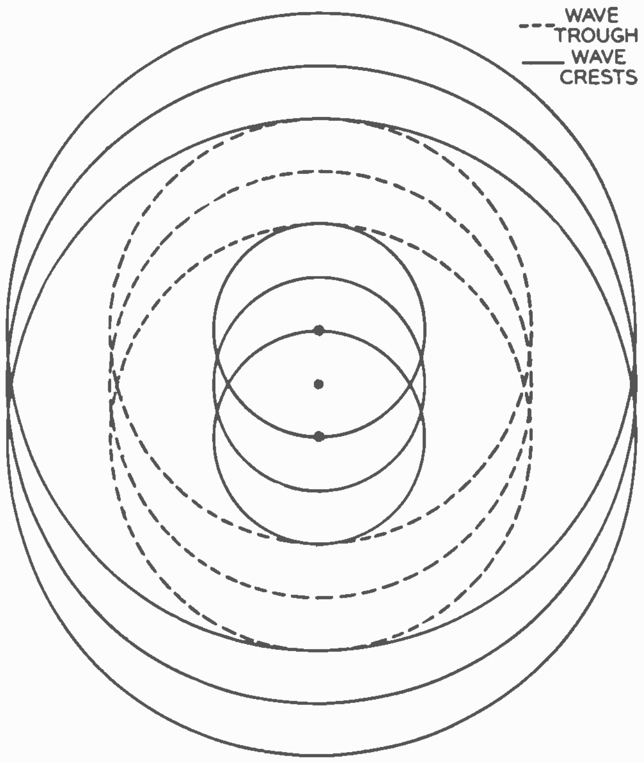
In contrast, a uniform radiation of 6 kilowatts would be equivalent to the signal strength which is radiated along the line of the antennas to the New Jersey communities near at hand. Beyond these communities where the intensity begins to fade out lie on one hand the Atlantic Ocean and on the other the Pocono Mountains.

Drawn on a map, the field of radiation takes the form of an hour glass, with Carteret and its surrounding communities falling within the neck of the glass, and with the bulbs enclosing the New York and Philadelphia areas.

The effect is obtained by the spacing of the antennas. This is calculated so that the waves they emit broadside are in step, the crests and troughs matching precisely and re-inforcing each other. The waves emitted lengthwise by two of the antennas, however, are out of step. They not only tend to neutralize each other in that direction but, as though squeezing in from the ends, react to re-inforce further the power emitted broadside.

Up to this point only the ground waves or those emitted horizontally have been taken into consideration. The design of the antenna also takes account of the effect of the sky waves, those emitted upward.

At night these waves are reflected back to earth from a layer of ionized atmosphere at an approximate height of 60 miles. Where returning sky waves mingle with ground waves, interference



Directional characteristics obtained from the antenna array of WOR, results from the interference of reinforcement of the waves from the three antennas

occurs unless one predominates with an intensity at least four times as great as the other.

The arrangement of the antenna actually aims the sky waves at certain strategic angles. For more than 50 miles around the station, ground waves will over-ride them. For example, the territory from Carteret to Morristown will receive ground waves. Beyond, sky waves will increase in relative strength so that at Wilkesbarre and Scranton they will clearly predominate. Similarly, Philadelphia will lie within the pure ground wave area while Baltimore and Washington beyond will receive clearly predominant sky waves.

The new broadcasting equipment will extend WOR's service over a much greater area than does its present 5 kilowatt equipment. Calculations indicate that at points as far distant as Miami, Florida, the station's apparent power will be 24 times greater than at present.

The broadcasting apparatus is connected with the antenna system by a concentric transmission line consisting of one copper tube within another, the outer being 2⅝ inches in diameter and the inner 11-16 inches in diameter. This line runs 600 feet from the transmitter building to a point midway between the two towers, being laid 5 feet underground. Not a single wire leaves the transmission house above ground.

Through a special network the transmission line divides at this point in three branch lines of similar construction. One is coupled to the central cable antenna. The other two extend 390 feet in opposite directions to each of the end towers. This length is above ground and is covered with heat-insulating material to eliminate sharp differences in temperature between the inner and outer tubes which would create uneven expansion and contraction.

The entire transmission line is filled with nitrogen under ten pounds of pressure and sealed. Moisture is thus entirely eliminated.

The transmitter is located on a swampy site. At hightide, a large area is actually under salt water. The transmitter is grounded in this swampy soil by an extensive system of underground conductors. There are 40 miles of No. 8 drawn copper wire under ground, part running at right angles to the line of antennas, and another radiating out beneath the end towers. Half of this system is below water level a greater part of the time.

The main ground bus, 1-16 inch thick by 6 inches wide, runs between the two towers and extends beyond them at either end. All lateral and radial ground wires are welded to the main bus and the north ends of the copper wires all terminate in the Rahway River. A length of ¾ inch stranded cable of bare copper is laid along the bottom of a creek which runs through the site and ends in the Rahway River also. All of the radial ground wires which cross this cable are welded to it.

Altogether 14,000 welds were made in the building, equipment and antenna system. The building itself constitutes virtually a metal sheath enclosing the transmitting equipment in a shield. Save for the office it has no windows. The metal sheathing of the walls, the copper roof, even the re-inforcing rods in the foundation, are welded to form a single continuous ground. The structural steel contains projections which protrude from the partitions so that they also can be welded in as part of the single unit.

Within the transmitter house a novel arrangement of panels and power equipment has made it possible to eliminate all overhead conduit and all overhead high voltage busses. Motor generators and transformers are arranged in the basement directly beneath the transmitter so that all leads come up through the floor directly into the respective panels where they terminate.

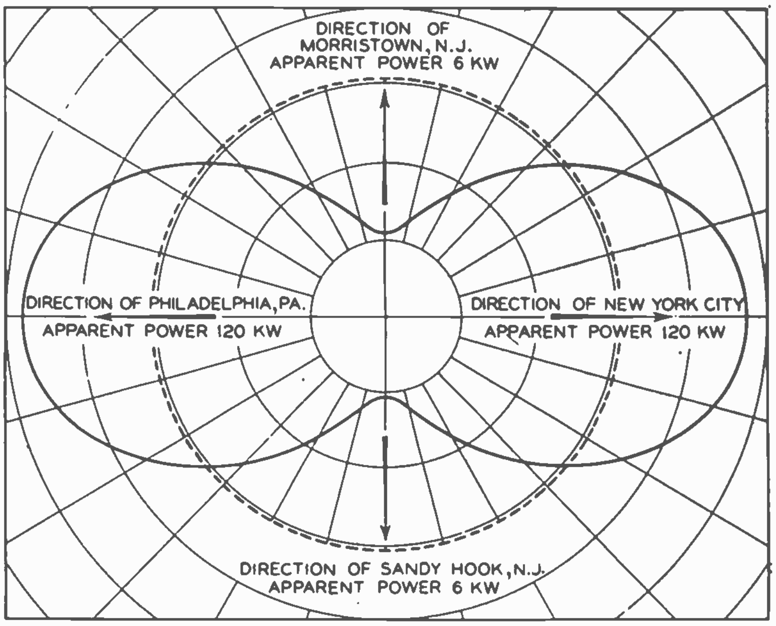
The building itself has no ordinary heating plant but is heated chiefly by the energy dissipated from the power tubes. This energy is equivalent to about 110 kilowatts and down to temperatures as low as 10 degrees above zero the building requires only between 35 and 70 kilowatts to be kept at 70 degrees. The distilled water circulated about the tubes is led into the building's air conditioning plant where it both heats the air and is itself partly cooled. Should the tube heat be inadequate at any time, two emergency electric heaters, also within the air mixing chamber, are controlled by a thermostat which automatically throws them on or off as required for the maintenance of even temperature.

As planned and developed, WOR will be a mecca for sightseers. The main control room is a virtual radio-apparatus theater. With the control desk in the middle as the nerve center, the entire room is panelled with radio equipment. In contrast to the ordinary straight line-up of apparatus, the first and last two panels of the 50-watt transmitter have been offset at a 45 degree angle so that the control man is nearly equidistant from all panels and controls. The transmitter forms one whole wall.

The rear wall of the room will be panelled with the present 5 kilowatt transmitter for utility purposes. A glass partition, enclosing the speech input equipment, forms another side of the room. To the left of the entrance will be a Western Electric aircraft radio beacon transmitter, the first to be operated by a commercial broadcasting station. Installed at the request of the Department of Commerce, this beacon will emit a special signal to warn aircraft of their presence in the vicinity of WOR. (For more complete description of this beacon apparatus see page 15, December 1934 "Commercial Radio.")

A special room has been set aside in which will ultimately be installed a short-wave transmitter for re-broadcasting to foreign countries.

From the main control room visitors may enter a gallery which encircles all of the equipment in the 50-kilowatt transmitter. Separated from it by glass partitions, this gallery opens up the entire system to their inspection.



Field intensity pattern of the ground wave, or direct radiation from WOR's new antenna. Dotted circle gives the distribution that would result from single non-directional antenna

ECLIPSE EFFECT ON SHORT WAVES

By CLANCY DAYHOFF

CONFIRMING theoretical research of the effect of a sun eclipse on short-wave radio, the 12 ground radio stations of Eastern Air Lines and pilots of six passenger-mail-express Douglas airliners of the company in the air at the time, reported that transmission and reception efficiency as well as distance was improved approximately 50 per cent at the peak of the partial sun eclipse Sunday, February 3rd.

Working with research engineers of the Bell Telephone Laboratories, designers of the short-wave equipment used by the Eastern Air Lines, Capt. E. V. Rickenbacker, general manager, ordered all ground stations and planes in the air to keep a careful check of conditions during the eclipse which lasted from 10:29 a.m. to 12:33 p.m. (EST).

"Conditions improved slowly until about 11:15 p.m.," reported Rickenbacker. "Then between 11:25 a.m. and 11:31 a.m., when the peak of the eclipse arrived, pilots and ground radio operators said that almost ideal conditions existed, being identical to twilight operation. Static noise was almost completely eliminated and signals 400 and 600 miles away boomed in over the receivers sufficiently to require volume control."

While Eastern Air Lines personnel were reporting the phenomena, research engineers of Bell Telephone Laboratories, J. P. Schafer and William M. Goodall, made observations and conducted ground tests which coincided with the work of the airline.

"There was a decrease of as much as 25 to 30 per cent in ionization in the lower levels of the so-called Kennelly-Heaviside layer," reported J. C. Schelleng, radio research engineer of the Bell Telephone Laboratories. "The excellent signal strength, improved transmission and reception of radio messages between ground stations and planes of the Eastern Air Lines was undoubtedly due to the decreased absorption of radio waves in the layer about 60 to 70 miles above the earth.

"Normally during the daytime these lower layers, as for example the 'E' region of the Kennelly-Heaviside layer, hangs like a curtain below the layer from which radio waves are reflected back to the earth. This weakens the signals before they reach the reflecting

(Continued on Page 20)

INTERNATIONAL ICE OBSERVATION AND ICE PATROL SERVICES, 1935

By L. C. COVELL, Assistant Commandant

FOR the purpose of carrying on the International Ice Observation Service and the Ice Patrol Service provided for by the International Convention for the Safety of Life at Sea, London, 1929, the United States Coast Guard vessels *Pontchartrain* and *Mendota* have been detailed for the season of 1935. The vessel (*Pontchartrain* or *Mendota*) assigned to Ice Observation duty will leave Boston when advisable and proceed to the vicinity of the Grand Banks to locate the ice fields and positions of the icebergs; keeping in touch with the situation; making such observations as practicable on the quantities of the ice, its kind, extent and drift; and obtain any other information that may seem to be of value.

The object of the Ice Observation Service is primarily to ascertain the location and progressive movement of the limiting lines of the regions in which icebergs and field ice exist in the vicinity of the Grand Banks, and the dissemination of the information so ascertained for the guidance and warning of navigators, and coordinately with these primary duties, in making oceanographical and meteorological observations. This Ice Observation duty is not necessarily continuous.

The vessel (*Pontchartrain* or *Mendota*) performing the Ice Observation Service will answer to the radio call NIDK as well as her own International radio call. The United States Coast Guard Cutter *General Greene* has been detailed to oceanographic duty only, and unless specifically directed, will not perform the duty of Ice Observation vessel as in previous years. Ice information will be broadcast four times daily as specified below, while the Ice Observation vessel is at sea. Mariners are requested to report to the Ice Observation vessel (*Pontchartrain or Mendota*) any field ice or icebergs sighted or reported sighted.

When the ice has moved southward so as to make a constant patrol necessary, the United States Coast Guard Cutters *Pontchartrain* and *Mendota* will begin the International Ice Patrol Service. These vessels will base at Halifax, Nova Scotia, for the duration of the Patrol and the Patrol will be continuous. The vessel on Patrol will not leave her station until relieved by the other vessel unless it is absolutely necessary to do so.

The object of the International Ice Patrol service is to locate the icebergs and field ice nearest to the trans-Atlantic steamship lanes. It will be the duty of the Patrol vessels to determine the southerly, easterly and westerly limits of the ice and keep in touch with these fields as they move southward. Radio messages will be transmitted daily giving the whereabouts of the ice, particularly the ice that may be in the immediate vicinity of the regular steamship lanes.

The ice having been located, the Patrol vessel will transmit four daily radio broadcasts giving ice information for the benefit of shipping, each broadcast being transmitted twice with an interval of two minutes. During these broadcasts, the radio silent period required by the International Telecommunication Convention, Madrid, 1932, will be observed. Each broadcast will be preceded by the general call "CQ" on 500 kilocycles (600 meters) and the conventional signal (QSY) to shift to 175 or 425 kilocycles. The text of the message will follow immediately on the frequency specified as shown in Table I.

The radio procedure will be in accordance with the provisions of the International Telecommunication Convention, Madrid, 1932.

TABLE I

	TIME		FREQUENCY	EMISSION
GCT	45th Meridian	75th Meridian	Kc/m	
0100	2200	2000	175 (1,715)	A1
1000	0700	0500	425 (705)	A2
1300	1000	0800	175 (1,715)	A1
2200	1900	1700	425 (7,05)	A2

TABLE II

Station	Call Letters	TIME GCT	75th Meridian	FREQUENCY (kilocycles)	EMISSION
Washington, D. C.	NAA	1700	1200	113, 9050	A1
		0500	2400	113, 4525	A1
Boston, Mass.	NAD	0518	0018	102	A1
		1630	1130	102	A1
		2200	1700	102	A1
New York, N. Y.	NAH	1530	1030	102	A1
		2130	1630	102	A1
Norfolk, Va.	NAM	0900	0400	122	A1
		1600	1100	122	A1
		2100	1600	122	A1

Ice information will be given by radio at any time to any vessel with which the Patrol vessel can communicate. Such information will be furnished as regular radio traffic (without charge) on commercial traffic frequencies.

Ice information broadcasts will be given in as plain, concise English as possible, and will state in the following order:

(a) Position of Patrol vessel.
(b) Location and description of ice.
(c) Other data.

The Ice Patrol vessel's general radio call letters are NIDK. This is a special International call for the vessel actually on Patrol and should not be confused with the regular radio call letters assigned to the individual vessels.

The radio messages from the Ice Patrol vessel and from other sources will be given publicity by the Hydrographic Office as shown in Table II.

It is requested that radio operators desist, as far as practicable, from operating during the broadcasts of ice information in order to lessen radio interference.

"WIRELESS DANCE" BAFFLES BYRD MEN

The problem of arranging a "dance" for the men of the Byrd expedition in Little America was surmounted through a unique exchange of radiograms between New York and the bottom of the world.

Since Admiral Richard E. Byrd was chairman of the President's birthday ball for Little America, it was considered appropriate that some sort of dance be held on the night of January 30th.

The following radiograms, between the Columbia Broadcasting System and Mr. Charles J. V. Murphy, communications officer for the expedition, illustrate how the problem was solved:

Charles Murphy Byrd expedition Little America. Elisa Ford beautiful model will dance with members of expedition during broadcast January thirtieth stop Suggest have men draw lots to see who gets first dance with her stop Columbia

Columbia Broadcasting System New York. How in the bottom of the world do you figure girl can dance with men down here as suggested stop Reply at once stop Murphy

Charles Murphy Byrd expedition Little America. Miss Ford will be in WABC studios during two-way broadcast and will dance before mike while orchestra plays stop She will carry on typical ballroom conversation as though dancing with explorers stop Hope you didn't think we were sending her down there stop Columbia

Columbia Broadcasting System New York. Men down here still don't quite get idea of how they'll dance with Miss Ford stop Are they supposed to talk back to her as though they're stepping on her feet stop What does she look like stop Murphy

Charles Murphy Byrd Expedition Little America. Miss Ford will talk as though actually dancing with the men stop for example she will probably say quote gee it's cold tonight isn't it unquote or perhaps some gags such as quote let's sit this next one out for six months unquote Columbia

Columbia Broadcasting System New York. Again please what does Miss Ford look like stop Men are asking stop Murphy

Charles Murphy Byrd Expedition Little America. Miss Ford is one of most beautiful models in America stop Served as model for birthday ball poster painted by Howard Chandler Christy stop Very stunning

(Continued on Page 8)

Foreign Communications Recommendations

PROPOSED NEW SECTION 223—SPECIAL PROVISIONS RELATING TO FOREIGN COMMUNICATIONS

No new wire or radio circuit intended for direct or indirect communication between the United States and any foreign country shall be opened or operated except after a finding by the Commission that American interests will be protected and served thereby; and all contracts, agreements or arrangements for or relating to the establishment or operation of such new circuits shall expressly provide that they are subject to the approval of the Commission. In determining whether or not any such proposed new circuit will protect and serve American interests, the Commission shall consider all facts and circumstances having to do with or leading up to the proposed establishment of the circuit including all acts done or promises made in such manner as to create a reasonable belief that they were performed or made with the intention or effect of influencing the establishment or operation of the circuits or any contract relating thereto, whether or not the persons performing such acts or making such promises are subject to this Act. There shall be a legal presumption that no new circuit will serve or protect American interests where the division of tolls or other compensation, terminal charges, out-payments, charges for equipment, payment of commissions, absorption of costs, solicitation of traffic, or any other matter which might influence the flow of traffic or communications is less favorable to American interests than in the case of any other circuit which is directly or indirectly handling traffic or communications which may be diverted to the new circuit.

The Commission shall have the right to suspend the opening of the circuit or the operation of any contract, agreement or arrangement for a reasonable time to permit it to make any necessary investigation in connection therewith. Should any cause or circumstance arising or first coming to the knowledge of the Commission subsequent to its approval of opening or operation of such new circuit be brought to the attention of the Commission which would have led to withholding of approval for opening or operation of such new circuit had the Commission been in possession of such information at the time of the approval thereof, the Commission shall have authority to withdraw or suspend its approval of the operation of any circuit so approved and thereupon the operation of the circuit shall be discontinued. The Commission shall not approve the establisment, opening or operation of any circuit for foreign communications upon terms which are less favorable to American interests than the most favorable terms upon which the same communication service is being rendered by any American company, or if it shall appear that the conditions under which such communication service is to be rendered are less favorable than those of any expiring contract which has been in effect if the Commission has reason to believe that such contract was not renewed because of anticipation of a new contract on terms less favorable to American interests.

The provisions hereof shall apply to all circuits opened subsequent to the enactment of this section, irrespective of the date of the contracts for or relating to such circuits, and to the continuation of existing circuits beyond the first date upon which they are terminable under any existing contract.

"WIRELESS DANCE" BAFFLES BYRD MEN

(Continued from Page 7)

stop Has the brown eyes of the Andes dark brown hair light complexion stands five feet eight and three-quarter inches with high heels weighs one-thirty is nineteen stop She wants to know what the men look like stop Columbia

Columbia Broadcasting System New York. Never mind what we look like stop Tell her she will be given a rush the like of which has not been seen since the opening of the Cherokee strip stop Tell her I personally want a waltz stop Your description of her sounds grand even at twenty-one cents a word stop Murphy.

(End)

250 Ship Applications

The month's record of applications for Ship Licenses:

Jan. 14, 15 and 16	45
Jan. 21	21
Jan. 24	7
Jan. 30	98
Feb. 6	80

NOTICE

Washington, D. C.
January 11, 1935

The Commission, at a general session, today adopted the following rules:

"247A. The term 'airway radio obstruction marker station' means a station of low power installed in the vicinity of an obstruction to air navigation and operated for the purpose of giving warning of the presence of that obstruction.

"254A. Airway radio obstruction marker stations will not be licensed to use a power greater than 50 watts. The exact power to be authorized is to be determined by the relation between the location of the marker station and the nearest radio range station operated by the Bureau of Air Commerce.

"260A. Airway radio obstruction marker stations will be licensed for a carrier frequency of 1200 cycles above or below the assigned frequency of the nearest airway radio range station serving the airway on which the obstruction is located. The marker transmitter carrier shall be one hundred (100) per cent. modulated at an audio frequency of 120 cycles per second and automatically keyed by continuously successive groups of 5 dashes each. Operations shall be continuous throughout the 24 hours and the assigned carrier frequency will be maintained within .05 per cent.

"260B. The Commission may from time to time, in cooperation with the Bureau of Air Commerce, specify radio stations which may be required to install airway radio obstruction marker stations and will specify the conditions under which such installations will be made."

The Commission also modified Rule 229 with respect to the frequencies 2850 kc. and 3000 kc. so as to read:

"m 2850 kilocycles—fixed

"m 3000 kilocycles—fixed

"Note (add) m—temporarily available for fixed service provided no interference is caused to any other service until June 1, 1935."

BELIEVE IT, OR NOT

An interesting story of present day radio broadcast is told in the case of WBNX, New York City, operated by the Standard Cahill Company, Inc.

In about two years the owner of the entire stock of the station has had to put up more than $200,000.00, for a station licensed for only 250 watts in the metropolitan area, and at the end of that time has an item carried of $162,064.97, in station prestige and good will, which at best is a matter of individual conjecture.

Correspondence

Dear Sir:

With reference to yours of January 19th, concerning an item in a newspaper relative to a new chain which it was stated would commence broadcasting January 1st, with WCFL as the key station.

We have given consideration to several contemplated hookups, the last with a regional chain of stations in nearby states. Plans in connection with this enterprise were unavoidably deferred until such time as our new transmission equipment has been installed.

Thanking you for the inquiry.

Yours very truly,
C. P. McAssey,
Advertising Manager WCFL

To those in smaller centers who wish to wrestle with figures, this, a typical one of large population area broadcasting will be interesting. With a complete staff of less than twenty-five employees, some of whom are on part time, and others of whom are commission salesmen, it shows in very simple language the positive necessity of a small station in a large area fighting for existence to have the backing of an "angel," and few angels there are in this day of such liberal proportions who have not already had their wings well clipped.

DISTURBANCES IN RADIO TRANSMISSION

By A. M. SKELLETT

Member of the Technical Staff, Bell Telephone Laboratories

ALL radio waves which traverse long distances over the earth's surface make use of the upper atmosphere. Indeed were it not for the electrical properties of these high regions*, by reason of which the waves are bent back toward the earth, radio transmission over distances greater than a thousand miles or so would be impossible. Short waves, at least, would simply pass out into space instead of following the curvature of the earth.

These electrical properties are due to the ionization of the gases; that is, the breaking up of the atoms and molecules into electrons and ions by ionizing agents. It is believed that the most important of these agencies is the ultra-violet light from the sun. Others which are believed to contribute to the ionization are the ultra-violet light from the stars, cosmic rays, meteors, and electrons, ions or neutral particles from the sun. None of these, except possibly cosmic rays, acts in a steady continuous manner, and in consequence the electrical state of the ionosphere varies continually. Some of these variations are fairly regular and cyclic while others are irregular and give rise to disturbances in long distance radio transmission.

One type of such disturbance occurs at the time of a "magnetic storm," and is very detrimental to short waves travelling over high-latitude paths. In fact, radio pulse experiments have shown that the ionosphere in polar regions completely absorbs short waves at such times. Coincident with the magnetic and radio effects other phenomena are observed, the most prominent of which are the abnormal electric currents in the earth's crust and the appearance of the aurora in unusually low latitudes. Since the magnetic aspect of these disturbances has received by far the greatest amount of study, the term magnetic storm is used in the discussion of any of these phenomena.

Theoretical considerations indicate the variations of the earth's magnetic field have only a minor effect on radio transmission in general, the changes in the ionization of the ionosphere being responsible for the major effects. The latter deviations appear to be of two kinds, a general increase in the amount of ionization and an increase in the turbulence. In the daytime the resultant effects on radio transmission vary greatly with the wave length: long distance transmission by long waves (5,000 meters or more) is better, but transmission by short waves (10 to 100 meters) may be severely disturbed or completely wiped out. During the night hours, the effect on the short waves is of the same kind as in the daytime, whereas the long waves experience a relatively mild depression in the strength of the received signals.

Apparently the general increase in ionization during disturbed periods enhances the "reflecting power" of the ionosphere for long waves during the day, while an opposite effect is produced on the short waves. It appears that the layer of ionization which is intensified by the disturbance acts both as reflector for the long waves and as absorber for the short, so that the increase in ionization affects the two ranges of frequency

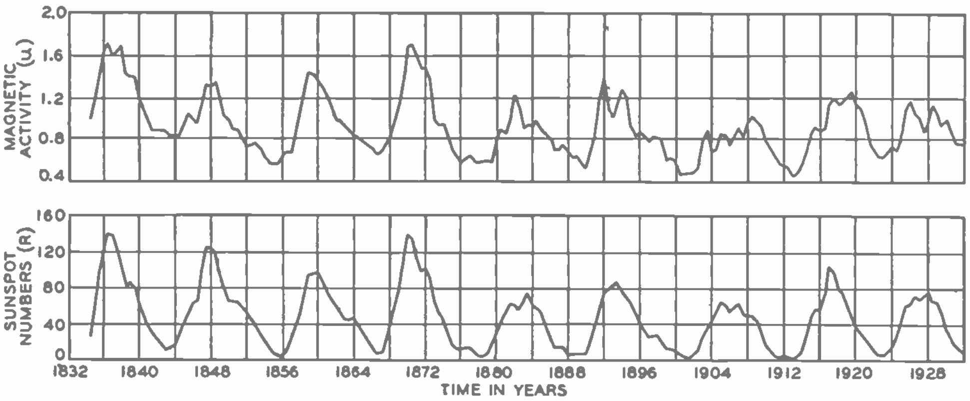


Fig. 1—Magnetic and sun spot data show an eleven-year period of variation. These data were compiled by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington

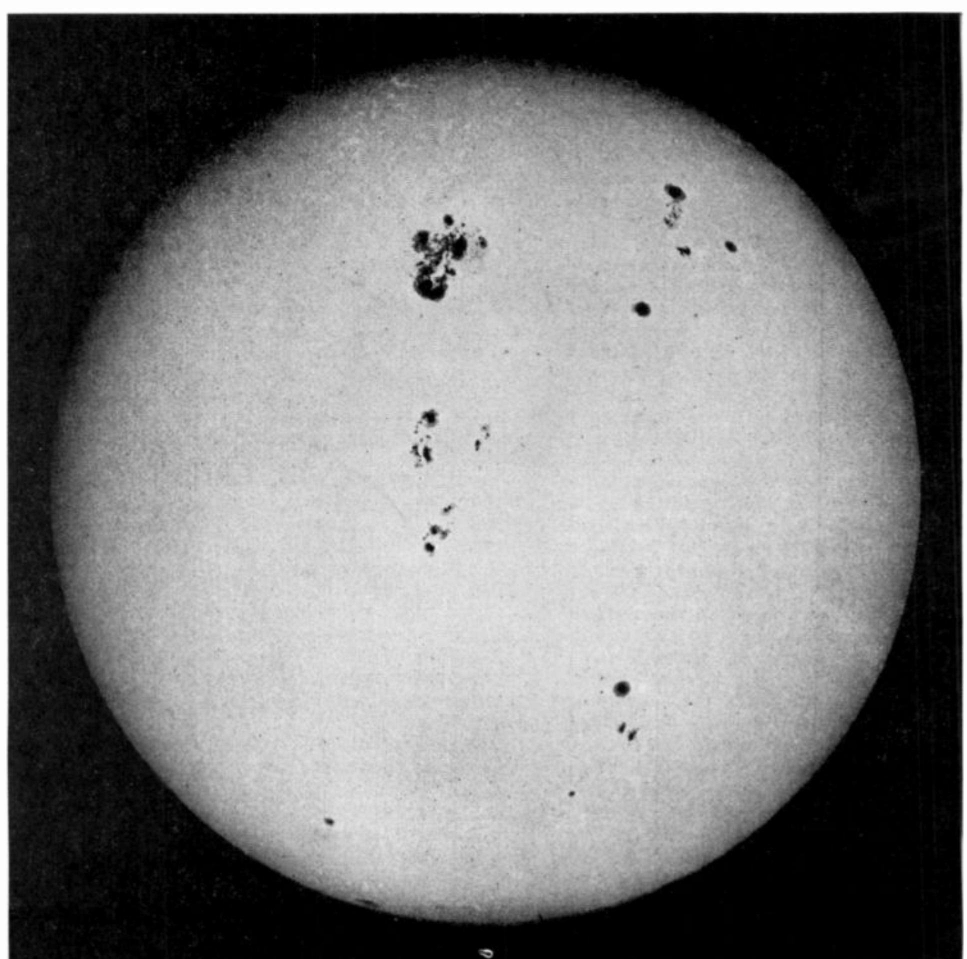


Fig. 2—This photoheliogram, taken by Ellerman at Mount Wilson Observatory, shows several sun spots

*The atmosphere may be divided into four parts: (1) the troposphere, extending to a height of about 7 miles; (2) the stratosphere or "isothermal region" from 7 miles to about 25 miles; (3) the ozonosphere from about 25 to about 45 miles and (4) the ionosphere above about 45 miles. The ionosphere is the region which is important in radio transmission.

oppositely. These facts imply that the short waves are reflected at a higher level than the long, and such is known to be the case.

The study of magnetic storms has furnished strong evidence that the fundamental cause of these various phenomena is to be found in the sun. This is indicated by the appearance, in the magnetic records, of the two major solar periods: the eleven-year period of sun spots and most other forms of solar activity (Figure 1), and the approximate twenty-seven-day period of the sun's rotation. There are now also enough radio data to show this twenty-seven-day period. In Figure 4 the size of a dot on the radio chart corresponds, roughly, to the relative intensity from day to day of the disturbances of the short-wave telephone circuits between New York and London. The tendency for these to recur time after time at intervals of approximately twenty-seven days is apparent. There are also enough data on the long waves to show an eleven-year period of variation over more than one solar cycle.

At the time of each of the nineteen great magnetic storms that occurred from 1875 to 1903, E. W. Maunder, an English astronomer, found that there was a large sun spot on the visible side of the sun. For storms of lesser magnitude the relation did not always hold. Magnetic disturbances sometimes occur when no spots are visible on the sun, and large spots are at times observed when no disturbances occur. Evidently the causes of the terrestrial disturbances must be sought further.

An instrument which makes such a study possible is the spectrohelioscope, which discloses phenomena entirely invisible in the ordinary telescope. As its name implies, it enables one to observe the sun in the light of any particular wavelength in the solar spectrum. If the instrument is set for one of the absorption lines of hydrogen, the distribution of this element over the solar surface may be seen. In this light the appearance of the sun is strikingly different from that given by white light (Figure 2). The granular structure is much coarser, and clouds of hydrogen are usually seen over the surface, while around the edge such clouds may often be observed as prominences or ruddily hued flames projecting out from the sun.

The prominences are sometimes seen to blow off into space with great velocities (Figure 5), and such observations strongly suggest a mechanism by which a disturbance may be transmitted from the sun to the earth. A number of bright eruptions have been observed to occur on the solar surface, usually near large spots, which were followed by magnetic storms on the earth after an average interval of about twenty-six hours. Theoretical considerations indicate that the speed of a particle ejected from the sun by radiation pressure would be a thousand miles per second, at which velocity the particle would take twenty-six hours to traverse the 93,000,000 miles from the sun to the earth. The conditions are not as simple as this would imply, however, and recent studies of the motions of prominences cast some doubt on the generally accepted importance of the role which is played by radiation pressure in ejecting them.

Regarding the means by which the disturbance is transmitted between the sun and the earth, it appears likely that
(Continued on Page 18)

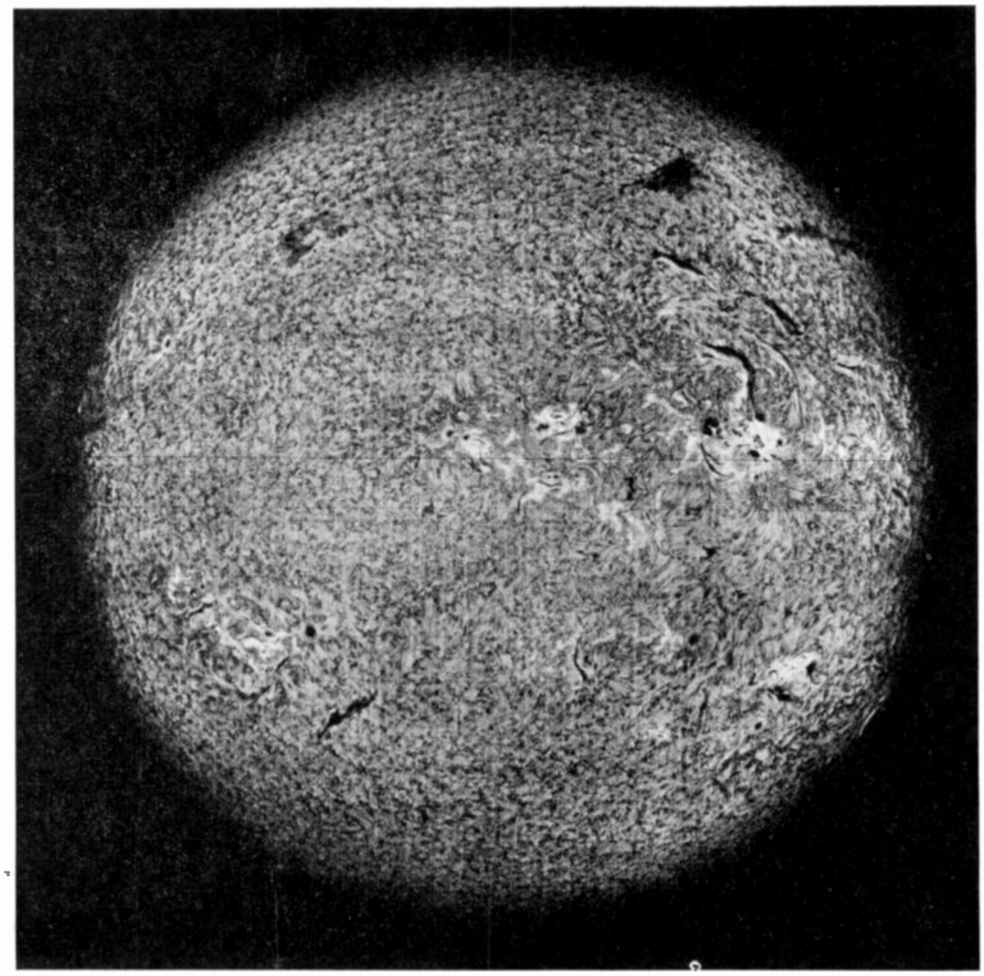


Fig. 3—This spectroheliogram (in the H α line) showing flocculi was taken at Mount Wilson at about the same time as Figure 2

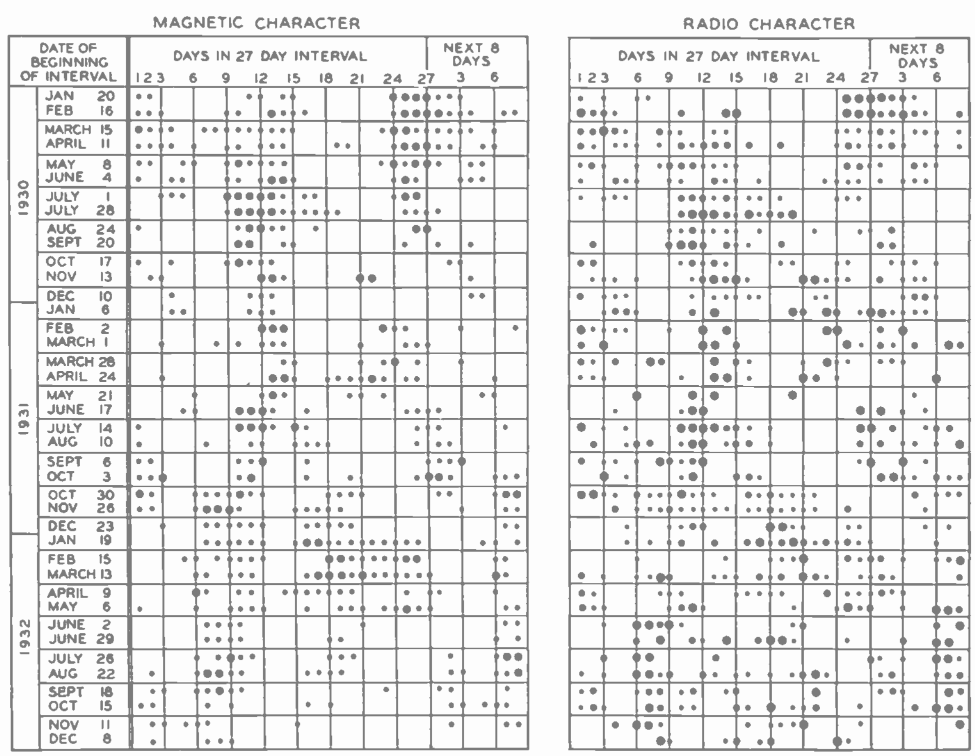


Fig. 4—Both magnetic and radio data show a twenty-seven-day period of variation

Archibald Augustas Gets a Scare

By VOLNEY G. MATHISON

SAMUEL Jones swears that if I don't leave off writing about him he's going to break my darned neck. He says he is getting to be the laughing-stock of the town and his reputation is ruined. (I didn't know it could be.) He indignantly declares that a local chemical factory has sent him a letter quoting him special bargain prices on wood-alcohol, formaldehyde, and nitro-glycerine in ten-gallon lots; and the other day some of his young lady friends presented him with a pillow cover on which was a big hand-embroidered snake merrily chasing the long, lanky brass-pounder up a cocoanut tree. Samuel is mad as a wet hen about it, and he warns me to cut out the funny stuff. I begged him to let me write just one more story about him that I have been keeping in mind for a long time, but he refused, point-blank. So now I am up against it. I can't think of any other code slinger who is such a side-splitting jackass as Samuel Jones.

Rummaging around through all the piles of old trash in the back alleys of my memory, however, I have come upon a sack of musty old recollections that have to do with a gone-and-forgotten wireless school that used to be in an old, ramshackle building down near the Frisco water front. Many years have slipped by since I sat in at the long practice table and went through the daily copying grind, starting in at nine a.m. at the top of the front page of the morning *"Examiner"* and winding up at five p. m. at the bottom of the last page of the evening *"Bulletin,"* but the singing of the practice buzzer and the inky smells from the print shop on the floor above come back to me as vividly as though they were of yesterday.

And no less distinctly do I remember the faces of that assembly of young villains (Samuel Jones was there, too, but I'm not writing about him, remember), who studied the function of the commutator by plastering thin, invisible chips of mica on the lower ends of the brushes, or demonstrated the actions of a closed oscillatory circuit by running a piece of number forty magnet-wire from the spark-gap and deftly fastening the end under the knob of the sending key, where some poor devil's thumb was sure to get tangled up in it. This stunt was invented by Shakespeare, the school poet, who could rhyme decrement with devilment as easily as he could do sleight-of-hand tricks with spare receivers or detectors or anything else lying around not so big as to rip his coat-pockets. Then we had Kid Brady, the housebreaker, who left his meal-ticket in the school one Saturday night, and who, coffee-and-less and hungry, got pinched next morning as he climbed up the rain-spout and jimmied a back window to get it.

"A very select body of students," the school circular called them, but a very villainous band of hundred per cent hooligans would have been better said; at least so declared Pop Cranby, the instructor who led a dog's life among them. Indeed, I remember how one time that gang of heartless young hyenas got hold of a poor unsophisticated ham, fresh from the country and in a hurry to get a job, and persuaded him to—but that reminds me of my friend Archibald Augustas. I'm mighty glad I thought of Archibald because he makes me think of a rattling good story, and now Samuel Jones and the rest of that hair-raising band of young Apaches in the old wireless school can go to the devil.

Mr. Archibald Augustas McGink used to be the assistant radio inspector. Tall and slim and supercorrectly dressed in classy tailor-made clothes, he always looked exactly like a billboard ad for Kubbleheimer Klothes. Indeed, Archibald Augustus was the very embodiment of dignity and reserve. All the hams within a thousand miles of San Francisco lived in mortal dread of him. And no wonder. In his day, Archibald Augustus shortened down and sharpened up more wave lengths, and scared more contumacious, law-breaking wireless fiends to death than any other man has ever done in the history of radio.

Nor were the amateur fanatics alone in their dread of Archibald Augustas. He was no less the terror of the regular sea-going brass-pounders, for he used to give them their license examinations. Everybody knows what a cold and unfriendly sort of dungeon a radio-inspector's office is, at best. Everything is stiff and formal and you always get a creepy feeling in the middle of your back as you listen to the dictation of a stern and awful letter proclaiming the license suspension of some depraved operator who has been found guilty of making superfluous signals to the outrageous extent of saying good morning old man to a fellow code-slinger, or perhaps some scoundrelly ham is being skinned and scalped for running his outfit on two hundred and one and a quarter meters, and so on and so on, *ad infinitum.* Put a reserved and coldly proud person such as Mr. Archibald Augustas McGink in such an atmosphere and you could not find a more frigid combination anywhere south of the north pole.

One chilly winter morning, punctiliously at nine a.m., Archibald Augustas stepped dignifiedly into the office, put away his hat and overcoat, bid Miss Frimble, the stenographer, a frozen good morning, and seated himself stiffly in the chief inspector's chair. Mr. Woodnut, the chief radio inspector, had just killed the decrement of the high power station out at Bolinas, and today he was going out with a shovel to bury it, leaving his assistant in supreme command of the front line trenches. So Archibald Augustas sat proudly in the chief's big swivel chair and importantly proceeded to read the morning mail.

While the assistant inspector was thus occupied, Miss Frimble sat gazing upon him; and as she gazed she sighed, deeply and longingly. Tall, skinny, and scrawny, Miss Frimble was the faded yet prim remains of a bud that had bloomed and blossomed so long ago that —but this is ancient history, anyway. She adoringly idolized Archibald Augustas and whenever occasion offered plainly showed that she thought him a perfectly wonderful man. Aware of her sentiments, the assistant inspector felt a profound secret disgust; though he sometimes consoled himself by reflecting that he couldn't help it if his wonderful personality was so irresistibly attractive.

By nine-fifteen a.m., Miss Frimble had, as usual, sighed wistfully twenty times as she sat looking hungrily upon Archibald Augustas, and at nine-sixteen a.m. she was about to make it twenty-one times, when she heard a sound of shuffling footsteps out in the corridor. A moment later, the office door was opened suddenly, and looking toward it Miss Frimble saw a sight that froze her maidenly blood with horror.

She had ample reason to be horrified. A hideous black Negro had slipped boldly into the office and now stood in the middle of the room, fidgeting strangely. Clad in a pair of ragged Charlie Chaplin trousers, with shoes to match, a shapeless felt hat jammed down on his head and wearing an old dirty coat a dozen times too big for him, he was indeed a frightful-looking object. Miss Frimble sat like one paralyzed.

Archibald Augustas had also heard the door open. For a few minutes, he affected to be busy with the mail on his desk; then he ostentatiously swung the big swivel-chair around and condescended to look at the Negro, who was still standing, nervously shifting his weight from one foot to the other.

"Well?" interrogated Archibald Augustas in his best secretary-of-the-navy style.

"I-I want to t-take the examination f-for a commercial f-first grade license," stuttered the dark-faced youth, acting as though a good deal embarrassed.

"Very well," replied the assistant inspector, coldly and without interest, "sit there,"—he indicated a small writing table near the stenographer's desk.

"Please give him the application blanks, Miss Frimble," directed Archibald Augustas, a trifle puzzled at the old maid's evident alarm. It was the first time a Negro had ever come to take a license examination, but still there was nothing surprising about it. The assistant inspector swung his chair around again and resumed his reading of the mail.

With extreme trepidation, Miss Frimble picked out the required blanks and laid them on the writing-desk before the frightful-looking Negro; and then she fled to Archibald Augustas.

"Mr. McGink, are you blind!" she hissed in to the sensitive ear of the assistant inspector. "Can't you see that awful fellow is wearing a disguise?"

Tremendously irritated at the rude way the homely stenographer hissed in his ear, Archibald Augustas shot around in his chair, an angry reprimand burning on his lips. But Miss Frimble's face was a sickly grey, and she was watching the Negro fearfully out of the corner of her eye. Involuntarily, the assistant inspector followed her glances, and with startling suddenness, he perceived that she was right. The fellow was not a Negro at all. His face was twice as black on one side as it was on the other, and a small white spot was plainly visible behind his right ear. His slouch hat was still pulled down onto his ears, but there was a bunch of hair resembling the frayed end of a manila hawser sticking out at the back, which looked strangely out of place on such a black person. As he wrote on the application blanks, the black stuff on his hands came off onto the paper, smudging everywhere.

"Yes, I knew he was disguised the moment I saw him," lied Archibald Augustas, affecting a calmness that he absolutely did not feel at all. "Go back to your desk and remain perfectly quiet. I will—er, I shall attend to him presently."

Bestowing an adoring glance upon Archibald Augustas, in appreciation of his wonderful courage, Miss Frimble retreated to her post, leaving the assistant inspector a great deal more alarmed than herself.

After a few moments, Archibald Augustas cautiously stole another glance at the disguised villain, and a cold dread suddenly clutched at the assistant inspector's heart as he observed that despite the blacking on the fellow's face, he bore a striking resemblance to an ugly-tempered Mexican amateur of North Beach whom Archibald Augustas had brought to justice not long before for malicious interference with the naval stations, and who had openly sworn that he would be revenged both for the confiscation of his apparatus and for the hundred-dollar fine he had been forced to pay. The more the assistant inspector looked, the more certainly did he seem to perceive that the black scoundrel who had him so neatly corralled was just that same Mexican. Archibald Augustas could see through it all closely. Somehow the fellow had learned of Mr. Woodnut's absence, and he had chosen this time for getting a bloody revenge.

Archibald Augustas was convinced that he was in awful danger. Already could he feel the keen blade lunging in between his ribs and things, and he winced and sickened as he imagined the grinning murderer taking a savage delight in twisting the knife around in his vitals like an angry farmer cranking a contrary Ford. The assistant inspector broke into a cold sweat. He tried to think what to do, and he immediately realized that there was only one thing to do; he must get away, someway, anyway—and mighty quick.

But that was easier thought of than done. Though there was a window close at hand, it was sixty feet to the street; and the black villain was sitting directly between Archibald Augustas and the door. It was a desperate predicament.

The assistant inspector soon decided that he had better make a dash for freedom rather than sit helplessly waiting for the murderous Mexican to spring upon him. There was a water-cooler near the door, and he made up his mind that he would step over to it, pretending that he was merely going to get a drink of water. Once that far, he would stand a slightly better chance of getting to the door, alive.

Mustering every atom of his insignificant stock of courage, Archibald Augustas arose hesitatingly from the big swivel-chair and walked nervously toward the water-cooler. He got to it safely, and was about to keep on going toward the door, but glancing warily at the disguised malefactor, from whom he was now separated by no more than the width of a desk, he saw that the fellow seemed to be watching him sharply. Instantly, the assistant inspector's mite of courage took wings and flew away. He leaned weakly against the cooler and shakily drew a glass of water. Just as he made to drink it, the pseudo-Negro inadvertently bumped his elbow into a large stack of books lying on the table at which he was sitting.

The books fell to the floor with a loud slam. Dismayed, Archibald Augustus involuntarily sucked in his breath, taking the glass of water down his windpipe instead of his throat Choking and terrified, and still clutching the drinking-glass, he shot to the door in a single stride. About one hundredth part of a second later he had vanished.

But we must not forget poor Miss Frimble! Fairly petrified with horror and dread at having been thus shamefully abandoned by Archibald Augustas, she could only sit gazing fascinatedly upon the hideous black villain who confronted her.

The pretended Negro was obviously much worried at the sudden disappearance of the assistant inspector. Finishing with the application blanks, he became aware of Miss Frimble's frozen gaze and he began to shift about nervously.

Minutes passed. The clock on the wall ticked with oppressive loudness in the absolute stillness of the room. Miss Frimble sat as though made of stone, without seeming even to breathe. The disguised stranger became increasingly nervous and fidgety. At last he could stand the scrawny stenographer's horrified stare no longer.

"Aw, what th' heck's the matter with you!" he burst out, in a voice and accent strangely unlike that of a Negro, or of a Mexican either, for that matter. "You don't have to sit there an' look like I was goin' to chew yuh up, you homely old battle-axe!"

"E-e-e-e-e! Murder! Help!" screeched Miss Frimble, springing to her feet and upsetting her chair. Electrified with terror and shrieking like the whistle of a pineywoods logging train, she made a giraffe-sprint to the door.

Just as she got to it, the door was violently thrown open and Archibald Augustas was kicked forcibly into the room by a big brawny policeman, who had the squirming assistant inspector firmly grasped by the back of the neck. Instantly Miss Frimble threw her arms around her hero and renewed her ear-splitting squeals.

The bluecoat caught sight of the black-faced cause of all the commotion and his eyes bulged with astonishment.

"In the noime of th' hivinly St. Patrick!" he ejaculated, letting go of the assistant inspector. "No wonder yez was runnin' down the sthreet loike twinty million divils was afther yez, begorrah!"

He slammed the door shut and placed himself against it, while Archibald Augustas struggled to untangle himself from the distasteful embrace of the frantic Miss Frimble.

"Yez be a grand lookin' sight be'ant yez!" exclaimed the policeman, staring at the dark youth's astonishing disguise. "Whur in th' divil did yez come from, an' what be yez thryin' to do here?"

"I know him, officer," panted Archibald Augustas, who had at last managed to free himself from the hysterical Miss Frimble. "He's a fellow we arrested and fined not long ago for malicious interfering. He said at the time he'd get even—he's a Mexican."

"Mexican your foot!" interjected the black-faced mystery, who seemed to be making a desperate effort at calmness. "I'm off'n the Chilean square-rigger lyin' out in the stream off Goat Island, if you want to know!"

"Yez talk more loike a West Oakland hoodlum than a Chileno," retorted the policeman.

"Well, I ain't no Chileno an' I ain't no hoodlum, neither," returned the mysterious captive. "I shipped cabin-boy last year on the steam schooner *Norwood* goin' to South America, an' I got left at Valparaiso, down in Chile. Then I got shanghaied onto the *Madrone*, a Chilean three-masted bark, where I been kept a prisoner ever since. We come into Frisco Bay about a week ago an' one night I went over the side an' swum ashore, but the next night the Chilenos spotted me down on the water-front an' they black-jacked me an' took me back aboard. Night before last I jumped out in these clothes an the black show-paint so the spigs wouldn't nail me again. But I reckon my outfit ain't much good."

"Begorrah, no! 'Tis mighty queer yez wasn't picked up sooner. But what were yez wantin' up here?"

"I used to have a amateur wireless set once, an' I know a good deal about wireless," replied the captive promptly. "I was goin' to try an' get a license an' get out on a ship. If I go down on the front an' try to ship cabin-boy again, I'll get crimped again sure."

"What's your noime, an' whur did yez come from in the first place?"

"Frank Morris, an' I come from Petaluma."

The policeman scratched his head. The distinguished youth's story was more than half plausible. He was hardly more than a boy, and it was not the first time the bluecoat had heard of victims being shanghaied and held prisoner aboard foul South American hookers. But yet, there was something strange about the fellow's coming into the radio inspector's office while wearing such a make up.

"I guess yez'll have to tell it to th' judge," decided the policeman, "come along."

The captive protested strenuously, but the bluecoat had heard of victims being sleeve and marched him down the street, accompanied (though not assisted) by Archibald Augustas.

Twenty minutes later the trio were in the police station. The prisoner was handed over for cross examination to a couple of raspy-voiced detectives, who raked him over the coals for half an hour without succeeding in budging him in the least from his story.

A little while later he was hailed before a police judge. Archibald Augustas and the policeman told of their parts in the affair, and then the prisoner repeated his story, exactly as he had told it before in the radio inspector's office. The judge listened with no great interest; he seemed inclined to accept the youth's statements.

"I don't see that the prisoner is guilty of any particular offense—" he began, but before he could say more one of the detectives came hurrying into the courtroom.

"Beg pardon, your honor," he broke in abruptly, "but we just phoned the marine exchange, and they say there is no Chilean ship of any description in the harbor; and according to the nautical register, there's no such vessel as the *Madrone* at all."

There was an ominous silence.

The judge regarded the prisoner with

an angry glare. Before he could speak, however, there was a violent commotion outside, and a moment later a puffing and perspiring person came rushing undignifiedly into the courtroom. Catching sight of the mysterious prisoner, he stopped and seemed to stagger.

"Good Lord!" he groaned, putting his hand to his head, "you're a sweet-looking sight, all right, all right!"

"How in heck did you find out I was here?" demanded the black-faced enigma.

"How did I find out!" barked the other, mopping the sweat and dust from his face with his handkerchief. "When you didn't show up this morning, and when I saw that hell-fired gang of young hyenas acting so blamed queer and snickering up their sleeves like they were, I knew blasted good and well something was rotten in Denmark; finally I got Kid Brady by the back of the neck and laid him out on a practice-table and sat on him until he spit out the truth. Then I breezed down to the inspector's office, where I found that old sister to a fire-wagon siren babbling something about a black monster, and right away I knew what'd happened, so I rambled up here —and when it comes to a twenty-four caret, double-barreled damn fool, you take the prize—!"

"Here, here!" yapped the judge, banging on his desk with his mallet. "What does all this mean, anyway?"

"Excuse me, Your Honor," answered the new-comer, turning to the judge, "I'm the instructor at the wireless school down on Main Street, and this poor, ignorant, addle-brained image of a countrified jackass is one of my pupils. That gang of criminals down at the school found out he was pretty shy on cash and in a hurry to get a license so he can get a ship; and so they talked him into this confounded crack-brained scheme. They bought the clothes and the nigger-paint, and early this morning they went up to where he rooms and dolled him up. The idea was to take the license examination in disguise, and if he passed all right, to come back in a few days without the coon-town outfit and take the ex over again in his own name. Why that cursed crowd of young ourang-utans made him believe it was a surefire stunt that's been pulled a dozen times before and—but Lord, I wish somebody'd tell me what they'll do next, blast 'em!"—and Pop Cranby mopped his face again.

The crowds in the courtroom were amazed.

"Where did you get that story about the Chilean ship?" demanded the judge of the youthful prisoner.

"The fellows picked it out of a dime novel fer me."

"Holy Mackerel!" groaned Pop Cranby.

Archibald Augustas cleared his throat. His face had become dignified and stern.

"This is outrageous, Your Honor," he began, in his coldest secretary-of-the-navy tone. "It is evident that this person has dangerous criminal tendencies. I suggest that he be sentenced to at least twelve months at hard labor."

Right here Archibald Augustas overstepped himself. Had he remained silent, things might have gone hard with the adventurous amateur, but the assistant inspector's overweening assumption bothered the judge

"I suggest that you keep your mouth shut!" snapped the ruler of the courtroom, glaring at Archibald Augustas with a glassy eye. "The case is dismissed. Get out!"

Fortunately for the young adventurer, Mr. Woodnut, the chief radio inspector, had a sense of humor, and in spite of all protests on the part of Archibald Augustas, he insisted that the amazing amateur from Petaluma be permitted to go through with the examination.

The candidate came through with flying colors. Since Mr. Woodnut chanced to be again absent on the day when the lucky amateur completed the examination, it devolved upon Archibald Augustas to check the question sheets. Grudgingly, the assistant inspector checked out a percentage amply sufficient for a license; grudgingly, he got out the license-book and filled out a commercial first-grade license; and thirty minutes later when the new operator came back with the oath of secrecy duly sworn to, he still more grudgingly signed his name to the document.

"The next time that you come for an examination in disguise, I would suggest that you engage a performer in a vaudeville minstrel show to give you a few points regarding the preparation of your costume," he remarked in his extra-best secretary-of-the-navy style, as he handed over the license.

The freshly-made operator rolled up the crinkly bit of paper and stowed it away safely in an inner pocket before replying:

"Humph, I reckon if that cop hadn't grabbed you you'd be runnin' yet!"—and with this the newly-fledged brass-pounder (er—it wasn't Samuel Jones, remember) drew himself up with all the proudness of an emperor and marched majestically from the room.

(The End)

"T" Shaped Vertical Found Most Suitable

A VERTICAL "T" shaped aircraft radio antenna three feet high has been found by the Bureau of Air Commerce, Department of Commerce, to be one of the most suitable types for use in "flying the beam" of the radio range directional beacons on the Federal Airways System, according to an announcement today by Eugene L. Vidal, Director of Air Commerce.

The detailed results of a study of various types of antennas and their effect on the reception of the radio beam have been sent out to air line operators, private owners and all others to whom the information may be useful.

The study was inspired by the experiences of pilots who reported discrepancies in the alignments of beam courses. Investigations revealed that the errors were due to the types of antennas used rather than to trouble in the radio range beam.

With this information the Bureau ran exhaustive tests on various types of antennas and found that inclined or "L" antennas caused apparent shifts in the courses particularly when the plane was flying at an angle to the course.

Final conclusions were that a "T" antenna with an actual vertical height of about three feet is equivalent to a five-foot vertical mast; that if installed longitudinally above or below the fuselage it will receive the signals accurately; that it should be less susceptible to trouble from ice formation than other types; and that it should create very little aerodynamic "drag."

New Broadcast Stations Licensed

T. H. Barton, El Dorado, Ark., 100 watts 1370 kc.

Attala Broadcasting Corp., Clarksdale, Miss., 100 watts, 1210 kc.

The Ashland Broadcasting Co., Ashland, Ky., 100 watts, 1310 kc.

James R. Doss, Jr., Decatur, Ala., 100 watts, 1370 kc.

Applications received for new Broadcast Stations

Clarence Wheeler, Rochester, N. Y., 100 watts, 1210 kc.

G. L. Burns, Brady, Tex., 100 watts, 1210 kc.

Walker Jamar, Duluth, Minn., 100 watts, 1200 kc.

W. B. Greenwald, Hutchinson, Kans., 100 watts, 1410 kc.

Robert K. Herbst, Fargo, N. Dak., 100 watts, 1310 kc.

Head of the Lakes Broadcasting Co., Milwaukee, Wis., 100 watts, 1370 kc.

Milwaukee Broadcasting Co., Milwaukee, Wis., 100 watts, 1310 kc.

E. L. Sherman and H. L. Corley, Trinidad, Colo., 100 watts, 1370 kc.

W. L. Gleason, Sacramento, Calif., 5 kw, 1490 kc.

P. A. McBride, Ironton, Ohio, 100 watts, 1500 kc.

LeRoy Haley, Durango, Colo., 100 watts, 1370 kc.

Paul R. Heitmeyer, Salt Lake City, Utah, 100 watts, 1210 kc.

Rochester Broad. Co., Inc., Rochester, N. Y., 250 watts, 1210 kc.

Edw. Mirante and Arthur Faske, New Britain, Conn., 100 watts, 1370 kc.

Black Hills Broad. Co., Rapid City, S. Dak., 100 watts, 1370 kc.

L. E. Robideaux, Bend., Ore., 250 watts, 1500 kc.

Ray J. Arend, Rochester, Minn., 100 watts, 950 kc.

Joseph H. Hallock, Vancouver, Wash., 100 watts, 1500 kc.

Metro Broadcasting Co., Los Angeles, Calif., 250 watts, 820 kc.

Acme Broadcasting Co., Huntington Park, Calif., 100 watts, 1370 kc.

A. I. Chilton, Kilgore, Tex., 500 watts, 990 kc.

St. Petersburg Chamber of Com., St. Petersburg, Fla., 100 watts, 1310 kc.

Tampa Broadcasting Co., Tampa, Fla., 100 watts, 1370 kc.

Ward Walker, Seattle, Wash., 250 watts, 760 kc.

Clark Standiford, Porterville, Calif., 100 watts, 1420 kc.

The Hartford Times, Inc., Hartford, Conn., 250 watts, 1200 kc.

Oklahoma Press Pub. Co., Muskogee, Okla., 100 watts, 1500 kc.

Louis Holzman, Hilo, Hawaii, 100 watts, 1420 kc.

Philip J. Wiseman, Lewiston, Me., 100 watts, 1210 kc.

Jack W. Hawkins and B. W. Hubbs, Pecos, Tex. 100 watts, 1420 kc.

Oscar C. Hirsch, Cape Girardeau, Mo., 1 kw., 930 kc.

Radio Chapel of the Air, Minneaoplis Minn,. 100 watts, 1370 kc.

Samuel N. Morris, Stamford, Tex., 100 watts, 1420 kc.

Pope Foster, Mobile, Ala., 100 watts, 1500 kc.

Edward Hoffman, St. Paul, Minn., 100 watts, 1310 kc.

Vacuum Tubes at Very High Frequencies

By F. B. LLEWELLYN

Member of the Technical Staff, Bell Telephone Laboratories

RECENT growth in the use of high-frequency electrical oscillations has been accompanied by considerable extensions in many applied branches of electrical theory. Nowhere is this more true than in the field of vacuum-tube electronics, dealing with the distribution and motion of electrons within a thermionic vacuum tube and with their influence on its properties. Certain simplifying assumptions which gave valuable results in earlier practice are not approximated in the operation of vacuum tubes at very high frequencies, and it has been necessary to abandon some of these assumptions to develop more widely applicable theories.

When the original investigation of vacuum tube electronics was attacked by early workers, such as Van der Bijl and Nichols in these laboratories, it was not necessary to consider the fact that an electron emitted at the cathode does not reach the anode instantaneously but requires a certain length of time to cross from one electrode to the other. The time of transit could be neglected because it was always very short when compared with a cycle of any of the alternating currents in use at that time. With this assumption there was developed the familiar concept of the equivalent internal circuit of the vacuum tube, consisting of a resistance in series with a generator whose emf is μ times the alternating component of the grid potential.

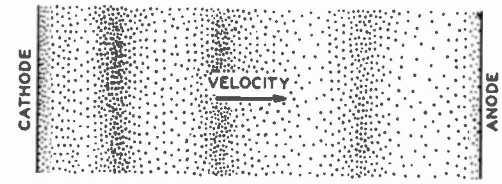


Fig. 1 (Left)—The distribution of electrons between the cathode and anode of a two-element vacuum tube, operating at a frequency whose period is shorter than the transit time of the electrons, is somewhat similar to that of the molecules of air in a sound wave

Fig. 2 (Left)—A graph of the electron densities pictured in Figure 1 shows them falling off in passing from the cathode to the anode

When the frequency is very high, the electron transit time may become comparable with or even greater than a period of the alternating current. For example, it would require 25x10^{-10} seconds for an electron to cross a space half a centimeter long under the influence of a potential difference of 100 volts, provided that the cathode emitted a sufficient number of electrons to maintain space charge. This time is the period of a four-hundred megacycle oscillation. In such a case the behavior of the vacuum tube departs widely from that which would be predicted from the simple equivalent circuit. Even at much lower frequencies, in fact, the effect of the transit time becomes of importance.

A rough representation of the complicating conditions can most easily be pictured for a case in which the transit time is supposed to be fairly long when compared with a period of the alternating current. The electron stream may then be thought of as a moving system of alternating rarefactions and condensations of electron density, in some respects like the molecular system into which sound waves can be analyzed. Thus the distribution of the charge density at a particular instant inside a two-element tube may be as shown in Figures 1 and 2. At the same instant, the values of the electron velocity at different points across the tube will be as shown in Figure 3.

It is well known that the product of charge density times charge velocity is equal to the "conduction current." Hence curve A, in Figure 4, obtained by multiplying together the ordinates of the curves in Figures 2 and 3, gives the distribution of the conduction current across the tube.

The conduction current, however, forms only a part of the total current in any electron system, the "displacement current" forming the remaining part. Between the plates of a condenser containing no free electrons, the current is all displacement current; in an ideal metal, the current is all conduction current. Moreover, the displacement and conduction currents are always related to each other in such a manner that at any given instant, the total current is the same at all points along the direction in which the current is flowing, although it may have a different value at a later instant.

Thus in Figure 4 the conduction current A plus the displacement current B must give a total current C which at the given instant is the same at all points between the two electrodes of the tube. At a later instant, that total current will have changed its value, thus giving rise to the effective high frequency current emitted by the vacuum tube. What successive values the total current will take is influenced by the successive distributions of conduction and displacement currents. A tube may be expected to behave quite differently at high frequencies, when these two components are not uniformly distributed between the elements, from the way it behaves at low frequencies when at any instant the distribution of these components is substantially uniform.

This pictorial view is suited to give only a very rough idea of electronic conditions within the tube. Actually transit times which are of the order of a fraction of a cycle up to one or two cycles are usually of more concern. To describe events under these conditions, mathematics must be used, but some of the results of the mathematical analysis may be stated fairly simply.

A two-element vacuum tube, for instance, appears at low frequencies to act like a resistance having a value given by the slope of the static characteristic of the tube. As the frequency is gradually increased so that the transit time comes into prominence, the impedance changes from a pure resistance to a combination of resistance and capacitance, and the resistive component actually becomes slightly negative at certain frequencies. It can be shown that oscillations would occur in such systems if the loss in the external circuits could be made sufficiently small. Practically this method of producing ultra-high frequency oscillations has not been very successful because of the difficulty of procuring circuits whose losses are sufficiently low at the high frequencies in question.

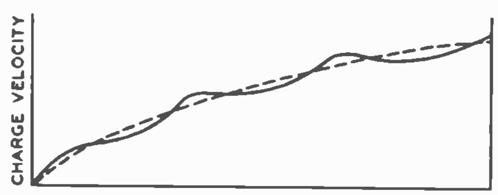


Fig. 3—Accompanying the decreasing electron densities graphed in Figure 2 are increasing electron velocities. The analogous sound wave would be one taking place in a wind whose velocity increased as it passed from cathode to anode

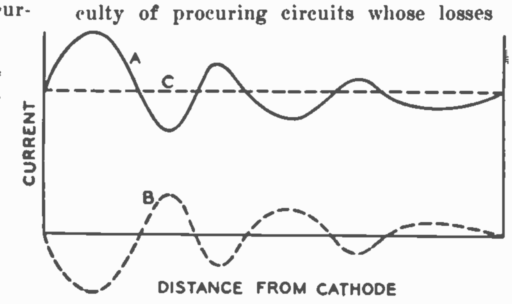


Fig. 4—The conduction current (A) is the product of the velocity and density of the charge (Figures 2 and 3). Accompanying it is the displacement current (B), and the sum of these two currents is the same at any one instant at all points of the tube (C)

In the case of a negative-grid triode, the cathode-plate path consists at low frequencies of a resistance in series with an effective generator. The high-frequency circuit changes into a resistance-capacity combination in series with a generator. The voltage of the generator is no longer opposite in phase to the excitation applied to the grid, but varies continuously in phase as the frequency is in-

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ASSIGNMENTS

MACKAY RADIO, New York

Radio Officer — Station

V. Reed—Colorado
F. Petersen (Jr.)—Cherokee
H. McGoldrick (Jr.)—Edouard Jeramec
L. Lawrence (chief)—Edouard Jeramec
O. Olsen—West Eldara
R. Annette (Jr.)—Seminole
R. Abernethy (Jr.)—San Jacinto
P. Kimball (Jr.)—Shawnee
S. Oliver (Jr.)—Exochorda
P. Rametta (chief)—Exarch
E. O. Lemieux—Black Heron
J. Kotzum—Ala
S. Fleisher—Cities Service Empire
R. Mathers—Broad Arrow
H. Burns (Jr.)—Seminole
T. Sirois (Jr.)—Excalibur
S. Rosenberg—Berwindvale
H. McGoldrick (chief)—Iroquois
R. MacDonald (chief)—Mohawk
E. Cole (Jr.)—Mohawk
V. Hopkins—Colorado
M. Sabando (Jr.)—Scanyork
H. Baine (Jr.)—Exeter
R. Muller (Jr.)—San Jacinto

Boston

R. H. Blake—Trawler Notre Dame
G. M. Bursell—Gulf Stream
B. H. Breedlove—Trawler Loon
Theron Copeland—Trawler Trimount
Julius Dolloff—Trawler Boston College
Arthur Donahue—E. T. Bedford
Harry di Napoli—The Angeles
George Doorakian—Trawler Ripple
John C. Edwards—Cities Svc Koolmotor
Leon Gromley—Trawler Tern
Ernest Gannett—Melrose
George C. Head—Nantucket
Arthur Iodice—Cities Svs Oklahoma
Charles Kelleher—Pat. J. O'Hara
C. F. Murray—Yacht Vanda
W. R. Clark—La Perla
R. Miller—Trawler Breeze
Patrick Regan—Trawler Ocean
H. Stanley—Trawler Amherst
J. H. Simpson—Trawler Curlew
A. Sienkowski—Trawler Wild Goose
G. E. Travis—Osage
J. W. Tierney—Peter H. Crowell
C. Paddock—Hartwelson
H. B. Whipple—Princeton
H. H. Zwicker—Everett
A. J. Falabella—Trawler T. J. Whalen
E. U. Stewart—Plymouth
P. W. Sewell—Suffolk
C. W. Saunders—Glen White

Baltimore

A. C. Draper—Steel Engineer
Hilary Bell—Chatham
W. W. Purvis—Carrabulle
F. Carroll—Dixie Arrow
J. B. Brady—City of Baltimore
J. H. Walberg—Oakmar
A. C. Goldbach—Chatham
M. L. Argazright—Fairfax
A. C. Moltzer—Malacca
J. L. Brannan—City of Newport News
J. A. Jense—Sagadahoc
C. E. Seibert—W. W. Bruce
C. E. Cook (2nd)—City of Hamburg
M. Courchene—Firmore
R. H. Miller—Southern Sword
B. W. Thomas—Millinocket
E. R. Messina—Jean Weems

STATES LINE, Portland, Ore.

Roy Welbon—General Pershing
H. Schoolfield—General Pershing
Karl Steiner—General Sherman

Ralph Dernbach—General Sherman
Everett Henry—General Lee
James Crouse—General Lee
Carl Anderson—New York
W. F. Mee—Wisconsin
R. S. Bean—Iowa
Ted Toppi—Michigan
Ben Cohen—California
Roy Whittington—Texas
W. T. Shultrich—Illinois
Howard McMahon—Oregon
A. A. Marsh—Kentucky
K. V. Harris—Pennsylvania
John Robinson—Washington
Frank Caldwell—San Angelo
E. I. Garrick—San Anselmo
D. L. Hughes—San Bernardino
D. E. Youngberg—San Clemente
Claude Wareham—San Diego
Dewayne Duncan—San Domingo
M. R. Darby—San Felipe
James Dinsdale—San Gabriel
Edward Betts—San Julian
Ralph Norgard—San Lucas
J. W. Risley—San Marcos
Sydney Ferguson—San Pedro
C. P. Burt—San Rafael
Herbert Oliver—San Simeon
F. G. Luecke—San Vincente
Glenn Peck—Peter Kerr
Fred Estes—Jefferson Myers

Galveston

L. J. Blackburn—West Tacook
A. Harding—Tug Miraflores
G. E. Higgins—Pat Doheny
Furrh—Whipple
D. Fontaine—Wm. B. Thompson
J. D. Holmes—Pueblo
J. Hover—Albert E. Watts

New Orleans

Thomas Alderman (chief)—Munplace
A. Pilzecker—Munplace (2nd)
J. B. Hinson—Delecto
E. K. Kendall—Defacto
F. F. Flickner—Domino
J. J. Arena—Tug Ontario
L. E. Trubey—Aquarius
Nelson Newton—Wawa
Joseph Gros (2nd)—Amapala
J. L. Vidrine—Seatrain New Orleans
P. S. Berry—Gansfjord
W. B. Kinnier—West Cohas
E. C. Sanders—Elmsport
L. E. Hastings—Nelson
W. E. Barnes—Quistconk
J. C. Hancock—Caliche
R. J. Carpenter—Oritani
W. Buchanan—West Moreland
A. T. Teeter—Point Bonita
A. P. Heyd—Dora
L. Spicer—Kuishacoquillas

T. B. Husser (2nd)—Del Sud
C. H. Myers—Afel
Malcolm Gardiner—West Hika
Rordam—Kateway City
J. Dennicke—West Kyska
Paul Brown—Betterton
Alfred Turner—Sinaloa
Harold Zahn—Olancho
C. Lund—Hibueras
Guillot (chief)—Sixaola
D. Freret (3rd)—Sixaola

RADIOMARINE CORP.—New York

G. W. Stewart—Daylight
E. J. Stenman—Veedol No. 2
V. Minzey—Susan A. Moran
C. F. Anderson—Buenaventura
C. P. Annis—Cambridge
H. S. Kutcka—Mariana
T. Nugent—Nourmahal
A. Zaft—Robin Adair
J. Meighan—Sarcoxie
S. N. DiLorenzo—Pan Bolivar
F. L. Siglin—Amer. Banker
J. H. Osmun—Oriente
Ed. Hamel—Relief
A. L. Bergom—Scanmail
W. A. Smith—Exchange
J. Mulhern—Santa Teresa
T. J. Welch—Wm. Rockefeller
S. Herald—Dorothy Luckenbach
J. M. Currie—Acme
V. C. Ellis—Gatun
A. Cohen—Robt. E. Lee
S. R. Price—Steel Scientist
A. C. Campbell—Chas. H. Cramp
R. Redlin—Ancon
A. G. Lupien—Cambridge
R. G. Wolf—Western World
H. Von Thun—President Roosevelt
C. P. Annis—President Roosevelt
M. A. Newton—Borenquin
A. W. Standford—Orion
E. J. Edmonds—Cerro Azul
W. L. Gray—Coamo
M. Pearlman—Pennsylvania (Tank)
R. Alexander—Nopara
W. J. McEntee—Caracas
L. H. Brennan—Borenquin
H. Scambler—West Lashaway
C. J. McKenna—Harry Luckenbach
C. H. Miller—Scanstates
M. Vinocour—Yoro
T. W. Briadwood—China Arrow
T. L. Narveson—Ligonier
W. Hagstrom—M. & J. Tracy
J. F. Smith—Orion
A. J. Costigan—Halsey

Vacuum Tubes at Very High Frequencies

(Continued from Page 14)

creased. The cathode-grid path, which at low frequencies can be represented with sufficient accuracy by a capacity, changes into a capacity-resistance combination in which the resistance becomes the predominating element. At very high frequencies, the loss in this resistance is so large as greatly to diminish the efficiency of oscillatory circuits containing such tubes. Even at frequencies as low as twenty megacycles, measurements made by J. G. Chaffee have shown that the resistance in the cathode-grid path of present standard tubes plays an important part in the determination of operating conditions.

Another system for generating oscilla-

(Continued on Page 20)

Trials of New Wide-Band Program Circuits

By H. S. HAMILTON

Member of the Technical Staff, Bell Telephone Laboratories

EARLY program circuits provided frequency bands about 5,000 cycles wide. These were in line with the capabilities of the radio broadcasting art and proved very satisfactory. Tests have shown, however, that better results could be obtained by transmitting wider bands, so that it seemed desirable to make improved facilities available. As a result the Laboratories, during the last few years, have developed program circuits capable of transmitting from 40 to 8,000 cycles. The circuits and apparatus made available for open-wire lines have recently been described. A field trial of this system was recently made on lines between Chicago and San Francisco.

One circuit, referred to as circuit No. 1, was routed over the central transcontinental route. The facilities making up this circuit were largely those normally assigned to the coast network of the National Broadcasting Company. The circuit was 2,395 miles long with 16 repeater points. The second circuit, No. 2, was made up of facilities largely assigned to coast network of the Columbia Broadcasting System. This circuit was routed through St. Louis and Kansas City to Denver and thence over the central transcontinental route to San Francisco, being 2,689 miles long with 19 repeater points. The open wire conductors were mostly 165- and 128-mil copper conductors although some 104-mil facilities were involved. Both 8-inch and 12-inch spaced wires occurred in various parts of the line. Non-loaded cable facilities were included at both ends of the circuits.

To equip two circuits of these lengths a large amount of apparatus is required, and because of this as well as of the distances covered, the installation plans were necessarily quite complicated. For the most part the circuits were used in commercial service for the regular 16-hour service period daily. The testing of the equipment and particularly the cutting of the new apparatus into commercial service, thus required careful planning and execution of schedules to avoid interference with the regular service.

The manufacture and installation schedules were set up so that the majori-

WIDE BAND PROGRAM CIRCUIT TRIAL
FORM (L)
RECORD OF SECTION LINEUP
(Cut over Data)

STATION Gr. Island
CCT. NO. Red
SHEET NO. 14
DATE 9/10/31
OBS. J.A.K.

From	Omaha				North Platte			
Date	9/10/31				9/10/31			
Time	12:45 A.M.				2:40 A.M.			
Temp.	80°				80°			
Weather	Clear				Clear			
Measured At	Line E-Jks		Rep. Out		Line W-Jks		Rep. Out	
	LOSS	DEV.	LOSS	DEV.	LOSS	DEV.	LOSS	DEV.
1000	7.2	X	-.04	X	6.55	X	-.12	X
35	5.34	+1.86	-.02	+.02	4.80	+1.75	-.26	-.14
50	5.45	+1.75	+.05	+.09	4.95	+1.60	-.20	-.08
100	5.75	+1.45	-.04	0	5.10	+1.40	-.26	-.14
200	6.37	+.83	-.10	-.06	5.60	+.95	-.28	-.16
500	7.03	+.17	-.12	-.08	6.25	+.30	-.25	-.13
1000	7.2	X	0	X	6.55	X	-.12	X
2000	7.57	-.37	+.03	+.03	6.85	-.30	-.02	+.10
3000	8.0	-.80	+.03	+.03	7.23	-.68	+.08	+.20
4000	8.52	-1.32	+.03	+.03	7.85	-1.3	+.02	+.14
5000	9.08	-1.88	-.08	-.08	8.48	-1.93	+.05	+.17
6000	9.65	-2.45	-.08	-.08	9.0	-2.45	-.09	+.03
7000	10.13	-2.93	-.04	-.04	9.6	-3.05	-.02	+.10
8000	11.52	-4.32	-.77	-.77	10.9	-4.35	-.85	-.73
1000	7.2	X	0	X	6.55	X	.05	X
Final Equal. Setting	L 2		H 2		L 1-2		H 2	
Atten. Setting	16.5				15.0			
Rep. Used	14-A		~~11-E~~		14-A		~~11-E~~	

Fig. 1—Record of section lineup—Omaha-Grand Island-North Platte

Fig. 2—Photograph of special equipment provided at San Francisco for overall tests

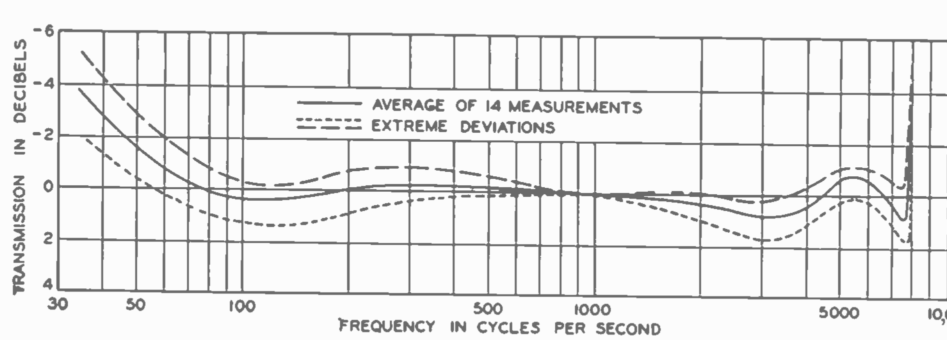


Fig. 3—Transmission frequency characteristics of circuit No. 2—San Francisco to Chicago

ty of equipment was delivered and installed between May and August of 1931. Equipment at three stations, Wichita, Garden City, and Lamar, was delivered and installed in April to permit preliminary tests to be made, since the section of line from Wichita to Lamar was not then required for commercial service.

The field trial may be considered to have covered three stages. In the first period the necessary changes were made in the regular carrier systems. The second period covered testing the program equipment and cutting it into commercial service. In the last stage the overall tests were conducted.

As this new program system occupied a frequency range up to 8,000 cycles, it was necessary to drop one of the type-C carrier channels which were assigned to the program pairs involved. The carrier conversion was handled generally in the following manner: The normal carrier systems operating on the program pairs were first transferred to some other pairs or temporarily taken out of service. The new 8,000-cycle line filters were then cut in in place of the existing 5,000-cycle carrier line filters. After this was done the carrier systems were returned to the program pairs and readjusted to operate on a two-channel basis. Six carrier systems were involved on the two program circuits. The carrier conversion was accomplished between August 1 and October 17.

Because of the close coordination required between the carrier and the program phases of the trial, and because of the number of stations and distances involved, detailed schedules for both carrier and program work had to be made out and carefully followed. Ten engineers were sent out to the field to make the various tests and to supervise the cutting in of the program apparatus. The testing schedule was so laid out that the engineers would be located not only at the repeater point where the program equipment station was to be cut into service, but also at adjacent repeater stations to cooperate in the repeater section test. In general, an engineer remained at a particular station a day or so after the apparatus was cut into service. This was required to assure that everything was functioning properly and to allow observations to be made on commercial service with the new equipment in operation.

A great deal of information was prepared for this trial, which was furnished to the field engineers and to the various Associated Companies involved in this project. The most important was a preliminary bulletin which described the new program system and its performance characteristics, and included instructions for testing and lining up. The other information consisted of memoranda describing special tests, plans for carrying out the trial, instructions regarding data to be recorded, etc. Fourteen different forms were provided for tabulating the results of the various tests.

Armed with the information mentioned above, a lot of enthusiasm, some experience, and a great deal of determination, the field engineers after the close of a three-day conference held in Chicago sallied forth on June 20 to the repeater stations which had been assigned to them. On arrival at a station the engineer's first duty was to make a quick check of the complete layout to find out whether any equipment was missing. The results of this inspection were reported back to the control office at Chicago. Detailed measurements were then made on each piece of apparatus installed. These measurements included transmission-frequency runs on each unit, performance tests on the amplifiers, and performance and operating tests on the complete station layout.

In addition to these tests it was necessary for the engineers to make attenuation-frequency measurements of the line sections on each side of the station. From these measurements were determined the initial equalizer and attenuator adjustments. Where the weather made it possible, these line measurements were repeated under different conditions so as to

(Continued on Page 20)

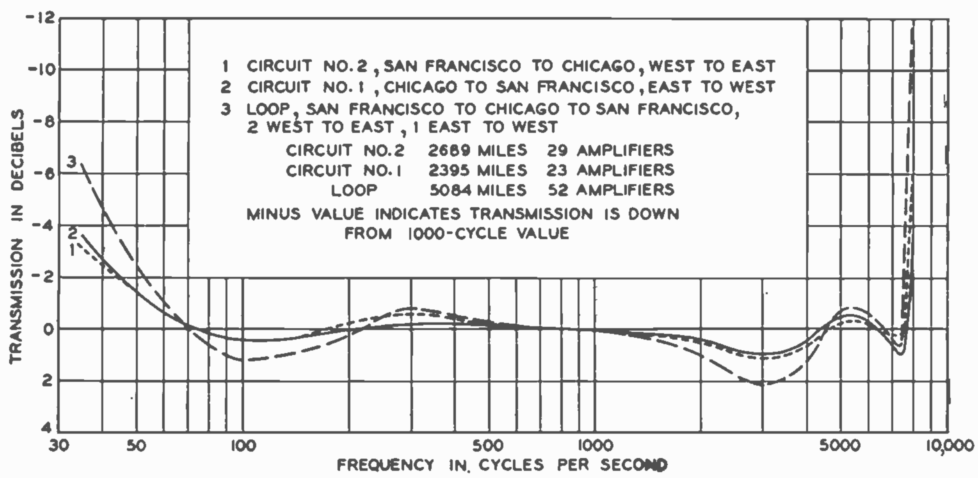


Fig. 4—Average transmission-frequency characteristics of Chicago-San Francisco program circuits

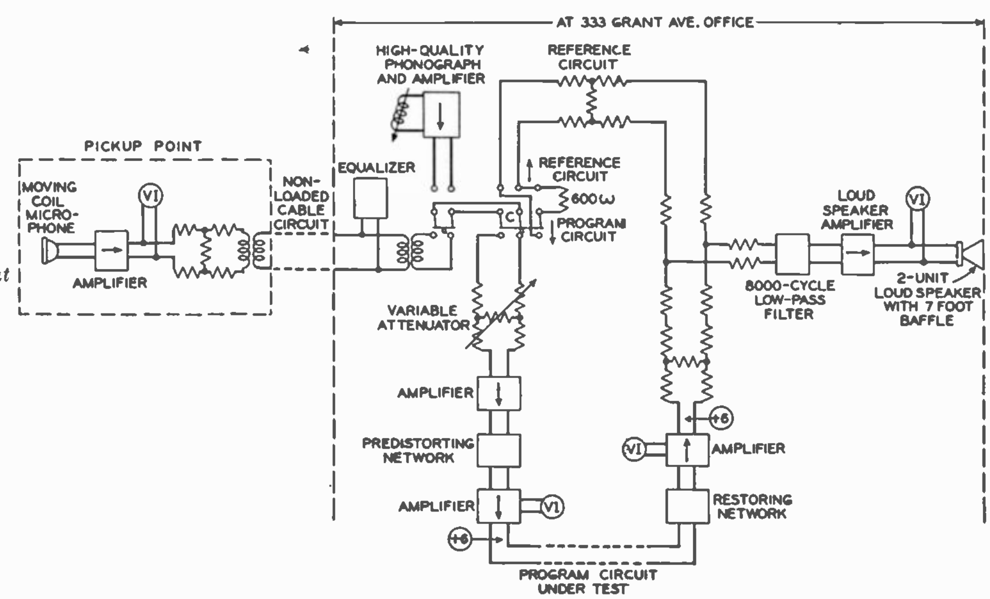


Fig. 5—Terminal arrangements at San Francisco for comparison tests

Disturbances in Radio Transmission

(Continued from Page 10)

the actual carriers are electrons or ions or a combination of both. The fact that the disturbance on the sun can be seen before electrical effects are experienced on the earth, implies a carrier other than light. Moreover the form and position of the aurora produced at such times have been reproduced in the laboratory by bombarding a magnetized iron sphere with electrons.

One may picture the origin of a magnetic storm in this way. First a solar eruption emits a stream of electrons and possibly ions into space; then some time later these charged corpuscles arrive at the earth and are so guided by its magnetic field that most of them enter the atmosphere around the polar regions. As they strike the outer atmosphere they ionize and disturb it, and as a direct result radio transmission through these regions is poor and a brilliant aurora appears. It has been suggested that electric currents would be set up in these high regions which would give rise to the magnetic and electrical effects observed at the earth's surface.

The durations of these great solar eruptions are very brief, astronomically speaking, usually a matter of hours or less, and since the sun can be observed only intermittently, the record of their appearance is necessarily very incomplete. It is probably significant that almost all of those observed have been followed by intense magnetic storms.

At times long distance transmission is disturbed when there is no magnetic storm. The question naturally arises: are there other means by which the normal behavior of the ionosphere may be altered? Is it possible, for example, that the haphazard bombardment of the upper atmosphere by meteors is one such cause of disturbance?

The average shooting star has a velocity many times that of the fastest rifle bullet. When it strikes an atmospheric molecule, the energy of impact is great enough to break up the molecule into ions and electrons. Often a bright meteor will leave a glowing train which floats in the upper atmosphere for some time after the meteor has disappeared and which may be a mile or more in diameter. It seems likely that such night-time trains are one of the phenomena accompanying ionization. They seem to occur exclusively in the lower layer of the ionosphere.

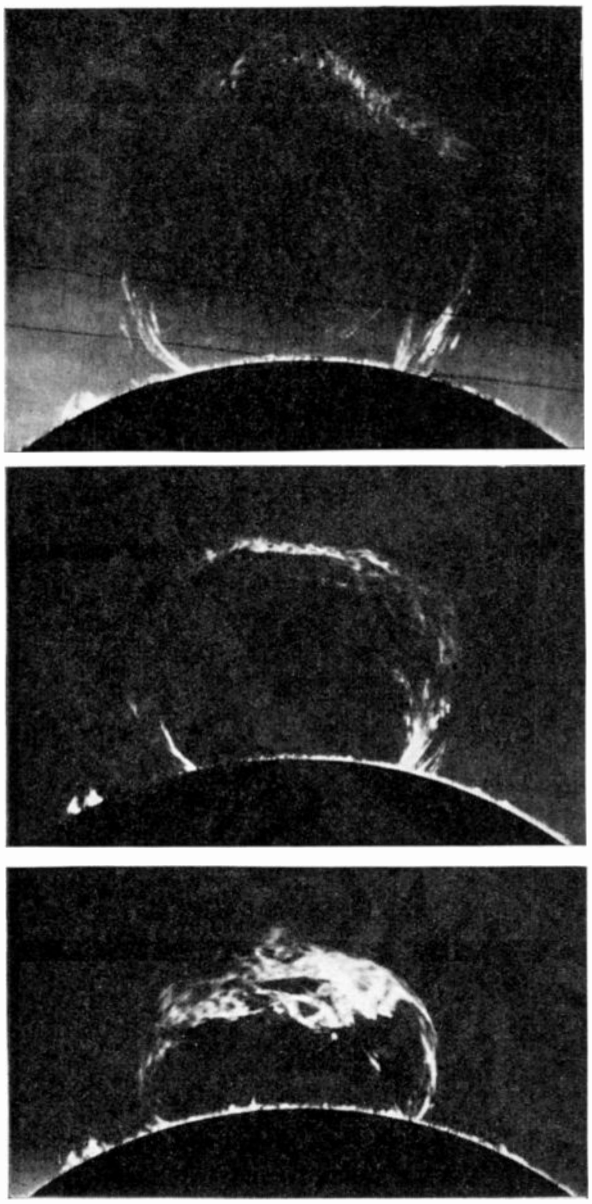


Fig. 5—These spectroheliograms show three successive stages of a prominence blowing off the sun. The time interval between 1 and 2 is about forty-four minutes, and between 2 and 3 about fifteen minutes. The pictures were taken by Pettit at the Yerkes Observatory

More direct proof of meteoric ionization was obtained at the Laboratories at Deal during the Leonid meteor shower of 1932. Measurements of ionization by the radio pulse method indicated increases in ionization directly overhead coincident with the passage of bright meteors through this region. For the brightest observed, the ionization increased by an amount in excess of that which is found at noon in summer. These observations, as well as others made by J. P Schafer and W. M. Goodall during other meteor showers, furnish direct evidence of the ionizing effects of visible meteors in the lower layer of the ionosphere.

A conservative estimate of the number of meteors which hit the atmosphere each day is one billion, averaging about five per square mile of the earth's surface. If each meteor spreads ionization around its path to a distance of a fraction of a mile, a radio beam which travels a long distance through the ionosphere will be subjected at normal times to a continuous bombardment. This brings up a question which has not as yet been answered: does this bombardment produce sufficient turbulence to cause fading?

It is in the general region of the lower layer, fifty to seventy-five miles above the earth, and in that neighboring it, that most of the shooting stars observed by the naked eye are seen. The telescope, however, reveals many more whose paths apparently lie in or near the region of the upper layer (175 to 190 miles high). These are much more difficult to observe since they are much fainter and traverse the field of the telescope in a very small fraction of a second. It is not unlikely, therefore, that the upper layer may experience meteor showers which are never seen. Whether or not they are the cause of unexplained interruptions of long distance transmission cannot be determined from present data, but that they constitute a possible source of such disturbances as these is evident.

New Inspection District

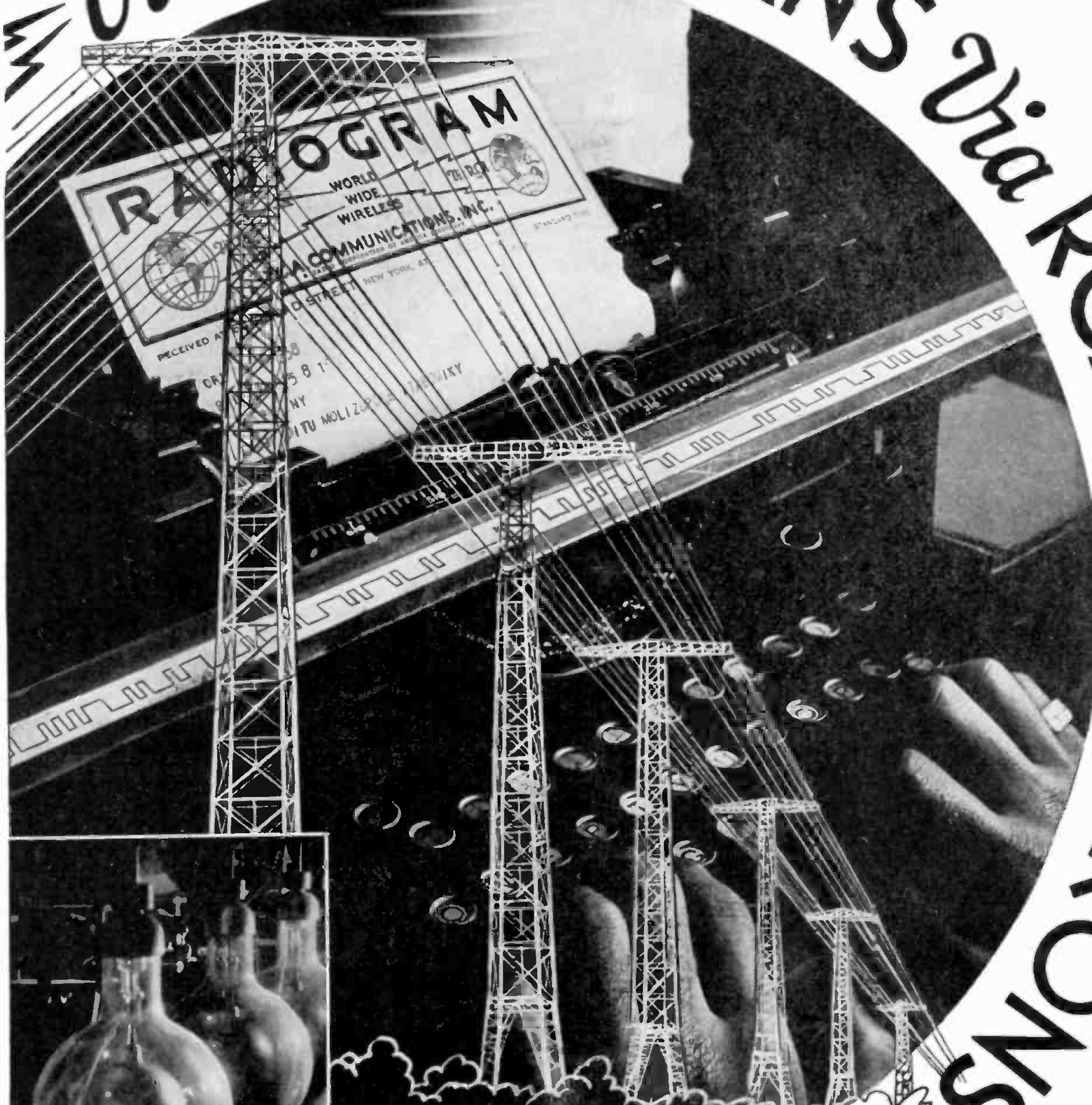
The Federal Communications Commission has established radio inspection district No. 21, embracing the Territory of Hawaii with headquarters in Aloha Tower, Honolulu.

James M. Chapple, formerly inspector in charge at Los Angeles, California, has been appointed inspector in charge at Honolulu and placed in charge of this district. Mr. Chapple sailed from Los Angeles for Honolulu February 8 and will open the office upon arrival. All radio matters originating in or pertaining to the Territory of Hawaii will be handled by this office.

Communications Officer Resigns

Effective Jan. 1, 1935, Hampson Gary resigned his position as one of the Federal Communications Commissioners. Mr. Gary was one of Division One composed of three members who devoted their time to broadcasting matters. The commission of seven members is divided two each to the three divisions under heading of Broadcasting, Telegraph and Telephone, with the chairman, E. O. Sykes, being the third man making up each division. This arrangement is by common consent of the commissioners as it was early believed the best method of handling the complicated affairs of the commission.

Via RCA MEANS Via RCA RADIOTRONS



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Trials of New Wide-Band Program Circuits

(Continued from Page 17)

provide further information on the adjustments required due to varying weather conditions. Since most of the circuits were used for commercial service, it was necessary to make the measurements on the lines after the program networks were "good night."

When this work was completed Chicago was notified, and arrangements were made to cut the station into service. It was generally possible to have our field engineers at the adjacent points, but the actual equipment was cut into the line wires by the plant forces. Our men made the necessary measurements and tests before and after the equipment was cut in.

Measurements made on the line sections during the cutover period were the most important of the field tests and were called "repeater section tests." From the measurements of attenuation of the line plus its line filters, the station equalizer settings were determined in accordance with a chart given in the bulletin. The settings thus determined were then applied to the station apparatus connected to the circuit and an overall repeater section measurement then made. In all cases it was found that the equalizer settings as indicated by the chart in the bulletin were the correct ones to use. The results of a typical section lineup are given on Figure 1. The first four columns apply to the Omaha to Grand Island repeater section, the receiving end of the circuit being at Grand Island. The first column gives the characteristic of the line and its associated filters. The second column is the deviation referred to 1,000-cycle zero. The third column gives the results of the overall repeater section measurements after the line equalizers and station attenuator had been adjusted in accordance with the data obtained from the output side of the repeater at Omaha to the output of the repeater at Grand Island. The fourth column is the deviation of this characteristic referred to 1,000 cycles. The four following columns give corresponding information for the section from North Platte to Grand Island with Grand Island as the receiving end of the section. The equalizer and attenuator settings required for these sections are indicated at the bottom of the form.

The individual station measurements, repeater section tests, and station cutovers, constituting the second phase of the trial, were completed with the cutover of the last stations on October 19. The engineers were then located at strategic stations between San Francisco and Chicago to cooperate in the overall tests which comprised the third phase of the field trial and which were completed by November 30.

The overall tests were conducted from San Francisco rather than Chicago for a number of reasons, but chiefly because the circuits could be obtained at about 11:00 p. m., Pacific time, corresponding to 1:00 p. m. Central standard time. This was early enough in the evening so that outside program sources could be obtained at San Francisco, whereas more difficulty would have been experienced in Chicago in obtaining suitable program sources after 1 or 2 o'clock in the morning.

A listening studio was set up in the Grand Avenue office of the Pacific Telephone and Telegraph Company at San Francisco. The room was of fair size and acoustically treated so as to obtain the proper reverberation time. A two-unit loud speaker was placed at one end of the room, and was operated from a powerful amplifier—the combined system having practically flat frequency characteristics from below 40 to above 8,000 cycles. Other special equipment provided at San Francisco included a phonograph outfit for vertical cut records, attenuators, switching arrangements, and filters of different cut-offs. The photograph of Figure 2 shows the special equipment placed in the Grant avenue office, and also the new program equipment provided on the two program circuits under discussion. The three right-hand bays accommodated the special equipment while the new program equipment was mounted in the bays to the left of these.

For program sources two outside pick-up points were used, one at the studios of the National Broadcasting Company at San Francisco and the other at the Mark Hopkins Hotel—a Columbia Broadcasting System pickup point. At both these places moving-coil type of microphones and the latest type of high quality speech input amplifiers were used. These program sources were supplemented by a number of vertical cut records, which included recordings of the Roxy Theatre orchestra as well as various solo and instrumental recordings.

The tests each night, planned as a rule after the previous day's data had been analyzed, were generally made between the hours of 10:00 or 11:00 P. M. and 4:30 A. M., Pacific time. This allowed one to retire at about 5:30 a. m., but all concerned managed to get enough sleep to carry on in good shape and also to get a considerable amount of testing done.

The nightly tests started with the station routine, i.e., check-up of repeaters, setting them to specified gains, etc. This was followed by section lineups; the circuits were divided in sections in accordance with the location of the engineers, and transmission measurements made at four frequencies, namely, 40, 100, 1,000 and 7,000 cycles. If the results were not within required limits the attenuators and equalizers were adjusted as required. The various sections were then connected together, and the overall circuit measured at several frequencies. The results of some of these overall frequency measurements are shown on Figures 3 and 4. Figure 3 shows the average characteristics and extreme deviations of one of the circuits from San Francisco to Chicago. Figure 4 shows the average characteristic of the two circuits and also the characteristic of the two looped together making a circuit over 5,000 miles long.

Various other kinds of measurements were made, such as load measurements, and measurements to determine whether the circuit had any undesirable non-linear effects. Very critical listening tests were made in addition, in which the quality of a program after it had been transmitted over various length circuits was compared with the same program transmitted over a reference circuit, which was distortionless over the frequency range for which the circuits were designed. Figure 5 shows schematically the terminal arrangements employed at San Francisco for these comparisons.

Various types of programs were used, such as speech, vocal and instrumental selections, and orchestral compositions—both classical and jazz. Quite a number of observers were used, some of whom were present on several tests and a few on all tests. On tests made on a San Francisco-Denver-San Francisco loop involving 2,600 miles of circuit, no observer was able consistently to differentiate between the quality over the reference circuit and that over the program circuit. On tests made on the San Francisco-Chicago-San Francisco loop certain of the more experienced observers were able to differentiate between the circuits somewhat more than 50 per cent. of the time, but this, it should be remembered, was on a direct comparison test. None of the observers could tell with any assurance which was the program circuit and which was the reference circuit if a few minutes were allowed to elapse between switches.

Eclipse Effect on Short Waves

(Continued from Page 6)

layer. Though the density of the ionization of the 'F' region, about 150 miles up, was probably also reduced, nevertheless it remained easily dense enough to reflect the waves. Consequently the eclipse reduced absorption but not reflection."

Very high frequencies penetrate the ionized strata with little absorption while the lower frequencies with longer wave lengths are more materially affected, according to Mr. Schelleng. This is the chief reason why Eastern Air Lines and other airlines use the higher frequencies in the daytime and lower at night. The day frequency used by the airline is 4122.5.

The Atlanta ground station of the airline reported that at 11:30 a.m. (EST) it brought in the two-way conversation between a United Air Lines pilot flying near Reno, Nev., and the Reno ground station of United Air Lines, a distance of about 2200 miles. It was pointed out, however, that skipping conditions might also have caused this although signal strength was comparatively strong.

Full reports as noted at the time by the radio operators of Eastern Air Lines have been turned over to Western Electric and Bell Telephone Laboratories' engineers by Captain Rickenbacker.

Vacuum Tubes at Very High Frequencies

(Continued from Page 15)

tions of ultra-high frequency utilizes a vacuum tube triode in which the grid is operated at a high positive potential compared with both the cathode and the plate. Although the operating efficiencies of this system are at present decidedly lower than those obtainable with the more usual low-frequency circuits, it nevertheless forms one of the most effective means available for producing oscillations with frequencies measured in thousands of megacycles. The answer to the question which will prove to be the better decimeter oscillator ultimately hinges on whether the efficiencies of the positive grid triode can be pushed upward, or the losses between the grid and cathode of the negative grid triode can be pushed downward, sufficiently to give one type or the other a decided advantage.

AVIATION NOW HAS RADIO COMPASS

Production of the Kruesi Radio Compass for the use of airlines, commercial operators and private pilots has been announced by the Fairchild Aerial Camera Corporation, manufacturers of high precision aerial cameras and instruments used by military and commercial organizations throughout the world. The Kruesi Radio Compass, developed by the U. S. Army Air Corps and used extensively by it as a standard unit under severest service conditions, including blind landings, now becomes generally available for the first time as an aerial navigation device which is especially effective in blind flying.

The Kruesi Radio Compass offers an outstanding advantage over other radio navigation devices in that it utilizes the programs broadcast by the hundreds of commercial broadcasting stations thruout the country as well as the signals broadcast by the federal airways radio range beacons and other stations.

Another distinct advantage is the fact that it operates as a "homing" device in such a way that the pilot can select any government beacon station or commercial station, secure a bearing on that and, by observing a sensitive pointer, fly straight to the source of the signals. Furthermore, the Kruesi Radio Compass may be used as an easy and accurate means of position-finding when the plane is in the air or on the ground, it was explained. Drift may be determined by comparisons between the radio compass and the directional giro or the magnetic compass.

The Kruesi Radio Compass is so simple to operate that it is not necessary to have special training or experience in bad weather flying in order to be assured of successful use. To use the Kruesi Radio Compass, the pilot tunes in on a station along his course or at his destination with his headphones. Then he switches from the headphones to the indicator. By holding the pointer on the indicator mounted on the instrument board centered at zero, he is able to fly direct to the selected station. A deflection of the needle to the left of zero indicates instantly that the airplane is heading to the right of the course. A deflection to the right indicates the airplane is to the left of the course.

To determine his position along the course it is necessary only for the co-pilot to turn the rotatable loop and secure bearings on any two stations to one side of his course, or for the pilot, in case a fixed loop is used, to train the plane on the off-course stations long enough to secure the required bearings. Simple plotting on a conventional map indicates the plane's location. The position-finding feature is particularly valuable in the event of a forced landing in isolated and unfamiliar areas.

The value of the Kruesi Radio Compass is indicated by the fact that it makes more efficient use of the established airways radio facilities and simplifies the operations involved. The pilot is able to quickly locate the radio range beam when he is lost or off the course, it was pointed out as an example, and may positively identify the quadrant in which he is flying, thus eliminating much of the difficulty in flying by beam with standard beam equipment. The pilot also may be independent of the established airway and leave the beam to fly around especially unfavorable weather without risking not being able to pick up the beam when desired.

Furthermore, the Kruesi Radio Compass provides a direction finding device in areas not served with airways facilities. This is particularly valuable for commercial operators and private pilots whose trips frequently carry them away from the airways.

The Kruesi Radio Compass has a longer range than the beacon receivers and can be relied upon in static which renders all other means of radio navigation useless. Satisfactory bearings under average conditions may be received at a distance of 300 miles over land and 700 miles over water. Under favorable conditions bearing indications have been obtained over 1500 miles. The compass eliminates the prolonged and tiresome concentration required in receiving aural radio beam signals.

The Kruesi Radio Compass was developed by Geoffrey G. Kruesi and the latest model is being manufactured exclusively by Fairchild. The military model serves as the key unit of the Air Corps' blind landing system with which several thousand total blind landings have been made. This system has attracted considerable attention and has been adopted by the Department of Commerce.

The Compass consists of four main units—the compass receiver, the bearing indicator, the remote control box and the fixed or rotatable loop. The radio compass receiver apparatus is concentrated on one complete unit. It has a frequency range of 150 to 1500 kc in the following bands: 150-300 kc.; 250-500 kc.; 450-900 kc.; and 800-1500 kc. It occupies less than 1000 cubic inches of space.

The tuning dial, the frequency band and headphone switches, and the headphones jack are mounted on the remote control box. It requires only 100 cubic inches of space and may be located wherever most convenient for the pilot. The indicator dial face is finished in black with pointer and scale painted with a luminous material.

The loop has a streamline cross section with a diameter of 21 inches and is so designed that it has a drag of only 8 pounds at a speed of 250 miles per hour. The rotatable loop mechanism includes a handwheel and a 360-degree scale to facilitate readings. Power is supplied by a dynamotor and a storage battery. The loop is used in conjunction with a standard mast antenna projecting no more than 6 to 8 feet from the fuselage or a fixed wire antenna between 9 and 19 feet long.

The radio compass unit is so compact it may be installed wherever convenient in the airplane. All adjustments are by remote control. The four units of the compass weigh only 45 pounds.

ROGERS GETS V. W. O. A. GOLD MEDAL

George W. Rogers, Chief Radio Officer on the Morro Castle at the time of the ship's fire was awarded the annual gold medal of the V. W. O. A. on February 11, at the tenth annual dinner of the organization.

George I. Alagna, his first assistant on the Morro Castle at the same time, received a testimonial certificate, as did William J. (Big Bill) Kirchoff, who was on the Sea Thrush; Russell McDonald, and Ernest H. Cole, who were on the Mohawk, and E. J. Robertson, and R. Lilkebakken.

The story of George W. Rogers on the Morro Castle is well known to readers of our book who will recall the full account of his feat in a previous issue.

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