DEPARTMENT OF COMMERCE

RADIO SERVICE BULLETIN

ISSUED MONTHLY BY RADIO DIVISION

Washington, December 31, 1928—No. 141

CONTENTS

ABBREVIATIONS AND SYMBOLS

The necessary corrections to the list of Commercial and Government Radio Stations of the United States and to the International List of Radiotelegraph Stations, appearing in this bulletin under the heading "Alterations and corrections," are published after the stations affected in the following order:

Name =Name of station.
Loc. =Geographical location. W=west longitude. N=north latitude. S=south latitude. E=east longitude.
Call =Call signal (letters) assigned.
Type of wave=Classified as follows: A1=continuous wave (tube), A, arc=continuous wave, A2=interrupted continuous wave, A3=phone, B=spark.
Range =Normal range in nautical miles.
W. l. =Wave lengths in meters; normal wave lengths in italics.
Fy. =Frequency in kilocycles; normal frequency in italics; wave length in meters in parentheses.
Service =Nature of service maintained: FX=point-to-point (fixed service), PG=general public (ship to shore), PR=limited public, RC=radio compass, FA=aeronautical station, AB=aviation beacon, RF=directional radiobeacon (ship work), P=private ship-to-shore, O=Government business exclusively (ship-to-shore and point-to-point or ship-to-shore only).
Hours =Hours of operation: N=continuous service, X=no regular hours, Y=sunrise to sunset.
F. T. Co. =Federal Telegraph Co.
I. R. T. Co. =Intercity Radio Telegraph Co.
I. W. T. Co. =Independent Wireless Telegraph Co.
M. R. T. Co. =Mackay Radio & Telegraph Co.
R. C. A. =Radio Corporation of America.
R. M. C. A. =Radiomarine Corporation of America.
T. R. T. Co. =Tropical Radio Telegraph Co.
C. w. =Continuous wave.
I. c. w. =Interrupted continuous wave.
A. c. =Alternating current.
V. t. =Vacuum tube.
U. S. L. =Applies only to the list of Commercial and Government Radio Stations of the United States.
△ =Equipped with a radio compass (direction finder).

NEW STATIONS

Commercial land stations, alphabetically, by names of stations

[Additions to the List of Commercial and Government Radio Stations of the United States, edition of June 30, 1928, and to the International List of Radiotelegraph Stations, published by the Berne bureau]

Station	Call signal	Frequency in kilocycles, meters in parentheses	Service	Hours	Station controlled by—
Bakersfield, Calif.[1]	KQX	2,506 (119.7), 3,010 (99.7), 3,286 (91.29), 4,188 (71.6), 5,585 (53.7), 5,990 (50.08).	FA and FX.	X	Boeing Air Transport.
Portland, Oreg.[1]	KVO	do	do	X	Do.

[1] Type of wave (system), A2 and A3.

Commercial ship stations, alphabetically, by names of vessels

[Additions to the List of Commercial and Government Radio Stations of the United States, edition of June 30, 1928, and to the International List of Radiotelegraph Stations, published by the Berne bureau]

Name of vessel	Call signal	Rates	Service	Hours	Owner of vessel	Station controlled by—
Alloway	KTAA	8	PG	X	C. P. Cox Corporation	Owner of vessel.
Bonnie Brook	KDGX	8	PG	X	U. S. S. B	R. M. C. A.
Curlew	KOSZ	8	PG	X	Portland Trawling Co	Do.
Fairfield	WHDM	8	PG	X	Argonaut S. S. Co	
Gar, Sr.[1]	WHDD	8	PG	X	Gar Wood	Owner of vessel.
Iconium	WQUO	8	PG	X	C. P. Cox Corporation	
Saunterer	WHDE				Jeremiah Willbank	R. M. C. A.
Sheldrake	KUFX	8	PG	X	Portland Trawling Co	Do.
Zelda	WHDK	8	PG	X	North Atlantic Trawling Corporation.	

[1] Type of wave (system), A1, A2, and A3.

Commercial land and ship stations, alphabetically, by call signals

[a, aeronautical station; b, ship station; c, coast station; f, fixed station]

Call signal	Name of station	Call signal	Name of station
KQX	Bakersfield, Calif—a–f	WHDD	Gar, Sr—b
KTAA	Alloway—b	WHDE	Saunterer—b
KVO	Portland, Oreg—a–f	WHDK	Zelda—b
KGDX	Bonnie Brook—b	WHDM	Fairfield—b
KOSZ	Curlew—b	WQUO	Iconium—b
KUFX	Sheldrake—b		

Commercial aircraft stations, alphabetically, by names of stations

[Additions to the List of Radio Stations of the United States, edition of June 30, 1928, and to the International List of Radiotelegraph Stations published by the Berne bureau]

Station	Call signal	Frequency in kilocycles, meters in parentheses	Service	Hours	Station controlled by—
F-15 [1]	KHCK	6,470 (46.37)	P	X	Western Air Express.
Liberty [2]	KHAL	333 (900), 375 (800), *500 (600)*	P	X	Joseph M. Patterson (Liberty Weekly).
No. 5092 [1]	KHAZ	8,810 (34.05)	P	X	Standard Oil Co. of California.

[1] Type of wave (system), A2.
[2] Type of wave (system), A2 and B.

Commercial aircraft stations, alphabetically, by call signals

Call Signal	Name of station	Call signal	Name of station
KHAL KHCK	Liberty. F-15.	KHAZ	No. 5092.

Broadcasting stations, alphabetically, by names of States and cities

[Additions to the List of Radio Stations of the United States, edition of June 30, 1928]

State and city	Call signal	Frequency in kilocycles, meters in parentheses	Power (watts)
Illinois: Chicago [1]	KYWA	1,020 (294.1)	5,000
Massachusetts: Gloucester	WHDH	830 (361)	1,000
New York: Tupper Lake	WHDL	1,420 (211.3)	10
Oregon: Marshfield	KOOS	1,370 (219)	50

[1] Construction permit issued to operate in synchronism with station KYW.

Broadcasting stations, alphabetically, by call signals

Call signal	Location of station (address)	Owner of station	Frequency in kilocycles, meters in parentheses	Power (watts)
KOOS	Marshfield, Oreg.	Harold H. Hanseth	1,370 (219)	50
KYWA	Chicago, Ill.[1]	Westinghouse Electric & Manufacturing Co.	1,020 (294.1)	5,000
WHDH	Gloucester, Mass., 209 Main St.	Matheson Radio Co.	830 (361)	1,000
WHDL	Tupper Lake, N. Y.	George F. Bissell	1,420 (211.3)	10

[1] Construction permit issued to operate in synchronism with station KYW.

Government land stations, alphabetically, by names of stations

[Additions to the List of Commercial and Government Radio Stations of the United States, edition of June 30, 1928, and to the International List of Radiotelegraph Stations published by the Berne bureau]

Station	Call signal	Frequency in kilocycles, meters in parentheses	Service	Hours	Station controlled by—
Buffalo, N. Y.	NCB		O		U. S. Coast Guard.

Government land and ship stations, alphabetically, by call signals

[b, ship station; f, fixed station; c, land station]

Call signal	Name of station		Call signal	Name of station
NCB	Buffalo, N. Y.	C		

Special stations, alphabetically, by names of stations

[Additions to the List of Commercial and Government Radio Stations of the United States, edition of June 30, 1928]

Station	Call signal	Frequency in kilocycles, meters in parentheses	Power (watts)	Station controlled by—
California:				
Los Angeles	W6XAV	1,604 (187), 2,530 (118.6)	250	Edward F. Walter, 1609 Hipoint St.
Do	W6XBC	6,420 (46.73), 12,850 (23.35)	250	R. N. Cheminant, 2500 Marvin Ave.
Wilmington (Catalina Terminal).	W6XAE	1,604 (187), 2,398 (125.1), 3,208 (93.5), 4,795 (62.56).	250	Lemert Engineering Corporation.
Connecticut: Hartford	W1XL	Above 28,000 (under 10.714)	500	Francis E. Handy, 15 Beacon St.
New Jersey:				
Bound Brook	W3XAL	6,100 (49.18), 9,570 (31.35), 11,720 (25.6), 15,130 (19.828), 17,780 (16.873), 21,500 (13.953).	20,000	R. C. A.
Jersey City	W2XCD	1,604 (187), 1,704 (176), 3,214 (93.34), 4,324 (69.38), 6,420 (46.73), 8,650 (34.68), 12,850 (23.35), 17,300 (17.341), 25,680 (11.682), 34,240 (8.762), 51,360 (5.841).	500	De Forest Radio Co., 139 Franklin St.
Newark	W2XCG	1,604 (187), 1,704 (176), 3,210 (93.5), 4,280 (70.09), 6,420 (46.73), 8,650 (34.68), 12,850 (23.35), 17,300 (17.341), 25,680 (11.682), 34,240 (8.762), 51,360 (5.841).	1,000	Federal Telegraph Co., 200 Mount Pleasant Ave.
New York:				
Brooklyn	W2XCE	1,604 (187), 1,704 (176), 3,210 (93.5), 4,280 (70.09), 6,420 (46.73), 8,650 (34.68), 12,850 (23.35), 17,300 (17.341), 25,680 (11.682), 34,240 (8.762), 51,360 (5.841).	20,000	Allen D. Cardwell Manufacturing Corporation, 81 Prospect St.
New Dorp	W2XCC	4,324 (69.38), 6,420 (46.73)	50	David Grimes, 649 Richmond Road, Stapleton, N. Y.
New York	W2XCI	1,604 (187), 1,704 (176), 3,210 (93.5), 4,280 (70.09), 6,420 (46.73), 8,650 (34.68), 12,850 (23.35), 17,300 (17.341), 25,680 (11.682), 34,240 (8.762), 51,360 (5.841).	250	R. C. A.
Schenectady (airport)	W2XCH	2,500 to 2,550 (120 to 117.6)	300	General Electric Co.
Stapleton	W2XCB	4,324 (69.38), 6,420 (46.73)	50	David Grimes.
Yorktown Heights	W2XCF	1,604 (187), 1,704 (176), 3,210 (93.5), 4,280 (70.09), 12,850 (23.35).	100	Pilot Electric Manufacturing Co., 323 Berry St.
Aircraft: X118E	W2XAQ	2,506 (119.7)	50	Sky Lines (Inc.).
Portable	W3XU	2,140 (140.2), 4,280 (70.09), 8,560 (35.05).	500	Universal Wireless Communications, 1725 Liberty Bank Building, Buffalo, N. Y.

Special stations, grouped by districts

Call signal	District and station	Call signal	District and station
W1XL	First district: Hartford, Conn.		Third district:
	Second district:	W3XAL	Bound Brook, N. J.
W2XAQ	X118E (aircraft).	W3XU	Portable.
W2XCB	Stapleton, N. Y.		Sixth district:
W2XCC	New Dorp, N. Y.	W6XAE	Wilmington, Calif. (Catalina Terminal).
W2XCD	Jersey City, N. J.	W6XAV	Los Angeles, Calif.
W2XCE	Brooklyn, N. Y.	W6XBC	Do.
W2XCF	Yorktown Heights, N. Y.		
W2XCG	Newark, N. J.		
W2XCH	Schenectady, N. Y. (airport).		
W2XCI	New York, N. Y.		

RADIOBEACON STATIONS

[Additions to the List of Commercial and Government Radio Stations of the United States, edition of June 30, 1928, and to the International List of Radiotelegraph Stations published by the Berne bureau]

SENTINEL ISLAND LIGHT STATION (LYNN CANAL), ALASKA.—Loc. 134° 54′ 37″ W., 58° 32′ 46″ N. Transmits groups of 1 dash, 1 dot and 1 dash for 60 seconds, silent 120 seconds, thus:

— · — — · — — · — — · — etc. (60 seconds) Silent (120 seconds)

Transmits continuously during thick or foggy weather and daily in clear weather from 5 to 5.30 and 11 to 11.30 a. m. and p. m. One hundred and thirty-fifth meridian time on 300 kilocycles (1,000 meters).

ALTERATIONS AND CORRECTIONS

COMMERCIAL LAND STATIONS

[Alterations and corrections to be made to the List of Commercial and Government Radio Stations of the United States, edition of June 30, 1928, and to the International List of Radiotelegraph Stations, published by the Berne bureau]

CLEVELAND, OHIO RADIO (WCY).—Read West Dover (Cleveland), Ohio; loc. (approximately) 81° 57′ 45″ W.; 41° 27′ 15″ N.

FRESNO, CALIF. (KGT).—Type of wave (system), A1; fy., 3,010 (99.7), 3,286 (91.2), 5,990 (50.08).

GALVESTON, TEX. RADIO.—Type of wave (system), A1; fy., 6,230 (48.18), 8,440 (35.55), 12,430 (24.14), 16,880 (17.773).

HILLSBORO, OREG. (KEK).—Type of wave (system), A2.

LOS ANGELES, CALIF. (KEU).—Type of wave (system), A1; fy. 3,010 (99.7), 3,286 (91.2), 5,990 (50.08).

LOS ANGELES, CALIF. RADIO (TORRANCE, KSE).—Type of wave (system), A1; fy., 6,410 (46.8), 8,490 (35.34), 12,820 (23.4), 16,980 (17.668); service PG; hours, N.

MARION, MASS. (WCC).—Fy., add 6,395 (46.92), 8,450 (35.5), 12,730 (23.57), 16,900 (17.751).

MEDFORD, OREG.—Type of wave (system), A1; fy., 3,010 (99.7), 3,286 (91.2), 5,990 (50.08).

NEW YORK, N. Y. RADIO (WNY).—Type of wave (system), A1; fy., 6,260 (47.92), 8,500 (35.29), 12,550 (23.9), 17,000 (17.647).

OAKLAND, CALIF. (KFO).—Type of wave (system), A1; fy., 5,990 (50.08).

PORT ARTHUR, TEX. RADIO.—Type of wave (system), A1–2; fy., 146 (2,055), 390 (769), 500 (600); station controlled by R. M. C. A.

SAN JUAN, P. R. (WJT).—Fy., 4,595 (65.28).

VANCOUVER, WASH.—Type of wave (system), A1–A3; fy., 2,506 (119.71), 3,010 (99.7), 3,286 (91.29), 4,188 (71.63), 5,585 (53.72), 5,990 (50.08); station controlled by Boeing Air Transport.

WAHIAWA, HAWAII RADIO (KHK).—Type of wave (system), A1; fy., 6,620 (45. 32); service PG; hours, N.

COMMERCIAL SHIP STATIONS, ALPHABETICALLY, BY NAMES OF VESSELS

[Alterations and corrections to be made to the List of Commercial and Government Radio Stations of the United States, edition of June 30, 1928, and to the International List of Radiotelegraph Stations, published by the Berne bureau]

ABSECON.—Name changed to James Ellwood Jones; owner of vessel, Pocahontas S. S. Co.

ALAMEDA.—Station controlled by M. R. T. Co.

ALASKA.—Station controlled by M. R. T. Co.

ALEUTIAN.—Station controlled by M. R. T. Co.

APACHE.—Station controlled by R. M. C. A.

ARGOSY.—Station controlled by R. M. C. A. (U. S. L.).

ARTEMIS.—Station controlled by R. M. C. A.

BAFSHE.—Station controlled by R. M. C. A. (U. S. L.).

BETTERTON.—Station controlled by M. R. T. Co.

BOSTON COLLEGE.—Station controlled by R. M. C. A.

CALICHE.—Station controlled by R. M. C. A.

CAMARGO.—Station controlled by R. M. C. A.

CARACAS.—Type of wave (system), A1–2; hours, N.
CATALINA.—Station controlled by R. M. C. A.
CATHLAMET.—Station controlled by R. M. C. A. (U. S. L.).
CHINCHA.—Type of wave (system), A2.
CITIES SERVICE EMPIRE.—Station controlled by M. R. T. Co.
COCKAPONSET.—Station controlled by R. M. C. A. (U. S. L.).
COLOMBIA.—Station controlled by R. M. C. A.
COLONEL JAMES M. SCHOONMAKER.—Station controlled by R. M. C. A.
COLUMBINE.—Station controlled by R. M. C. A.
COMAL.—Station controlled by R. M. C. A.

COMMERCIAL SHIP STATIONS, ALPHABETICALLY, BY NAMES OF VESSELS

COOT.—Station controlled by R. M. C. A.
CORINTO.—Station controlled by R. M. C. A.
CORMORANT.—Station controlled by R. M. C. A.
COURAGEOUS.—Station controlled by R. M. C. A.
COVENA.—Station controlled by M. R. T. Co.
CREST.—Station controlled by R. M. C. A.
CYRUS.—Station controlled by R. M. C. A.
DARDEN.—Station controlled by R. M. C. A.
DENALI.—Station controlled by M. R. T. Co.
DEPERE.—Station controlled by M. R. T. Co.
DERBLAY.—Station controlled by M. R. T. Co.
DRYDEN.—Station controlled by R. M. C. A.
ECUADOR.—Station controlled by R. M. C. A.
EDGEMONT.—Station controlled by R. M. C. A. (U. S. L.).
EL CEDRO.—Station controlled by R. M. C. A.
ELMSPORT.—Station controlled by R. M. C. A.
EXPORTER.—Station controlled by R. M. C. A. (U. S. L.).
F. A. WARNER.—Station controlled by R. M. C. A.
FRANK G. DRUM.—Station controlled by M. R. T. Co.
GALE.—Station controlled by R. M. C. A.
GAR, SR.—Name changed to Gar, Sr. II.
GEMMA.—Station controlled by R. M. C. A.
GEORGE PIERCE.—Station controlled by R. M. C. A. (U. S. L.).
GEORGETOWN.—Station controlled by R. M. C. A.; owner of vessel, Trawler Georgetown (Inc.).
GEORGE WASHINGTON (KDCL).—Station controlled by R. M. C. A.
GLADYSBE.—Station controlled by R. M. C. A.
GULFBIRD.—Station controlled by R. M. C. A.
GULFHAWK.—Station controlled by R. M. C. A.
GULFWING.—Station controlled by R. M. C. A.
HELEN VINMONT.—Station controlled by M. R. T. Co.
HIGHO.—Station controlled by R. M. C. A.
H. M. FLAGLER.—Station controlled by R M. C. A. (U. S. L.).
HOLY CROSS.—Station controlled by R. M. C. A.
ILLINOIS (KDSZ).—Station controlled by R. M. C. A.
JOHN F. CUSHING.—Station controlled by R. M. C. A.
KEWANEE.—Station controlled by M. R. T. Co.
KINGFISHER.—Station controlled by R. M C. A.
LAKE GILTEDGE.—Station controlled by R. M. C. A.
LAKINA.—Station controlled by M. R. T. Co.
L. J. DRAKE.—Station controlled by R. M. C. A.
LOON.—Station controlled by R. M. C. A.
MADISON.—Owner, Eastern S. S. Lines.
M. & J. TRACY.—Station controlled by R. M. C. A. (U. S. L.).
MERICOS H. WHITTIER.—Station controlled by M. R. T. Co.
MIST.—Station controlled by R. M. C. A.
MUNARGO.—Owner, Munargo S. S. Line.
NABESNA.—Station controlled by M. R. T. Co.
N. & K. No. 2.—Station controlled by R. M. C. A.
NEW YORK (WECF).—Type of wave (system), A1–2 and B; fy., 141 (2,128), 143 (2,098), 151 (1,987), 160 (1,875), 425 (705), 500 (600).
NISHMAHA.—Station controlled by R. M. C. A.
NIZINA.—Station controlled by M. R. T. Co.
NORTHWESTERN.—Station controlled by M. R. T. Co.
NOURMAHAL.—Station controlled by R. M. C. A.
ODUNA.—Station controlled by M. R. T. Co.

ONTARIO (WSBP).—Station controlled by R. M. C. A.
OREGON (KUTD).—Station controlled by owner.
OSSA.—Name changed to Exbrook.
OTHO.—Station controlled by R. M. C. A.
PADNSAY.—Station controlled by R. M. C. A.
PAUL SHOUP.—Station controlled by M. R. T. Co.
PLOVER.—Station controlled by R. M. C. A.
POINT ARENA.—Station controlled by R. M. C. A.
POINT BONITA.—Station controlled by R. M. C. A.
POINT FERMIN.—Station controlled by R. M. C. A.
POINT JUDITH.—Station controlled by R. M. C. A.
POINT LOBOS.—Station controlled by R. M. C. A.
POINT MONTARA.—Station controlled by R. M. C. A.
POINT REYES.—Station controlled by R. M. C. A.
POINT SUR.—Station controlled by R. M. C. A.
PUEBLO.—Station controlled by R. M. C. A.
QUINCY.—Station controlled by R. M. C. A.
REDONDO.—Station controlled by M. R. T. Co.
SALINA.—Station controlled by R. M. C. A.
SANTA BARBARA.—Station controlled by R. M. C. A.
SCHENECTADY.—Station controlled by R. M. C. A.
SEEKONK.—Station controlled by R. M. C. A.
SHENANGO.—Station controlled by R. M. C. A.; owner, Gulf Refining Co.
SHICKSHINNY.—Owner, South Atlantic S. S. Co.
SHREVEPORT.—Station controlled by M. R. T. Co.
SILVEROAK.—Station controlled by R. M. C. A.
SILVERSPRUCE.—Station controlled by R. M. C. A.
SUNOIL.—Station controlled by R. M. C. A.
TAMPA.—Owner, Eastern S. S. Lines.
TANANA.—Station controlled by M. R. T. Co.
VELERO II.—Station controlled by M. R. T. Co.
VICTORIA.—Station controlled by M. R. T. Co.
WACOSTA.—Station controlled by R. M. C. A.
WEST ALSEK.—Station controlled by R. M. C. A.
WEST ARROW.—Station controlled by R. M. C. A. (U. S. L.).
WESTPORT.—Station controlled by R. M. C. A. (U. S. L.).
WEST SAGINAW.—Station controlled by R. M. C. A.
Strike out all particulars of the vessel M. J. Barteline.

COMMERCIAL LAND AND SHIP STATIONS, ALPHABETICALLY, BY CALL SIGNALS

KSEA, *read* James Ellwood Jones; KUFZ, *read* Exbrook; WCDI, *read* Westward Ho.–b (U. S. L.); WCY, *read* West Dover (Cleveland), Ohio; WKK, *insert* Ceiba, P. R.–c (U. S. L.); WKX, *read* WCDI (U. S. L.); WOBN, *read* Gar, Sr. II; WOH, *read* WMX (U. S. L.); WPB, changed to WDDL, *read* William C. Atwater–b (U. S. L.); WPD, *insert* Tampa, Fla.–c (U. S. L.); KDYD, changed to WACB, *read* California–b (U. S. L.); KYD, *insert* Mount Baker (permanently moored vessel near Naknek, Alaska)–c (U. S. L.); strike out all particulars following the call signal WDDV.

BROADCASTING STATIONS, BY CALL SIGNALS

[Alterations and corrections to be made to the list of Commercial and Government Radio Stations of the United States, edition of June 30, 1928]

KFJF (Oklahoma City (Nicoma Park), Okla.)—Power, 5,000.
KFJM (Grand Forks, N. Dak.).—Fy., 1,370 (219).
KFKA (Greeley, Colo.).—Power, 1,000 day, 500 night.
KFON (Long Beach, Calif.).—Call changed to KFOX.
KFPY (Spokane, Wash.)—Power, 500.
KFQB (Fort Worth, Tex.).—Call changed to KTAT; owner, Texas Air Transport Broadcast Co.
KFQZ (Hollywood, Calif.).—Fy., 850 (353).
KGDE (Barrett, Minn.).—Changed to Fergus Falls, Minn.
KGIM (Stockton, Calif.—Power, 50.
KGWF (Ravenna, Nebr.).—Power, 50.
KGGF (Picher, Okla.).—Power, 500.
KGHF (Pueblo, Colo.).—Fy., 1,320 (227.3).

KGHI (Little Rock, Ark.).—Power, 500.
KIDO (Boise, Idaho).—Owner, Boise Broadcast Station; power, 1,000; fy., 1,250 (240).
KLDS (Independence, Mo.).—Power, 500 night, 2,500 day.
KLRA (Little Rock, Ark.).—Power, 500.
KMBC (Independence, Mo.).—Power, 500 night, 2,500 day.
KMED (Medford, Oreg.).—Fy., 1,310 (229).
KOAC (Corvallis, Oreg.).—Power, 1,000.
KOL (Seattle, Wash.).—Owner, Seattle Broadcasting Co.
KRLD (Dallas, Tex.).—Power, 10,000.
KSAC (Manhattan, Kans.).—Power, 500 night, 1,000 day.
KTAB (Oakland, Calif.).—Fy., 550 (545).
KTHS (Hot Springs, Ark.).—Owner, Hot Springs Chamber of Commerce; power, 10,000.
KXRO (Aberdeen, Wash.).—Power, 75.
WBAK (Harrisburg, Pa.).—Fy., 1,430 (209.8).
WBAP (Fort Worth, Tex.).—Power, 10,000.
WBCN (Chicago, Ill.).—Power, 25,000 normally, 50,000 experimentally.
WBMS (Union City, N. J.).—Changed to Fort Lee, N. J.; power, 250.
WBSO (Wellesley Hills, Mass.).—Power, 250.
WCAC (Storrs, Conn.).—Power, 250; fy., 600 (500).
WCBA (Allentown, Pa.).—Power, 250; fy., 1,440 (208.3).
WDBJ (Roanoke, Va.).—Power, 250 night, 500 day.
WDEL (Wilmington, Del.).—Power, 250 night, 350 day; fy., 1,120 (267.9).
WENR (Chicago, Ill.).—Power, 25,000 normally, 50,000 experimentally.
WFBR (Baltimore, Md.).—Fy., 1,270 (236.2).
WHB (Kansas City, Mo.).—Power, 500 night, 1,000 day.
WHBU (Anderson, Ind.).—Power, 100.
WHDI (Minneapolis, Minn.).—Fy., 1,390 (215.8).
WHN (New York, N. Y.).—Owner, Marcus Loew Booking Agency.
WIBW (Topeka, Kans.).—Power, 1,000 night, 2,500 day.
WICC (Easton, Conn.).—Fy., 1,190 (252.1); daytime only.
WJBK (Ypsilanti, Mich.).—Power, 50.
WKBN (Youngstown, Ohio).—Power, 500.
WLBZ (Dover-Foxcroft, Me.).—Changed to Bangor, Me.; owner, Maine Broadcasting Co.; power, 250 night, 500 day; fy., 620 (483.6).
WLEX (Lexington, Mass.).—Power, 100 night, 250 day.
WMBD (Peoria Heights, Ill.).—Power, 500 night, 1,000 day.
WMBI (Addison, Ill.).—Owner, The Moody Bible Institute Radio Station.
WNBR (Memphis, Tenn.).—Power, 500.
WOS (Jefferson City, Mo.).—Power, 500 night, 1,000 day.
WRAX (Philadelphia, Pa).—Fy., 1,020 (294.1), daytime only.
WSAN (Allentown, Pa.).—Power, 250; fy., 1,440 (208.3).
WSAZ (Huntington, W. Va.).—Power, 250.

Strike out all particulars following the call signal WEAM (North Plainfield, N. J.).

SPECIAL STATIONS, BY NAMES OF STATIONS

[Alterations and corrections to be made to the List of Radio Stations of the United States, edition of June 30, 1928]

BOUND BROOK, N. J. (W3XL).—Fy., 2,850 (105.3) to 2,950 (101.7), 6,020 (49.83).
DENVER, COLO. (W9XA).—Fy., 9,530 (31.48); power, 750.
NEW YORK, N. Y. (portable) (W2XBS).—Fy., 2,000 (150) to 2,100 (142.9).
PORTLAND, OREG. (W7XAO).—Fy., 2,750 (109.1) to 2,850 (105.3).
SAN RAFAEL, CALIF. (W6XAC).—Fy., 1,604 (187.03), 1,704 (176.06), 3,214 (93.3), 4,324 (69.4), 8,650 (34.68), 17,300 (17.341), 34,240 (8.76); power, 1,000.
Strike out all particulars of Rocky Point, N. Y. (W2XR).
AIRCRAFT: Unnamed airplane (W8XA).—Fy., 2,506 (119.71), 4,188 (71.63).
COLONIAL AIR TRANSPORT PLANE No. NC-8000 (Hadley Field, N. J.) (W2XBJ).—Number changed to NC-8004.

RADIOBEACON STATIONS

[Alterations and corrections to be made to the list of Commercial and Government Radio Stations of the United States, edition of June 30, 1928, and to the International List of Radiotelegraph Stations published by the Berne bureau]

FIRE ISLAND LIGHTSHIP, N. Y.—Frequency changed to 305 (983.6).

MISCELLANEOUS

Vessels equipped with a radio compass

[Additions to the list of Commercial and Government Radio Stations of the United States, edition of June 30, 1928, and to the International List of Radiotelegraph Stations published by the Berne bureau]

Name	Call signal	Owner
Crocus		Government Department of Commerce, Bureau of Lighthouses.

REGULATIONS GOVERNING THE ISSUANCE OF RADIO OPERATORS' LICENSES

1. *Commercial extra first class.*—To be eligible for examination, an applicant for this class of license must have held a commercial first-class license and must have been actually engaged as an operator at stations open to public correspondence for at least 18 months during the 2 years previous to his application. A speed in transmission and reception of at least 30 words per minute, in code groups, Continental Morse Code, and 25 words per minute, in plain language, American Morse Code, 5 characters to the word, must be attained. The questions in this examination will cover the same subjects required for a commercial second-class license but considerably wider in scope. A total percentage of at least 80 will constitute a passing mark. Holders of licenses of this class are authorized to act as chief operator at any licensed radio station.

2. *Commercial first class.*—To be eligible for examination, an applicant for this class of license must have been actually engaged as an operator at stations open to public correspondence for at least 12 months. Applicants for this class of license must pass code tests in transmission and reception at a speed of at least 20 words per minute in Continental Morse Code, in code groups, and 25 words per minute in Continental Morse Code, in plain language (5 characters to the word). The practical and theoretical examination will cover the same subjects as required for the commercial second-class license. A total percentage of 75 will constitute a passing mark. Holders of this class of license are authorized to act as chief operator at any licensed radio station.

3. *Commercial second class.*—Applicants for this class of license must pass code tests in transmission and reception at a speed of at least 16 words per minute in Continental Morse Code, in code groups, and 20 words per minute in Continental Morse Code, in plain language (5 characters to the word). The practical and theoretical examination shall consist of comprehensive questions under the following headings:

(*a*) Diagram of radio installation: Applicants are required to draw a complete wiring diagram of a modern marine radio installation as used aboard American vessels. The applicant may be required to draw either a spark, arc, or vacuum tube transmitter (with radiotelephone attachment).

(*b*) General principles of electricity, theory, adjustment, operation, and care of modern radiotelegraph and radiotelephone apparatus.

(*c*) Receiving apparatus.

(*d*) Operation and care of storage batteries.

(*e*) Motors and generators.

(*f*) International regulations governing radio communication and the United States Radio Laws and Regulations.

(*g*) Experience: The applicant's answers will be rated on the basis of 100 per cent. In addition to the percentage thus obtained, an allowance for experience will be added as follows: Three months' or more satisfactory service at a station open to public correspondence under a commercial license, 10 per cent; two months' satisfactory service at a station open to public correspondence under a commercial license, 7.5 per cent; one month's satisfactory service at a station open to public correspondence under a commercial license, 5 per cent; service at United States Government stations open to public correspondence, same as above; service at other United States Government stations of three months or more duration, 5 per cent; less than three months, in proportion; graduates of residence radio schools, 5 per cent; amateur operators or graduates of correspondence radio schools, 2 per cent. Applicants must present satisfactory

written evidence of their experience in order to obtain due allowance. A total percentage of 65 will constitute a passing mark for this class of license.

This license is valid for the operation of any licensed land or aircraft radio station or on any vessel except as indicated in the following. Holders of this class of license are not authorized to act as chief operator on a vessel in the first class. They will be authorized to act as chief operator on a vessel in the second class upon submission of written evidence at any time during the term of the license indicating six months or more satisfactory service as an operator at a station open to public correspondence.

4. *Broadcast class.*—Applicants for this class of license must pass code tests in transmission and reception at a speed of at least 20 words per minute in Continental Morse Code, in code groups, and 25 words per minute in Continental Morse Code, in plain language (5 characters to the word). The theoretical examination will cover the same subjects as indicated for the commercial second-class license, except that under subject (*a*) the applicant is required to draw a diagram of a modern broadcast transmitter and under subject (*b*) the questions will relate strictly to broadcast apparatus. An allowance for service as an operator at a broadcast or other station will be made in accordance with the scale indicated under 3.—Commercial second class. Holders of this class of license are authorized to act as operator only at a licensed broadcast station.

5. *Radiotelephone class.*—No code test is required for this class of license. The practical and theoretical examination for this class of license shall consist of questions on adjustment and operation of radiotelephone apparatus and knowledge of international regulations governing radio communication and the United States Radio Laws and Regulations. The applicant must demonstrate his ability to transmit and receive clearly conversation by telephone apparatus. Whenever possible, a demonstration of the applicant's ability to operate radiotelephone apparatus will be required. A percentage of 75 will constitute a passing mark. Holders of this class of license are authorized to act as operator only at licensed radiotelephone stations of 300 watts or less imput power.

6. *Amateur extra first class.*—To be eligible for examination, an applicant for this class of license must have had at least two years, service as a licensed radio operator and must not have been penalized for violation of the radio laws. The applicant must pass code tests in transmission and reception at a speed of at least 16 words per minute in Continental Morse Code, in code groups, and 20 words per minute in Continental Morse Code, in plain language (5 characters to the word). An applicant must pass a special examination relating to amateur apparatus and international regulations and acts of Congress affecting amateur stations and operators. A percentage of 75 will constitute a passing mark. This license is valid for the operation of licensed amateur radio stations only.

7. *Amateur class.*—Applicants for this class of license must pass a code test in transmission and reception at a speed of at least 10 words per minute, in Continental Morse Code (5 characters to the word). An applicant must pass an examination which will develop knowledge of the adjustment and operation of the apparatus which he desires to use and of the international regulations and acts of Congress in so far as they relate to interference with other radio communications and impose duties on all classes of operators. A percentage of 70 will constitute a passing mark. This license is valid for the operation of licensed amateur radio stations only.

8. *Temporary amateur license.*—Amateurs who can not present themselves for examination may be issued temporary licenses valid for the operation of a particular station until such time as they can be examined for a regular license but not to exceed a period of one year. The applicant must submit a sworn statement attesting to his ability to transmit and receive at a speed of not less than 10 words per minute in Continental Morse Code.

9. *Renewals.*—(*a*) Commercial extra first class: These licenses may be renewed without examination provided the record shows 12 months' satisfactory service in a land or ship station open to general public service, at least 6 months of which must have been during the last 12 months of the license period. Holders of these licenses employed as radio inspectors, radio instructors or in similar occupations requiring exceptional qualifications where the duties require the testing, or demonstrating, or otherwise using commercial radio apparatus and the telegraph codes may be issued renewals of their licenses without examination, provided such employment has covered a period of 18 months out of the 2-year license period. Where the applicant has not regularly used the telegraph codes, he will be given the code examination as for an original license, and if he has used only one code, he will be examined in the code not used.

(*b*) Other renewals: Renewal licenses may be issued to operators of other classes without examination, provided the operator has had three months' satisfactory service during the last six months of the license term. One year satisfactory service out of two years of the license term may be accepted for renewal at the discretion of the examining officer.

(*c*) Holders of commercial first-class or commercial second-class radio operator licenses who have not had sufficient service at commercial stations to permit the unconditional renewal of such licenses, but indicate satisfactory service at broadcasting stations for the length of time necessary for renewal, and are unable to pass the required code test or to present themselves for a code test, may be issued restricted renewals of their existing licenses. The licenses so issued should bear across their face, preferably in red, the following restrictions: "This license not valid for the operation of any limited or general public stations."

Applicants holding restricted commercial operators' licenses, broadcast or radio-telephone operators' licenses may be issued renewals of such licenses provided the service records indicate three months' satisfactory service during the last six months of the license term. One year satisfactory service out of the two-year term of the license may be accepted at the discretion of the examining officer. Renewal commercial first class or commercial second class licenses so issued shall bear the indorsement, "This license not valid for the operation of any limited or general public station."

Holders of restricted licenses may have this restriction removed at any time during the term of this license by passing the code test required for the class of license held by them. This restriction will be removed by the supervisor of radio or examining officer by drawing lines through the restriction and adding on the license adjacent thereto the following: "Restriction removed," date and initials of the examining officer. The expiration date of the license will remain the same.

Applicants who have passed the regular commercial examination but who hold renewal commercial licenses indorsed, "This license is not valid for the operation of any limited or general public station," may be issued unconditional renewals of such licenses provided they have the required service as indicated above and pass the code test required by the regulations for the class of license held by them.

(*d*) Renewals or new licenses may be issued a reasonable length of time previous to the expiration of existing licenses but must bear the exact date of issue, which must correspond with the date on Form 756 forwarded to the radio division. Operators who fail to apply for renewal of their licenses on or prior to the date of expiration must be reexamined. If, because of circumstances over which the applicant has no control, an operator is unable to apply for renewal of license on or prior to the date of expiration, an affidavit may be submitted to the radio division through the supervisor of radio or examining officer, attesting to the facts, which will be considered by the radio division, which will advise the supervisor of radio or examining officer in regard to the issue of a renewal of the license without reexamination. Service records must be completed and signed only by masters, employers, or the duly authorized agents of either. Any improper alteration of the service record or the forgery of masters' or employers' signatures constitutes a violation of the regulations, and the operator may suffer suspension of license for a period not exceeding two years, at the discretion of the Secretary of Commerce.

10. *Duplicate licenses.*—Operators who have lost a valid operator's license may submit an affidavit to the radio division through the supervisor of radio or examining officer, attesting to the facts, which will be considered by the radio division which will advise the supervisor of radio or examining officer in regard to the issue of a duplicate of the lost license. Duplicate of licenses will bear the same date of issue and will expire on the same date as the original. If the original license is recovered, it must be forwarded to the radio division or one of its offices for cancellation and filing. Duplicates of amateur station licenses or of expired operator licenses will not be issued.

11. *Reexamination.*—No applicant who fails to qualify will be reexamined within three months from date of the previous examination. However, when an applicant for the commercial first-class license fails in the code examination he will be reexamined the same day for any other one class of license desired. Those who pass the code test successfully but fail to attain a total percentage of at least 75 but do attain a total percentage of at least 65 will be issued a commercial second-class license, if desired. Those who fail in the code examination for the broadcast-class license will be examined the same day for either the radiotelephone or amateur class license, if desired. An applicant for the broadcast-class license

who fails to attain a total percentage of at least 75 but does attain a percentage of at least 65 will be issued a radiotelephone-class license, if desired. All examination papers, except amateur, whether the applicant qualifies or not, will be forwarded to the Department of Commerce, radio division, for filing.

REGULATIONS GOVERNING THE RENEWAL OF COMMERCIAL OPERATORS' LICENSES EXPIRING AFTER JANUARY 1, 1929

Operators now holding commercial extra first-class licenses will be issued renewal licenses of the same class without examination, provided they have the required length of service.

Operators now holding commercial first-class licenses will be issued one of the new commercial first-class licenses without theoretical examination, provided they can show satisfactory service for a period of at least 12 months as an operator at stations open to public correspondence, have knowledge of the operation of radiotelephone apparatus, and can successfully pass code tests as required under the new regulations.

Operators now holding commercial first-class licenses who have had less than 12 months but more than 6 months' satisfactory service as operators at stations open to public correspondence will be issued commercial second-class licenses without examination, authorizing them to act as operator in any station, except as chief operator on vessels of the first class.

Operators now holding commercial first-class licenses, who have had less than six months' satisfactory service as an operator at stations open to public correspondence, will be issued a commercial second-class license without examination, authorizing holder to act as operator on any vessel except as chief operator on a vessel in the first or second class.

No renewals will be made of present commercial second-class licenses, and after January 1, 1929, licenses of this class still valid after that date will be valid only for the operation of broadcast, technical and training, experimental, limited commercial, or amateur stations. Holders of broadcast station operator licenses will be issued the new broadcast license provided they have the required service and pass the new code tests.

All present licenses will be valid for the term indicated, but at any time during the term of the old license an operator may make application for and be issued a new license provided he can meet the requirements therefor. In any event, if a new license is issued the old license must be canceled.

Effective January 1, 1930, holders of present commercial first-class licenses are not authorized to act as chief operators on vessels in the first class. If they desire to obtain such authority, they must meet the requirements and make application for one of the new licenses. The regulations and instructions requiring that a first-class operator be the chief operator on a first-class vessel applies only in the cases of vessels in the international service and not to vessels plying between ports of the United States.

CORRECTION TO THE LIST OF AMATEUR RADIO STATIONS OF THE UNITED STATES

Page 91 of the above-named list, edition June 30, 1928, should be changed to show that the first letter (prefix letter) of the call signals for the stations of the Territory of Porto Rico is "K" in lieu of "W."

REVISED UNITED STATES AMATEUR REGULATIONS

(Superseding those dated September 1, 1928)

An amateur station is a station operated by a person interested in radio technique solely with a personal aim and without pecuniary interest. Amateur licenses will not be issued to stations of other classes.

Amateur radio stations are authorized for communication only with similarly licensed stations, except as indicated below, and on wave lengths or frequencies within the following bands and at all times unless interference is caused with other radio services, in which event a silent period must be observed between the hours of 8 and 10.30 p. m., local time, and on Sundays during local church services.

Kilocycles	Meters	Kilocycles	Meters
401, 000 to 400, 000	0. 7481 to 0. 7500.	7, 300 to 7, 000	41. 10 to 42. 86.
60, 000 to 56, 000	5. 00 to 5. 36.	4, 000 to 3, 500	75. 0 to 85. 7.
30, 000 to 28, 000	10. 00 to 10. 71.	2, 000 to 1, 715	150. 0 to 175. 0.
14, 400 to 14, 000	20. 83 to 21. 43.		

Amateur radiotelephone operation will be permitted only in the following bands:

Kilocycles	Meters
60, 000 to 56, 000	5. 00 to 5. 36
3, 550 to 3, 500	84. 50 to 85. 70
2, 000 to 1, 715	150. 00 to 175. 00

Amateur television and operation of picture transmission apparatus will be permitted only in the following bands:

Kilocycles	Meters
60, 000 to 56, 000	5. 00 to 5. 36
2, 000 to 1, 715	150. 00 to 175. 00

Spark transmitters will not be authorized for amateur use.

Amateur stations must use circuits loosely coupled to the radiating system or devices that will produce equivalent effects to minimize key impacts, harmonics, and plate supply modulations. Conductive coupling, even though loose, will not be permitted, but this restriction shall not apply against the employment of transmission line feeder systems to Hertzian antennæ.

Amateur stations are not permitted to communicate with commercial or Government stations unless authorized by the licensing authority except in an emergency or for testing purposes. This restriction does not apply to communication with small pleasure craft, such as yachts and motor boats holding limited commercial station licenses which may have difficulty in establishing communication with commercial or Government stations.

Amateur stations are not authorized to broadcast news, music, lectures, sermons, or any form of entertainment, or to conduct any form of commercial correspondence.

No person shall operate an amateur station except under and in accordance with an operator's license issued to him by the Secretary of Commerce.

GENERAL ORDERS OF THE FEDERAL RADIO COMMISSION

Extension of coastal, point to point, experimental, and ship station licenses until January 31, 1929 (General Order No. 54, December 22, 1928).—It is ordered that all existing licenses covering coastal, point to point, experimental, and ship radio transmitting stations, heretofore extended by the commission's General Orders 1, 3, 26, 39, and 47, be, and the same are hereby, further extended for a period of 31 days to terminate at 3 o'clock a. m., eastern standard time, January 31, 1929. This order, however, is subject to the conditions that it shall not be deemed or construed as a finding or decision by the commission, or as any evidence whatsoever, that the continued use or operation of any of said stations serves, or will serve, public interest, convenience, or necessity, or that public interest, convenience, or necessity would be served by the granting of any pending application for a renewal of any of said licenses; and any licensee subject to this order who continues to use or operate his station during the period covered by this order shall be deemed to have consented to said conditions. The commission reserves the right to change the frequency assignment of any station, the license of which is affected by this order, during the extension herein provided if, in the opinion of the commission, such changes are advisable.

This order is only subject to the following exception: It shall not apply to any licenses heretofore issued by this commission (as distinguished from licenses issued by the Department of Commerce prior to the establishment of the com-

mission under the radio act of 1927, approved on February 23, 1927), all licenses in such cases to be governed by the terms and conditions of their respective licenses from the commission.

Allocation of frequencies between 1,500 and 6,000 kilocycles (General Order No. 55, December 22, 1928).—The commission, in order to carry out the provisions of the radio act of 1927, having determined that public interest, convenience, or necessity requires the allocation of certain frequencies, within the band of frequencies between 1,500 and 6,000 kilocycles, to those services and classes of stations hereinafter enumerated, hereby enters the following order. It is ordered:

PARAGRAPH I. That of those frequencies between 1,500 and 6,000 kilocycles, the following are hereby allocated to those services and classes of stations enumerated herein, for assignment to individual stations in conformity with this order.

(*a*) *Mobile services*

1. Ship stations and coastal stations: The frequencies 1,504, 1,508, 1,512, 1,516, 1,520, 1,524, 1,528, 1,532, 1,536, 1,540, 1,544, 1,548, 1,552, 1,556, 1,560, 1,564, 1,568, 1,572, 1,576, 1,580, 1,584, 1,588, 1,592, 1,596, 1,660, 1,672, 1,684, 1,708, 2,320, 2,332, 2,350, 2,368, 2,380, 2,416, 2,428, 2,446, 2,452, 2,476, 2,482, 2,554, 2,566, 2,584, 2,596, 2,614, 2,626, 2,632, 2,638, 2,644, 2,668, 2,692, 2,728, 2,740, 3,076, 3,106, 3,118, 3,130, 3,142, 3,420, 3,428, 3,436, 4,116, 4,148, 4,172, 4,188, 4,196, 4,755, 4,775, 5,525, 5,555, 5,585, 5,615, 5,645, 5,675.

2. Aircraft and aeronautical stations: The frequencies, 1,608, 1,612, 1,616, 1,620, 1,624, 1,628, 1,632, 1,636, 1,640, 1,644, 1,648, 1,656, 1,668, 1,676, 1,688, 2,302, 2,326, 2,344, 2,362, 2,374, 2,392, 2,506, 2,518, 2,524, 2,530, 2,536, 2,542, 2,560, 2,578, 2,590, 2,608, 2,620, 2,650, 2,662, 2,680, 2,698, 2,722, 2,734, 3,070, 3,082, 3,100, 3,112, 3,124, 3,136, 3,148, 3,452, 3,460, 3,468, 3,484, 3,492, 4,108, 4,124, 4,140, 4,164, 4,180, 4,765, 4,785, 5,510, 5,540, 5,570, 5,600, 5,630, 5,660, 5,690.

3. Portable stations: The frequencies 1,600, 1,652, 1,664, 1,680, 1,704, 1,712.

4. Railroad rolling stock stations and railroad harbor and tug stations: The frequencies 2,410, 2,422, 2,440, 2,458, 2,470.

(*b*) *Fixed services*

1. Point to point: The frequencies 3,202, 3,208, 3,214, 3,220, 3,226, 3,238, 3,244, 3,250, 4,212, 4,220, 4,228, 4,244, 4,268, 4,276, 4,284, 4,396, 4,405, 4,415, 4,455, 4,465, 4,475, 4,485, 4,495, 4,505, 4,515, 4,535, 4,545, 4,865, 4,875, 4,885, 4,895, 4,905, 5,115, 5,125, 5,135, 5,145, 5,155, 5,165, 5,175, 5,185, 5,195, 5,205, 5,215, 5,225, 5,235, 5,245, 5,255, 5,265, 5,275, 5,285, 5,295, 5,305, 5,405, 5,415, 5,425, 5,435, 5,445, 5,455, 5,465, 5,475, 5,485, 5,720, 5,735, 5,750, 5,765, 5,780, 5,795, 5,900, 5,975, 5,990.

2. Amateur: The band of frequencies between 1,715 and 2,000 kilocycles, inclusive, and that band of frequencies between 3,500 and 4,000 kilocycles, inclusive.

3. Experimental visual broadcasting: The frequencies 2,002 to 2,300, inclusive, and 2,750 to 2,950, inclusive.

4. Experimental: The frequencies 1,604, 2,398, 3,088, 4,795.

The following frequencies allocated to fixed services, point to point stations, are to be assigned exclusively to stations devoted to promoting the interests of agriculture in addition to such assignments as may hereafter be made above 6,000 kilocycles: Frequencies 3,202, 4,244, 5,485.

The following frequencies are reserved for assignment to stations rendering emergency services: Frequencies 3,208, 3,214, 3,220, 3,226, 3,238, 3,244, 3,250.

PAR. II. No license shall be granted to any applicant for a fixed station, coastal station, or aeronautical station who is unable to satisfy the commission that he can maintain the assigned station frequency with an accuracy of 0.05 per cent or better at all time.

PAR. III. Licensees of fixed, coastal, or aeronautical stations shall obtain and use for tuning and checking the tuning of their transmitters suitable frequency-measuring equipment which shall be accurate within 0.025 per cent on the frequencies on which the transmitter is licensed to operate. Furthermore, such licensees shall, at frequent intervals, take steps to have the frequency-measuring instruments calibrated or compared with the standards made available by the Department of Commerce.

PAR. IV. Licensees must use radiotransmitters, the emissions of which, by reason of actual decrement high-speed signaling modulation, spacing waves,

harmonics, frequency modulation, key clicks, and mush do not cause interference detrimental to traffic and programs being carried out on other authorized channels of communications.

ILE D'YEU LIGHTHOUSE (FRANCE) RADIOBEACON CHANGED

The signals are now transmitted during fog, commencing at the tenth, twentieth, thirtieth, fortieth, fiftieth, and sixtieth minutes of each hour. They consist of five successive repetitions of the following group:

— • — — — • — — — • — — (10 seconds)	— — — (30 seconds)
— • — — — • — — — • — — (10 seconds)	Silent (10 seconds)

Total duration of group, 1 minute; frequency, 292.5 (1,025); type of wave, A2.

STUBBENKAMMER (GERMANY) RADIOBEACON CHANGED

The signals now consist of the transmission of the letters SRSR (. . . . — . . . . — .), followed by thirteen 1-second dashes (— — — — — etc.) every 30 seconds, thus:

. . . — . — . . . — . (9 seconds)	Silent (1.3 seconds)
— — — — — — — — — — — — — (16.6 seconds (0.3 second interval between each dash))	Silent (3.1 seconds)

CAPE VILLANO (SPAIN) RADIOBEACON CHANGED

The signals are now transmitted every five minutes, as follows:

. . . — . . . — . . . — etc. (47 seconds)	— — — — (10 seconds)	. . . — (3 seconds)	Silent (4 minutes)

CAPE FINISTERRE (SPAIN) RADIOBEACON CHANGED

The signals are now transmitted every five minutes, as follows:

. . — . . . — . . . — . etc. (47 seconds)	— — — — (10 seconds)	. . . — . (3 seconds)	Silent (4 minutes)

RADIOBEACON ESTABLISHED AT PORTLAND (DYRHOLAEY), ICELAND

A radiobeacon has been established at the lighthouse in approximately latitude 63° 24′ N., longitude 19° 09′ W. The signals are transmitted on a frequency of 300 kilocycles (1,000 meters), as follows:

— . . — — . . — — . . (12 sec.)	Silent (2½ sec.)
25 dashes (— — — — — &c.) of 1 sec. duration, with ¼ sec. intervals. (31 sec.)	Silent (2½ sec.)
— . . — — . . — — . . (12 sec.)	Total duration: 1 min.

The whole character of the signal consists of the above group transmitted nine times in 10 minutes, with silent intervals of 7½ seconds between each group.

During thick or foggy weather the whole character of the signal, occupying 10 minutes, will be transmitted three times every hour (commencing at 00, 20, and 40 minutes past each hour).

During clear weather the whole character of the signal will be transmitted once every hour (during the first 10 minutes of the hour).

BAR LIGHT VESSEL (ENGLAND) RADIOBEACON CHANGED; SUBMARINE OSCILLATOR ESTABLISHED

The radiobeacon of this light vessel located in Liverpool Bay in approximately latitude 53° 32′ N., longitude 3° 20′ W., has been changed as follows:

Frequency.—300 kilocycles (1,000 meters).

Details.—During thick or foggy weather the following signals will be transmitted continuously:—

(*a*) The call signal GGM (— — . — — . — —), at the rate of 15 words per minute, repeated for approximately 50 seconds.

(*b*) A long dash (————) of approximately 10 seconds' duration.

(*c*) The letters GGM made once. (The whole transmission of (*a*), (*b*), and (*c*) to take exactly 60 seconds.)

(*d*) A silent interval of 15 seconds.

(*e*) The characteristic emission of the synchronous signal; that is, the letters GGM made twice.

(*f*) A "warning signal" consisting of a dash of 1½ seconds (the whole transmission of (*e*) and (*f*) to occupy approximately 8 seconds).

(*g*) A silent interval of 112 seconds.

(*h*) Repetition of (*e*) and (*f*).

(*i*) A silent interval of approximately 37 seconds, followed by a repetition of (*a*), (*b*), (*c*), etc., and so on, continuously.

During clear weather the letters GGM will be transmitted for one minute, at 0, 4, 8, 28, 32, and 36 minutes past each clock hour, as at present.

A description of the submarine oscillator is as follows: Sounds a group of notes corresponding to the letters GGM, occupying 10 seconds, once every minute. To enable vessels to determine their distance from the light vessel by measuring the difference in time of the reception of the submarine and radiobeacon signals, the commencement of alternate submarine signals will be coincident with the termination of the "warning signal" (see (*f*) of radiobeacon). The present submarine bell will be discontinued when the oscillator is established.

RADIOBEACON ESTABLISHED ON KIEL LIGHT VESSEL, GERMANY; SUBMARINE OSCILLATOR AND NAUTOPHONE CHANGED

The radiobeacon established on this light vessel located at Kieler Forde, Baltic Sea, operates on a frequency of 286 kilocycles, 1,050 meters. The characteristic of the signals is as follows: Sounds the letters KI KI (— . — . . — . — . .) for 9 seconds, silent 1.3 seconds, followed by 13 dashes, each of 1 second's duration and separated by silent intervals of 0.3 of a second each. After the thirteenth second there is a silent period of 3.1 seconds; total, 30 seconds. The complete signal will be transmitted seven times in 3.5 minutes, followed by a silent period of 4 minutes. This group of seven signals will be sent six times an hour, from 15m and 00s to 56m and 00s.

The submarine oscillator will be changed to sound the letters KI (— . — . .); the period and phases to be the same as those of the nautophone described hereunder.

The submarine signal commences simultaneously with the end of the second dot of the second letter "I" of the radio signal, and by noting in the receivers on board ship the coincidence of the first sound of the submarine signal and one of the dashes (of the series of 13 dashes) of the radio signal, the distance of a vessel from the light vessel can be determined, each dash representing a distance of one mile. Thus, if the tenth dash of the radio signal coincides with the first sound of the submarine signal, the distance from the light vessel is 10 miles.

The nautophone will be changed to sound the letters KI (— . — . .) every 30 seconds, blast 1.8 seconds, silent 0.6 second, blast 0.6 second, silent 0.6 second, blast 1.8 seconds, silent 1.8 seconds, blast 0.6 second, silent 0.6 second, blast 0.6 second, silent, 21 seconds.

IMPORTANT EVENTS IN RADIO—PEAKS IN THE WAVES OF WIRELESS PROGRESS—1827 TO 1928

1827. Savary found that a steel needle could be magnetized by the discharge from a Leyden jar.

1831. Farady discovered electromagnetic induction between two entirely separate circuits.

1837. The first patent for an electric telegraph was taken out by Cooke and Wheatstone (London) and by Morse (United States).

1838. Steinheil discovered the use of the earth return.

1840. Henry first produced high-frequency electric oscillations and pointed out that the discharge of a condenser is oscillatory.

1842. Morse made wireless experiments by electric conduction through water.

1843. Lindsay suggested that if it were possible to provide stations not more than 20 miles apart all the way across the Atlantic there would be no need of laying a cable.

1845. Lindsay made experiments in transmitting messages across the River Tay by means of electricity or magnetism without submerging wires, using the water as a conductor.

1849. Wilkins revived the same suggestions for wireless telegraphy.

Doctor O'Shaughnessy succeeded in passing intelligible signals without metallic conduction across a river 4,200 feet wide.

1862. Heyworth patented a method of conveying electric signals without the intervention of any continuous artificial conductor.

1867. Maxwell read a paper before the Royal Society in which he laid down the theory of electromagnetism, which he developed more fully in 1873 in his great treatise on electricity and magnetism. He predicted the existence of the electric waves that are now used in wireless telegraphy.

1870. Von Bezold discovered that oscillations set up by a condenser discharge in a conductor give rise to interference phenomena.

1872. Highton made various experiments across the River Thames with Morse's method.

1879. Hughes discovered the phenomena on which depend the action of coherer. The coherer was later used practically by Marconi.

1880. Trowbridge found that signaling might be carried on over considerable distances by electric conduction through the earth or water between places not metallically connected.

1882. Bell's experiments with Trowbridge method on the Potomac River resulted in the detection of signals at a distance of 1½ miles.

Professor Dolbear was awarded a United States patent in March, 1882, for wireless apparatus in connection with which he made the statement that "electrical communication, using this apparatus, might be established between points certainly more than one-half mile apart, but how much farther I can not say." It appeared that Professor Dolbear made an approach to the method that was, subsequently in the hands of Marconi, to be crowned with success.

1883. Fitzgerald suggested a method of producing electromagnetic waves in space by the discharge of a conductor.

1885. Edison, assisted by Gillilaud, Phelps, and Smith, worked out a system of communication between railway stations and moving trains by means of induction and without the use of conducting wires. Edison took out only one patent on long-distance telegraphy without wires. The application was filed May 23, 1885, at the time he was working on induction telegraphy, but the patent (No. 465971) was not issued until December 29, 1891. In 1903 it was purchased from him by the Marconi Wireless Telegraph Co.

Preece made experiments at Newcastle-on-Tyne which showed that in two completely insulated circuits of square form, each side being 440 yards, placed a quarter of a mile apart, telephonic speech was conveyed from one to the other by induction.

1886. Dolbear patented a plan for establishing wireless communication by means of two insulated elevated plates, but there is no evidence that the method proposed by him did, or could, effect the transmission of signals between stations separated by any distance.

1887. Hertz showed that electromagnetic waves are in complete accordance with the waves of light and heat, and founded the theory upon which all modern radio signaling devices are based.

Heaviside established communication by telephonic speech between the surface of the earth and the subterranean galleries of the Broomhill Collieries, 350 feet deep, by laying above and below ground two complete metallic circuits, each about 2¼ miles in length, and parallel to each other.

1889. Thompson suggested that electric waves were particularly suitable for the transmission of signals through fogs and material objects.

1891. Trowbridge suggested that by means of magnetic induction between two separate and completely insulated circuits communication could be effected between distances.

1892. Preece adopted a method which united both conduction and induction as the means of affecting one circuit by the current in another. In this way he established communication between two points on the Bristol Channel and at Lochness in Scotland.

Stevenson, of the Northern Lighthouse Board, Edinburgh, advocated the use of an inductive system for communication between the mainland and isolated lighthouses.

Branly devised an appliance for detecting electromagnetic waves, which was known as a coherer.

1894. Rathenau experimented with a conductive system of wireless telegraphy and signaled through 3 miles of water.

1895. Smith established communication by conduction with the lighthouse on the Fastnet.

Marconi's investigations led him to the conclusion that Hertzian waves could be used for telegraphing without wires.

1896. Marconi lodged his application for the first British patent for wireless telegraphy. He conducted experiments in communicating over a distance of 1¾ miles successfully.

The first demonstartion of directional wireless using reflectors was given in England. Experiments were conducted to determine the relative speed of propagation of light waves and the electric vibrations which actuated a receiver at a distance of 1½ miles between reflectors.

1897. March: Marconi demonstated communication being established over a distance of 4 miles.

March 17: Balloons were first used for the suspension of wireless aerials.

July 10–18: Marconi maintained communication between the shore and a ship at sea distances up to 10 miles.

September and October: Apparatus was erected at Bath, England, and signals received from Salisbury, 34 miles distant.

November 1: First Marconi station erected at the Needles, Alum Bay, Isle of Wight. Experiments were conducted covering a range of 14½ miles.

December 6: Signals transmitted from shore to a ship at sea, 18 miles distant.

December 7: First floating wireless station was completed.

1898. June 3: The first paid radiogram was transmitted from the Needles (Isle of Wight) station.

July 20–22: Events of the Kingstown regatta in Dublin reported by wireless for Dublin newspaper from steamer *Flying Huntress*.

1899. April 22: The first French gunboat was fitted with wireless telegraph apparatus at Boulogne.

The American battleships *New York* and *Porter* were equipped with radio apparatus.

July: During the naval maneuvers three British warships equipped with Marconi apparatus interchanged messages at distances up to 74 nautical miles (about 85 land miles).

The international yacht races which took place in September and October were reported by wireless telegraphy for the New York Herald. At the conclusion of the races series of trials were made between the United States cruiser *New York* and the battleship *Massachusetts*, signals being exchanged between the vessels at distances up to 36 miles. On the return journey from America Marconi fitted the steamship *St. Paul* with his apparatus, and on November 15 established communication with the Needles station when 36 miles away. Reports of the progress of the war in South Africa were telegraphed to the vessel and published in a leaflet entitled "The Transatlantic Times," printed on board.

1900. February 18: The first German commercial wireless station was opened on Borkum Island.

February 28: The first German liner fitted with wireless apparatus communicated with Borkum Island over a range of 60 miles.

November 2: The first wireless land station in Belgium was finished at Lapanne. Between 1900 and 1905 Doctor De Forest was granted numerous patents in the United States and other countries for inventions connected with wireless telegraphy.

1901. January 1: The bark *Medora* was reported by wireless as waterlogged on Ratel Bank. Assistance was immediately sent.

January 19: The *Princesse Clementine* ran ashore, and news of the accident was telegraphed to Ostend by wireless.

February 11: Communication was established between Niton Station, Isle of Wight, and the Lizard station, a distance of 196 miles.

March 1: A public wireless telegraph service was inaugurated between the five principal islands of the Hawaiian group, viz, Oahu, Kauai, Molaki. Maui, and Hawaii.

October 15: The first fan aerials were erected for experiments between Poldhu and Newfoundland.

December 12: The letter "S" was received by Marconi from Poldhu, England, at St. Johns, Newfoundland, a distance of 1,800 miles.

Prof. R. A. Fessenden applied for United States patent on September 28 for "Improvements in apparatus for the wireless transmission of electromagnetic wave, said improvements relating more especially to the transmission and reproduction of words or other audible signals." It appears that in connection with this apparatus there was contemplated the use of an alternating-current generator having a frequency of 50,000 cycles per second. Professor Fessenden was granted a number of United States patents between 1890 and 1905 covering devices used in connection with radiotelegraphy.

1901–1904. During this period Dr. John Stone was granted more than 70 United States patents covering radiotelegraphy.

1901–1905. More than 40 United States patents were granted to Harry Shoemaker covering certain apparatus used for radio communication.

1902. February: Steamship *Philadelphia*, American Line, received messages a distance of 1,551½ statute miles and received Morse signals up to a distance of 2,099 statute miles from Poldhu station, Cornwall, England.

June 25: The first moving wire magnetic detector actuated by clockwork was installed on the Italian cruiser *Carlo Alberto*.

July 14–16: Marconi received messages from Poldhu on the Italian cruiser *Carlo Alberto*, lying at Cape Skagen, a distance of 800 miles; and at Kronstadt, 1,600 miles.

December: On the 17th the first wireless message was transmitted across the Atlantic. On the 18th wireless messages were dispatched from Cape Breton station to King Edward VII.

1903. January 19: President Roosevelt sent a trans-Atlantic radiogram to King Edward via Cape Cod and Poldhu stations.

March 30: First transoceanic radiogram was published in the London Times.

August 4: First International Radiotelegraphic Conference was held at Berlin.

Poulsen patented the improved arc oscillation generator, using a hydrocarbon atmosphere and a magnetic field.

1904. January 20: The first press message was transmitted across the Atlantic.

August 15: The wireless telegraph act of Great Britain was passed.

November 16: Dr. J. Ambrose Fleming took out his original patent No. 24850 for thermionic valves.

1905. In October of this year erection of Clifden, Ireland, high-power radio station was commenced.

1906. Doctor De Forest was granted a patent on January 18 for a vacuum rectifier, commercially known as the audion.

Second International Radiotelegraphic Convention was held at Berlin, and a convention was signed by a majority of the principal countries of the world.

Dunwoody discovered the rectifying properties of carborundum crystals and Pickard discovered the similar properties of silicon crystals. These discoveries formed the basis of the widely used crystal detectors.

1907. October 17: Trans-Atlantic stations at Clifden and Glace Bay were opened for limited public service.

Tests of radio apparatus, including radiotelephone, were carried out through the use of facilities of the United States Navy, the first shipboard radiotelephony tests being conducted in 1907 and 1908 during a world cruise.

1908. February 3: Trans-Atlantic radio stations were opened to the general public for the transmission of messages between the United Kingdom and the principal towns in Canada.

In carrying out his invention Professor Fessenden constructed a high-frequency alternator with an output of 2.5 kilowatts at 225 volts and with a frequency of 70,000 cycles per second. Later Professor Fessenden reported successful wireless telephonic communication between his station located at Brant Rock, Mass., and Washington, D. C., a distance of about 600 miles.

During 1908 to 1911 the United States Navy built the first substantial high-power radio traffic station at Arlington, Va.

1909. The steamship *Republic*, after colliding with the steamship *Florida* off the coast of the United States on January 23, succeeded in calling assistance by

wireless, with the result that all her passengers and crew were saved before the vessel sank.

1910. The steamship *Principessa Mafalda* received messages from Clifden at a distance of 4,000 miles by day and 6,735 miles by night. On April 23 the Marconi trans-Atlantic (Europe-America) service was opened.

June 24: Act approved by the United States Government requiring radio equipment and operators on certain passenger-carrying vessels.

1911. July 1: Radio service organized in Department of Commerce and Labor to enforce the act of June 24, 1910.

1912. F. A. Kolster, of the Bureau of Standards, invented and developed the Kolster decremeter, which is used to make direct measurements of wave length and logarithmic decrement. This instrument has been used by the radio service of the Department of Commerce since it was invented.

Early in the year the American Marconi Co., absorbed the United Wireless Co., of the United States.

In February the Marconi Co. procured the patents of Bellini and Tosi, including those for the wireless direction finder.

On February 9 the Australian Commonwealth station was opened.

On April 15 the steamship *Titanic*, on her maiden voyage, struck an iceberg and sank, but owing to the prompt wireless call for assistance the lives of more than 700 of her passengers were saved.

The International Radiotelegraphic Conference opened in London on June 4 and approved important regulations to have uniformity of practice in wireless telegraph services. On July 5 the International Radiotelegraphic Convention was signed at London.

July 23: Act approved by the United States Government extending act of June 24, 1910, to cover cargo vessels and requiring auxiliary source of power, efficient communication between the radio room and the bridge, and two or more skilled radio operators in charge of the appratus on certain passenger-carrying vessels.

August 13: Act approved by the United States Government licensing radio operators and transmitting stations.

1913. F. A. Kolster submitted to the Government a paper pointing out the advantages of certain applications of radio signaling for use at lighthouses, lightships, and life-saving stations, especially in time of fog.

During this year the Governments of France and the United States experimented between the Eiffel Tower station and Washington by wireless to procure data for comparing the velocity of electromagnetic waves with that of light.

In June a wireless telegraph bill was presented to the Ottawa Parliament and passed under the title "Radiotelegraph act of Canada."

On October 11 the *Volturno* was burned in mid-Atlantic, and in response to the wireless appeal 10 vessels came to the rescue, 521 lives being saved.

November 12: Safety at Sea Conference held in London. At this conference the use of radio received appropriate consideration.

On November 24 the first practical trials with wireless apparatus on trains were made on a train belonging to the Delaware, Lackawanna & Western Railroad.

The station at Macquerie Island was the means of keeping Doctor Mauson, the Australian explorer, in touch with the outer world. Radio dispatches were published in a small journal which was established, called the Adelle Blizzard.

November 24. The first practical trials with wireless apparatus on trains were made, messages having been received and transmitted on board trains.

1914. Experiments in wireless telephony were carried out between several vessels lying at anchor five-eighths of a mile apart, ordinary receivers being used with success. The wireless-telephone experiments were continued between two warships on the high seas, and the reception was consistently good over a distance of 18½ miles. Successful wireless-telephone communications were effected later, using only very limited energy, between vessels on the high seas 44 miles apart. These experiments were repeated where land intervened between the communicating vessels, and in this case again excellent results were obtained. On this day radiotelephonic communication was constantly maintained for 12 hours.

On April 15, at Godalming, a memorial was unveiled to the memory of Jack Philips, chief radio operator of the ill-fated *Titanic*, who died at his post when the vessel foundered in mid-Atlantic on the 15th of April, 1912.

A new departure in the application of radiotelegraphy to the safety of life at sea was the equipment of the motor lifeboats of the steamship *Aquitania* with radio apparatus.

High-powered transoceanic stations were completed at Carnarvon, Wales, Belman, Honolulu, and San Francisco during the autumn of 1914. The Hono-

lulu-San Francisco stations were opened to public service September 24. The Tuckerton-Eilvese and Sayville-Nauen stations were in operation about this time.

Most of these stations made use of the latest developments in the art, using undamped and long waves as produced by the Poulsen arc and the radio-frequency alternator.

On October 6 E. H. Armstrong was issued a patent covering the regenerative circuit also known as the feed-back and the self-heterodyne circuit.

During 1914 and 1915 the United States Navy duplexed its principal shore stations in order that these stations could communicate with ships and with each other simultaneously.

1915. During this year F. A. Kolster, of the Bureau of Standards, developed a radio compass said to be more effective than that which was being used.

On February 20 the Panama-Pacific Exhibition at San Francisco was officially opened by President Wilson at Washington, through the medium of wireless telegraphy.

On May 12, in Battery Park, New York City, the mayor unveiled the monument in memory of wireless operators who had lost their lives at the post of duty.

On July 27 wireless communication between the United States and Japan was effected. Two terminal stations were located at San Francisco and Funabashi, near Tokyo, and the messages were relayed through Honolulu.

On July 28 the American Telephone & Telegraph Co., working in conjunction with the Western Electric Co., succeeded in telephoning the wireless across the American Continent from Arlington to Hawaii, a distance of nearly 5,000 miles.

On October 26 the wireless telephone experiments were continued, communication being effected across the Atlantic from Arlington to the Eiffel Tower, Paris.

During this year ship service was greatly improved through the installation of new equipment, embodying features of great practical value, by various operating companies. Efficient emergency radio transmitters came into wider use, owing considerably to the efforts of the radio service of the Department of Commerce and its refusal to pass inefficient equipment. Such installations, considered as essential, are safeguards to shippers and the seagoing public.

1916. During the course of a severe blizzard in the United States during February wireless telegraphy was extensively used for train dispatching as the telegraph wires were down.

The determination of the difference in longitude between Paris and Washington with the aid of radio which had been in progress since October, 1913, was completed during May, the result, expressed in terms of time, being 5 hours 17 minutes 35.67 seconds, and has a probable accuracy of the order of 0.01 second.

The initiation of the newly established trans-Pacific wireless service between the United States and Japan was celebrated on November 5 by an interchange of messages between the Mikado and President Wilson.

During the year the United States Navy installed 16 radio compass sets on battleships.

1917. June 2 marked the "coming of age" of wireless telegraphy in England; that is, that 21 years had elapsed since the registration of patent 12039 in 1896.

1918. The trend of progress toward continuous-wave communication as distinct from that by damped waves was very marked during this year, a particular impetus being given by the continued development of the electron tube as an efficient receiver and generator of undamped oscillations. Steady improvement was also evident in the arc form of generator which was installed in many new high-power stations.

Wireless telephony also progressed to a marked extent, particularly in the direction of reliability and increase of range, due mainly to the development of valve generators and receivers.

In the equipment of aircraft with wireless great progress was made, both in radiotelegraphy and radiotelephony.

In April a high-power station was opened at Stavanger, Norway, for the use of the Norwegian Government. The station communicates with the United States.

In the Argentine the erection of a station destined for direct communication with the North American continent was commenced in the vicinity of Buenos Aires.

The extension in the application of wireless telegraphy to merchant vessels continued, and at the close of the year some 2,500 to 3,000 vessels of the British Merchant Marine carried installations.

On July 31 the United States Government took over all wireless land stations in the United States, with the exception of certain high-power stations, which remained under the control of commercial companies.

On September 22 messages transmitted from Carnarvon were received in Sydney, 12,000 miles away. Cable confirmations of these messages were sent forward at the same time, but were received some hours later than the corresponding radiotelegrams.

At the end of the year a high-power station, erected by the United States Government, was opened at Croix d'Hins, near Bordeaux.

1919. The successful trans-Atlantic flights of Alcock and Brown, of the American *NC4*, and of the British dirigible *R34* during the summer of the year focused attention upon the application of radio for aviation purposes and its great value for aerial navigation.

In February a Spanish decree was issued to the effect that all sailing vessels of 500 tons or over and carrying 50 or more passengers must be equipped with wireless apparatus.

On June 30, 1919, there were 2,312 ship stations of the United States, having increased from 1,478 on June 30, 1918. At this time new ship stations were increasing at the rate of 100 a month. This increase was due to the great number of vessels built during the war period.

The temporary war measures relative to the installation of wireless telegraph apparatus on all merchant vessels of 1,600 tons or over under the British flag was made permanent by a bill passed by the British Parliament.

During the year the Radio Corporation took over the radio interests of the American Marconi Co.

The war-time ban on private and experimental wireless stations was removed.

1920. The steady development of continuous-wave wireless work was continued during the year and some further progress made in the commercial application of tube apparatus.

On January 14 a law was passed in Greece making the carrying of wireless apparatus obligatory on all Greek merchant ships of 1,600 tons gross and over, or having 50 or more persons aboard, including crew.

On January 25 a new high-power station was opened at Monte Grande, Argentina, call letters LPZ.

Amateur radio work in this and other countries progressed steadily during the year with the gradual removal of war-time restrictions.

Bordeaux, France, high-power station opened.

1921. Experiments were carried out in France with successful results in the application of Baudot and similar high-speed telegraph apparatus to radio work.

The progress made in amateur and experimental wireless is exemplified by the attempts made in February and December of this year to effect communication on short-wave lengths between the wireless amateurs of the United States and Great Britain. The first attempt was unsuccessful, but during the second test signals from many American amateur stations were heard both by British radio amateurs and by the representative of the American Radio Relay League who was sent over for the tests. The signals were also heard in Holland.

The American Radio Relay League held its first annual convention in Chicago, August 30–September 3, at which many thousands of amateurs of the United States were present.

The first licenses for broadcasting stations were issued in September of this year.

New York radio central station opened on Long Island.

1922. During this year broadcasting stations increased rapidly in keeping with the great interest taken in the art.

First Annual Radio Conference held in Washington, D. C., February 27.

On June 7 E. H. Armstrong read a paper before the Institute of Radio Engineers on some recent developments by him of regenerative circuits. Professor Armstrong was granted a patent for the superregenerative circuit.

Experiments in radiotelephony from ship to shore were conducted during this year. In tests from the steamship *America* it was proved possible to communicate with land telephone stations more than 400 miles distant from the ship.

1923. On March 2 L. A. Hazeltine, of Stevens Institute of Technology, presented a paper before the Radio Club of America on tuned radiofrequency amplification with neutralization of capacity coupling. Professor Hazeltine was granted a patent for the nonradiating neutrodyne receiver.

On March 4 the Cleveland, Ohio (KDPM), station of the Westinghouse Electric & Manufacturing Co., successfully repeated short waves from the East Pittsburgh, Pa. (KDKA), station for the first time in history.

Second Annual Radio Conference held in Washington, D. C., March 20.

The Marconi Co. made a tender, which was accepted, for the erection of a transmitting station in Australia of a power of 1,000 kilowatts with 20 steel masts, 800 feet high. Corresponding stations were to be provided in England and Canada. The receiving arrangements would permit simultaneous reception from five stations.

The construction of a large radio station in a valley between the Herzogstand and the Stein, two of the foothills in the Bavarian Alps, was undertaken. The aerial will be suspended by wire cables stretched between the tops of the two hills, the aerial wires being suspended from these cables.

The increase in traffic on some of the large liners of the Atlantic route led to the installation of apparatus for high-speed automatic transmission and reception on several lines.

Successful tests on wireless-controlled airplanes were carried out at the Etampes Aerodrome in France. Flights were made without a pilot. Flights were also made with a pilot using a gyroscopic stabilizer and special steering motors which could be controlled from the ground.

The International Commission for Aerial Navigation agreed, as a general principle, that all aircraft engaged in public transport must carry radio apparatus.

The General Electric Co. developed a tube capable of delivering 20 kilowatts of high-frequency energy to an aerial. Using six of these tubes in parallel with 15,000 volts on the anode, a current of 310 amperes in an Alexanderson multiple tuned aerial was obtained. A tube of the magnetron type was developed by the same company capable of giving 1,000 kilowatts at 20,000 cycles with an efficiency of 70 per cent.

Great progress was made during the year in the development of vacuum tubes.

Short-wave lengths were used to greater advantage than heretofore.

The McMillan expedition to the polar regions had radio for their only means of direct communication. Using low power and short-wave lengths, their vessel, *Bowdoin*, communicated with several stations in the United States while they were frozen in thousands of miles away. Broadcasting concerts from United States stations were heard during the long dark nights of the Arctic Zone.

During the year foreign countries became interested in radiotelephone broadcasting.

Broadcasting in the United States heard in England. British stations also heard in the United States.

On December 31, East Pittsburgh, Pa. (KDKA), transmitted a program to Great Britain on a short wave.

1924. In January radio was used in the region of the Great Lakes during a blizzard for dispatching trains.

The high-power station at Monte-Grande, Argentina, was opened in January for direct communication with New York, Paris, and Berlin. The service will be extended to Great Britain when a corresponding transmitting station is available. The power of the station is 800 kilowatts, the aerial being carried on 10 masts, each 690 feet high. The receiving station is at Villa Eliza, 30 kilometers from Buenos Aires, the actual control being effected from a central office in Buenos Aires.

On February 5 a radio program broadcasted in the United States from the East Pittsburgh, Pa. (KDKA), station of the Westinghouse Electric & Manufacturing Co. was received and rebroadcast in England for the benefit of English stations.

On February 23 a concert broadcast by the same station and relayed from London, England, was heard clearly in Calcutta, India.

In July an agreement was concluded between the British Government and the Marconi Wireless Telegraph Co. (Ltd.) for the construction of a wireless station on the beam system, capable of communicating with Canada and of being extended to India, South Africa, and Australia, the transmitting station to have an input of at least 20 kilowatts and the receiving station to have an aerial designed to focus the received waves within an angle of 30°.

The short-wave direction system of radiotelegraphy and the results obtained in tests made on it were described in a lecture before the Royal Society of Arts, in July, by Senatore Marconi.

During the period from August 5 to September 24 the East Pittsburgh, Pa. (KDKA), station maintained communication with the ship *Arctic* while on its expedition to the Arctic regions. Upon the ship's return it was reported that messages sent on short waves by the East Pittsburgh station were received at Cape Sabine within 11° of the North Pole. This is the farthest north radio messages have been received.

Third National Radio Conference held in Washington, D. C., October 6.

On October 11 signals from the East Pittsburgh station were successfully repeated from a station in Cape Town, Africa.

An expedition from the United States, under the leadership of Hamilton Rice, which will explore the Amazon and Orinoco Rivers in Brazil and Venezuela, in the interest of geographical sciences in general, will have radio as their only means of communication.

Roger Babson, economist, estimates that during this year the American people will spend approximately $350,000,000 for radio equipment. Sales of radio equipment are running nearly twice as large as all kinds of sporting goods.

A wireless lighthouse has been set up on an island in the Firth of Forth, Scotland. Wireless waves are concentrated by reflectors into a beam which can be sent 100 miles, giving ships their position in a fog.

1925. Considerable progress was made during 1925 in working with short waves. Several transoceanic stations are working foreign stations at great distances on wave lengths varying from 22 to 103 meters.

In an experiment between the Hastings (Nebr.) station and the East Pittsburgh (Pa.) station the Westinghouse Electric & Manufacturing Co. demonstrated that a 64-meter wave could be picked up, and by placing it on a short transmission line to the transmitting station, increasing the strength of the signals to their original power or greater, if necessary, the amplified wave could be transmitted onward. This experiment shows that repeater stations can be constructed in different parts of the world and be fairly certain of transmitting a strong signal.

A number of short-wave transmissions were made by East Pittsburgh (KDKA) transmitting to South Africa and Australia.

Amateur operators by their interest have made considerable achievements in the development of short waves.

During July programs were broadcast to the American naval fleet in Australian waters.

Radio compass (direction finder) came into greater use on board vessels. Over 100 American vessels are equipped.

The Lighthouse Service, Department of Commerce, established several new radio fog signal stations on all coasts of the United States.

The practical use of the telephone and radio for the transmission of photographs was more clearly demonstrated during the year.

As a means of eliminating interference, the transmitters of high-powered broadcasting stations were moved to the outlying districts of several large cities, the studios remaining in the cities.

Broadcasting programs from airplanes was done in a few instances.

The General Electric Co., the Radio Corporation of America, and the Westinghouse Electric & Manufacturing Co. conducted experiments in broadcasting, using as high as 50 kilowatts.

The Department of Commerce placed in commission a "radio test car" which is equipped with an assortment of radio instruments used in conducting tests and investigations.

The Fourth National Radio Conference was held in Washington, D. C., November 9, 1925.

The Radio Corporation of America began the operation of a high-powered broadcasting station at Bound Brook, N. J., for transmission of programs to Europe. This station is equipped so as to use as high as 50 kilowatts.

One of the large electrical companies conducted experiments to determine the characteristics and peculiarities inherent in the piezo crystals. Several stations are now using this quartz crystal to maintain a constant frequency which eliminates to a great extent the "beat notes" resulting from two stations heterodyning at an audio-frequency. The radio-inspection service of this department has been supplied with these crystals to insure accuracy in frequency or wave-length measurements.

1926. During this year directional or beam transmission developed to a point where it may now be considered as practical for commercial usage.

The use of quartz plates for maintaining constant frequency or radio transmitters advanced considerably during the year.

Successful radiotelephone experiments were conducted between New York and London. This service will be used commercially in the near future.

With the development of transmitting pictures by radio it is now practical to transmit weather maps to vessels at sea.

Considerable progress was made in the perfection of receiving sets. The single-dial receiver came into greater use for reception of programs from broadcasting stations.

A committee representing the departments of the United States Government directly concerned studied our radio problems and prepared proposals for consideration by the International Radiotelegraph Conference which is contemplated being held in Washington during 1927.

Commercial pictoradiogram services are now in operation between New York and London and between San Francisco and Hawaii.

The use of the radio compass (direction finder) on shipboard increased materially. At the close of the year about 300 merchant vessels of this country were so equipped. A very large number of naval vessels are also equipped with this apparatus.

On July 8 the Attorney General of the United States rendered a decision to the effect that the Secretary of Commerce has no jurisdiction as to the wave length, with the exception of the band between 600 and 1,600 meters reserved for Government stations, or the power used by commercial stations, including broadcasting stations.

The joint resolution of Congress approved December 8 requires the applicant for a radio-station license to waive any right or any claims of right against the United States to any wave length or to the use of the ether in radio transmission because of previous license to use the same or because of the use thereof.

Since July the number of broadcasting stations increased 155, making the total number licensed on December 31, 671. A large number of the stations in this class increased their power and changed their wave lengths during this period.

Radiotelephone was used for the first time in directing the filming of a naval scene, off the coast of California, for a photoplay.

During the year successful development of a wireless system for controlling fog signals from unattended lighthouses and beacons marked a great advance on the automatic or semiautomatic systems for starting and stopping acetylene fog-signal gun by wireless impulses.

Successful experiments of synchronizing two or more stations in order that simultaneous operation on the same wave length without interference may be accomplished were conducted by the Westinghouse Electric & Manufacturing Co. during the year.

1927. Transatlantic radiophone service opened to the public on January 7.

Radio act of 1927 passed February 23, creating the Federal Radio Commission.

On April 7 the experimental radio station of the Bell Telephone laboratory at Whippany, N. J. (3XN), was successfully used in a public demonstration of television; the facial expression and voice of Secretary of Commerce Hoover could be seen and heard in New York distinctly and at the same time.

Radio was used in connection with the floods in the Mississippi Valley during the spring and New England during the fall, when other means of communication were inoperative or inaccessible. Several amateur stations rendered valuable aid.

Radio was used by the airplane *America* on June 29 for the first time by an airplane in crossing the Atlantic Ocean from the United States to France.

International Radio Telegraph Conference held at Washington, D. C., October 4 to November 25.

Receiving vacuum tubes with filaments heated from alternating current gained in popularity.

Chain broadcast programs greatly increased during the year.

Beam transmission on short waves increased considerably during the year; at the present time there are about 15 stations of this class in operation throughout the world.

Radio was a vital factor in the saving of an exceedingly large number of lives at sea.

As a result of experiments conducted during the past two years on methods of synchronization broadcasting stations WBZ at Springfield, Mass., and WBZA at Boston, Mass., owned by the Westinghouse Electric & Manufacturing Co., are now being regularly operated simultaneously in absolute synchronism, the wave length of the transmitter at the Boston station being automatically controlled by the Springfield transmitter so that any variation at Springfield will create a similar variation at Boston, assuring absolute synchronism at all times during the operation of these stations.

Experiments are now being conducted for the synchronization of two or more transmitters by radio control instead of by wire as in the case of the two stations referred to.

The U. S. S. *Kittery*, experimenting with a radio compass during hurricane weather, found that the intensity of static may be useful in detecting and locating storms at a considerable distance.

The experimental station of the General Electric Co. at Schenectady, N. Y., call signal 2XAG, in experiments used a vacuum tube of 100,000 watts power.

The Department of Commerce began the installation of directional radiobeacons for use in aviation. Two-way communication experiments between plane and ground carried on with considerable success.

1928. January: Commander A. Hoyt Taylor, United States Navy was awarded the Morris Liebman memorial medal by the Institute of Radio Engineers for research in short-wave phenomena during the previous year.

February 8: A successful television demonstration was carried on during the night between station 2KZ in London, England, and amateur station 2CVJ in Hartsdale, N. Y.

March 7: A successful ship to shore television test was conducted from a London (England) station with the steamer *Berengaria*.

March 28: Amendment to the radio act of 1927 approved.

June 27: A two-way short-wave radio circuit was first used commercially for telephony between America and Europe. This short-wave circuit supplements the long-wave circuit which was opened for commercial service during 1927.

September 11: Station WGY, Schenectady, N. Y., was the first station to broadcast a play by television. The play, a 1-act drama, entitled "The Queen's Messenger," was broadcast during the afternoon and again in the evening.

November 6: In broadcasting the returns of the presidential election the National Broadcasting Co. had 59 stations throughout the United States connected into a single network, and the Columbia Broadcasting System had 26 stations connected in another network.

November 12: The steamship *Vestris* sank about 275 miles off Cape Hatteras. Radio played a prominent part in the rescue of the survivors.

November 26: The trans-Atlantic radiophone service between North America and Europe was extended to another continent—Africa—by the establishment of service to Ceuta, Spanish Morocco.

December: Commander Richard Byrd, on a scientific expedition in the Antarctic, operated a radio station, located farther south than any station heretofore, to keep in touch with civilization. Programs of the short-wave relay broadcasting station of the East Pittsburgh (Pa.) station of the Westinghouse Electric & Manufacturing Co. were received by the station.

At one time during the political campaign 106 broadcasting stations in the United States were connected into a single network by means of approximately 25,000 miles of telephone circuits together with about 48,000 miles of telegraph circuits for program coordination and auxiliary communication.

During the year radio apparatus was used to detect mineral deposits in the United States.

Amateur and commercial stations were used to great advantage through lack of other means of communication during the Florida and Porto Rico storms.

The use of receiving sets operated by house current and dynamic loud speakers came into greater use during the year.

The General Electric Co. developed a vacuum tube, 5 inches in diameter and about 2 feet long. It is operated as a self-excited oscillator on a wave length of 6 meters and is capable of radiating from 10 to 15 kilowatts of high-frequency power—probably fifty times as much as any short-wave tube has heretofore been able to radiate.

The use of shortwaves were used to a greater extent than heretofore for ship communication and for point to point communication over long distances.

UNIDIRECTIONAL RADIOBEACON FOR AIRCRAFT

During the development by the Bureau of Standards of a directional beacon for guiding aircraft it appeared that the usefulness of the beacon could be increased by making the radiated field unidirectional. This was accomplished by the combined use of a vertical antenna with the two crossed-coil antennas utilizing the directive and nondirective fields simultaneously, with the proper phase and amplitude relations between them to secure unidirectional transmission.

The system is explained in a paper—Unidirectional Radiobeacon for Aircraft—by E. Z. Stowell in the Bureau of Standards Journal of Research for December, 1928, Research Paper No. 35. Reprint copies of this paper may be obtained for 10 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

REFERENCES TO CURRENT RADIO LITERATURE

This is a monthly list of references prepared by the Bureau of Standards and is intended to cover the more important papers of interest to professional radio engineers which have recently appeared in periodicals, books, etc. The number at the left of each reference classifies the reference by subject, in accordance with the scheme presented in A Decimal Classification of Radio Subjects—An Extension of the Dewey System, Bureau of Standards Circular No. 138, a copy of which may be obtained for 10 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C. The various articles listed below are not obtainable from the Government. The various periodicals can be secured from their publishers and can be consulted at large public libraries.

R000.—*Radio communication*

R007.1 Dellinger, J. H. Analysis of broadcasting station allocation. Proc. Inst. of Radio Engrs., **16**, pp. 1477–85; November, 1928.

A discussion of the technical aspects of the reallocation of November 11, 1928.

R100.—*Radio principles*

R113 Diagramme des champs électriques mésures a Meudon pendant le deuxième semestre 1927. (Diagrams of electric fields measured at Meudon during the second half of 1927.) L'Onde Electrique, **7**, pp. 458–460; October, 1928.

Curves taken on LY, UA, WSS, and GBL during second half of 1927.

R113.1 Colwell, R. C. Fading curves along a meridian. Proc. Inst. of Radio Engrs., **16**, pp. 1570–1573; November, 1928.

Fluctuations in signal strength of KDKA, Pittsburgh, Pa., were observed through the sunset period of Morgantown, W. Va. Observations made covered 21 days. On bright, clear days the curve fluctuated considerably, while on cloudy days the curve was fairly steady.

R113.1 Merritt, E., and Bostwick, W. E. A visual method of observing the influence of atmospheric conditions on radio reception. Proc. Nat. Acad. of Sci., **14**, pp. 884–83; November, 1928.

A method is described which utilizes the cross-coil system and a cathode-ray oscillograph. It was possible to notice visually several successive rotations of the plane of polarization of the downcoming wave during sunset period.

R113.4 Størmer, C. Short-wave echoes and the aurora borealis (letter). Nature (London), **122**, p. 681; Nov. 3, 1928.

Report on signals and echoes received at Bygdø, Oslo, from the short-wave station at Eindhoven, Holland. The echoes arrived from 3 to 15 seconds later than the principal signal. The writer explains these belated echoes by the theory that radio waves penetrate the Heaviside layer, passing then into empty pockets of large dimensions. The pockets are surrounded by walls of electrons from which the waves are reflected.

R113.4 Radio echoes and magnetic storms (letters). Nature (London), **122**, p. 768; November 17, 1928.

Two notes, one by S. Chapman and the other by E. T. Eckersley, with respect to the note (Nature, p. 681, Nov. 3, 1928) by Størmer on the explanation for the long-time interval echoes. Eckersley calls attention to his paper in the Philosophical Magazine, June, 1925, where he explained the whistles of lowering pitch by means of dispersion and the group velocity along the path in the Heaviside layer. Chapman calls attention to the fact that the positive ions are also present in addition to the electrons which were considered in Strømer's theory.

R113.4 Beatty, R. T. Short-wave signals which travel over a million miles and return. Wireless World and Radio Review, **23**, pp. 722–23; Nov. 28, 1928.

A picturization of electron vortices of extremely large dimensions and their possible effects on radio transmission explaining long-time interval echoes.

R113.4 Schelleng, J. C. Note on the determination of the ionization in the upper atmosphere. Proc. Inst. of Radio Engrs., **16**, pp. 1471–1476; November. 1928.

Describes a method of estimating distribution of ionization in upper atmosphere; this method based on measurements on several frequencies of effective height as determined by interference or echo experiments.

R116 Bergmann, L., and Holzlöhner, G. Über die Fortpflanzungschwindigkeit elektrishcer Wellen an dünnen Drähten von verschiedenem Leitvermögen (On the velocity of propagation of electric waves along thin wires of different conductivity.) Annalen der Physik, **87**, pp. 653–676; No. 21, 1928.

Brief review of the theories of propagation by Hertz, Rayleigh, Drude, Mie, Sommerfeld, Mercier, Hund, and experimental data with thin wires of copper, aluminium, brass, German silver, manganin, and constantan.

R145.3 Bashenoff, V. I. Supplementary note to "Abbreviated method for calculating the inductance of irregular plane polygons of round wire. Proc. Inst. of Radio Engrs., **16**, pp. 1553–1558; November, 1928.

Additional discussion based on this paper.

R200.—*Radio measurements and standardization*

R210 Rangachari, T. S. A method of calibrating a low-frequency valve generator with a single-frequency standard source. Experimental Wireless and Wireless Engineering. (London), **5,** pp. 633–634; November, 1928.

The source of unknown frequency is connected across a series combination of resistance and an inductance, and the former is varied until the voltage across it is the same as across the inductance. The same is done when an emf of known frequency is impressed. The unknown frequency can then be calculated from resistance settings and the known frequency.

R214 Hitchcock, R. C. Quartz crystals: How to cut and grind them. Radio Broadcasts, **14,** pp. 85–87; December, 1928.

Formulas for the thickness vibration are given for the 30° and the Curié cut. The method of cutting and grinding piezo-electric quartz plates is described.

R214 Harrison, J. R. Piezo-electric oscillator circuits with 4-electrode tubes. Proc. Inst. of Radio Engrs., **16,** pp. 1455–1470; November, 1928.

Description of two piezo oscillator circuits which use screen-grid vacuum tubes. One circuit utilizes two pairs of electrodes, and feed-back takes place through the crystal. In the other circuit the two electrodes of the crystal are connected between the plate and the control grid.

R214 Terry, E. M. The dependence of the frequency of quartz piezo-electric oscillators upon circuit constants. Proc. Inst. of Radio Engr., **16,** pp. 1486–1506; November, 1928.

Mathematical theory of the piezo-electric quartz oscillator is given. It treats the case where the quartz element is between the grid and the filament as well as the case when between the grid and the plate. The analysis is made for the tuned-plate circuit, inductance, and resistance load.

R214 Strout, R. S. Temperature coefficient, of quartz crystal oscillators. Physical Review, **32,** pp. 829–831; November, 1928.

The temperature coefficient of the frequency of a quartz plate 1.8 by 1.8 by 0.11 oscillating with the thickness frequency was found to decrease linearly from 22.7 parts per million per degree at 65° C. to 1.6 parts per million per degree at −189° C.

R280 Rybner, J. Note sur les experiences relatives aux proprietes dielectriques des gaz ionises de MM. Gutton et Clement. (Note on the experimental results of dielectric properties of ionized gas found by Gutton and Clement). L'Onde Electrique, **7,** pp. 428–436; October, 1928.

Shows that the experimental facts observed originally by Gutton and Clement can be explained by the classical theory and that it is not necessary to assume that the ions are not free and their movement due to quasi elastic forces.

R300.—*Radio apparatus and equipment*

R330 Millen, J. The control grid glow tube. Radio Engineering, **8,** pp. 18–19; September, 1928.

Description of this tube giving the breakdown characteristic and other useful data.

R331 Van Dyck, A. F., and Engel, F. H. Vacuum tube production tests. Proc. Inst. of Radio Engrs., **16,** pp. 1532–52; November, 1928.

General description is given of methods and apparatus for testing tubes in large quantities.

R343 Van Dyck, A. F., and Dickey, E. T. Quantitative methods used in tests of broadcast receiving sets. Proc. Inst. of Radio Engrs., **16,** pp. 1507–1531; November, 1928.

General classes of receiving set measurement used by authors are outlined as special engineering tests and production tests. New form of radio-frequency generator designed for this type of work is described.

R343.7 Warren, A. G. Surges in eliminator smoothing circuits. Experimental Wireless and Wireless Engineer (London), **5,** pp. 601–606; November, 1928.

A discussion of the effects of surges occurring in an eliminator circuit which is supplied from direct-current mains. It is shown that the effects are most serious when the set is not connected or the filaments of the set are not burning.

R344 Aisberg, E. Utilisation des lampes de T. S. F. pour la production de musique electrique. (Use of vacuum tubes for the production of electric music.) L'Onde Electrique, **7,** pp. 455–458; October, 1928.

Reviews the various systems for producing music by means of vacuum tube generators.

R344 A tuning fork controlled audio oscillator. Journal Scientific Instruments (London), **5,** pp. 361–362; November, 1928.

Description of audio oscillator made by General Radio Co.

R385.5 Meyer, E. Über eine einfache Methode der automatischen Klanganalysis und der Messung der Nichtlinearität von Kohlemicrophonen. (A simple method of automatic sound analysis and measurement of distribution in carbon microphones.) Elektrische Nachrichten Technik, **5,** pp. 398–403; October, 1928.

A bridge method is described for testing carbon microphones. The method is a simplified arrangement for sound analysis.

R388 Coursey, P. R. A portable oscillograph equipment for observation of transient electrical phenomena. Experimental Wireless and Wireless Engineer (London), **5,** pp. 616–619; November, 1928.

Description of the apparatus.

R400.—*Radio communication systems*

R470 Fuller, L. F., and Tolson, W. A. Power line carrier telephony. Jour. Amer. Inst. Elec. Engrs., **47,** pp. 711–715; October, 1928.

Outlines briefly modern communication requirements, provision of communication, and different types of equipment available for this service.

R470 Wolfe, W. B., and Sarros, J. D. Problems in power line carrier telephony and recent developments to meet them. Jour. Amer. Inst. Elec. Engrs., **47,** pp. 727–731; October, 1928.

Outline of difficulties met in application of high-frequency communication to power systems. Description of recent developments in equipment.

R500. *Applications of radio*

R520 Craft, E. B. Airways communication service. Bell System Technical Jour., **7,** pp. 797–807; October, 1928

Two-way radio telephone communication between airplane and ground experiments by the A. T. & T. Co.; describes in addition the system used by the United States Government and between London and Paris; suggests that further channels in the high-frequency band should be assigned to this work.

R531.2 Radio stations of the world on frequencies above 1,500 kilocycles Proc. Inst. of Radio Engrs., **16,** pp. 1575–1604; November, 1928.

List of high-frequency stations throughout the world.

R551 Bigourdan, G. Sur l'unification des signaux horaires radio telegraphiques. (On the unification of radio time signals). Rev. Generale d'électricité, **24,** pp. 702–703; Nov. 10, 1928.

Chart for time signals.

R582 Scheppmann, W., and Eulenhöfer, A. Der Bildfunk nach dem System Lorenz-Korn. Picture transmission system of Lorenz-Korn). Elektrische Nachrichten Technik, **5,** pp. 373–381; October, 1928.

Describes sending and receiving equipment as well as the latest development in synchronization.

R582 Oglobinski, M. G. Derniers progress de la transmission Belinographique en France. (Latest progress on the transmission of pictures by the Belin system). L'Onde Electrique, **7,** pp. 446–455; October, 1928.

Description of the improved Belin system using photo-electric tubes.

R584 Hermann, P. W. High-frequency electric furnaces. Radio (San Francisco), **10,** pp. 12–13; December, 1928.

Methods and equipment used for melting precious metals.

R800.—*Nonradio subjects*

535.3 Bergstein, M. Applications of the photo-electric cell in industry. Radio Engineering, **8,** pp. 28–30; September, 1928.

Uses in commercial work.

538 Maurain, Ch. Activité solaire et magnetisme terrestre. (Solar activity and terrestrial magnetism). L'Onde Électrique, **7,** pp. 414–427; October, 1928.

Review of the solar activity and its relation to the diurnal variations; includes a list of references.

621.314.6 Turner, H. M. The constant impedance method for measuring inductance of choke coils. Proc. Inst. of Radio Engrs., **16,** pp. 1559–1569; November, 1928.

Description of a method of measuring at power frequencies the inductance of iron-cored choke coils of type commonly used in radio as filters.

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