Radio aboard the RMS *Titanic*

How it worked

Effect of radio on the the disaster

Effect of the disaster on radio

de Fred Archibald, VE1FA

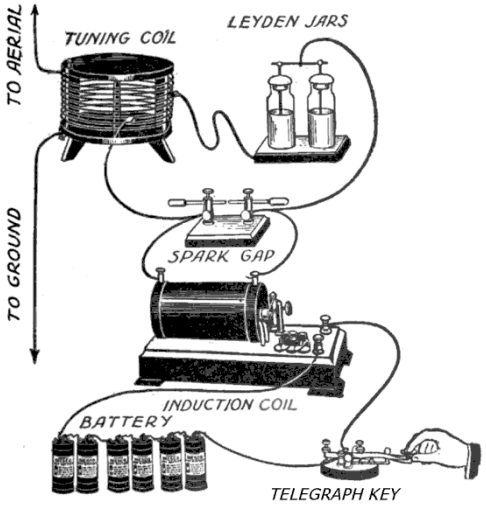
Radio Technology: 2 living, 3 extinct species

Without amplifiers

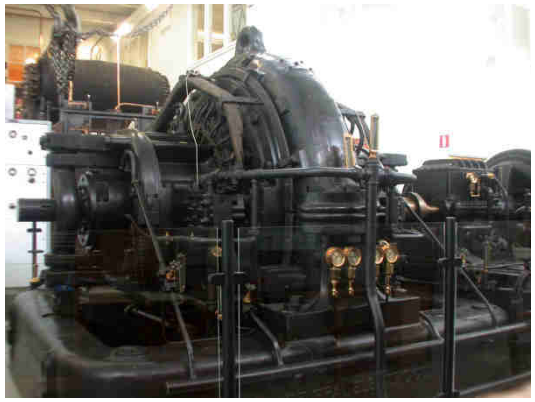
1. Spark 1886 → early 1920s ....**extinct**
2. RF Alternator 1902....1920s: a few apps into 1950s; now **extinct**

With amplifiers

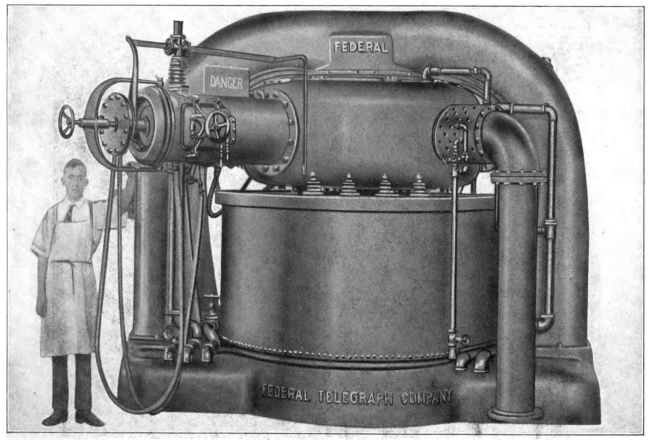
3. Arc 1905 → 1940s .... **extinct**
4. Vacuum Tubes: 1906 → 1970s...**some apps continue**
5. Semiconductors: 1947 →**Present**



"plain spark" transmitter

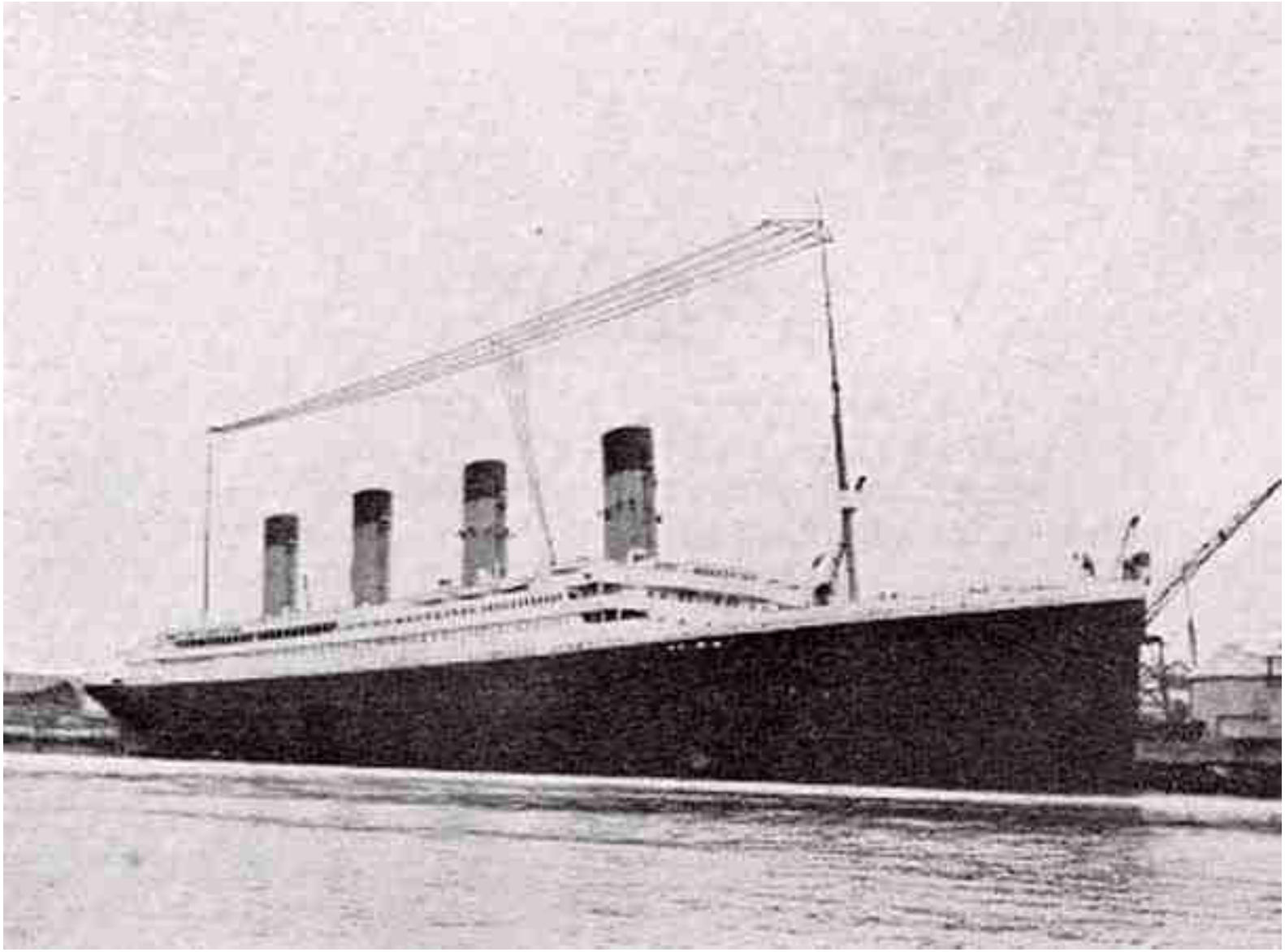


200kW Alexanderson RF alternator



1 MW Federal Arc (plasma amplifier)

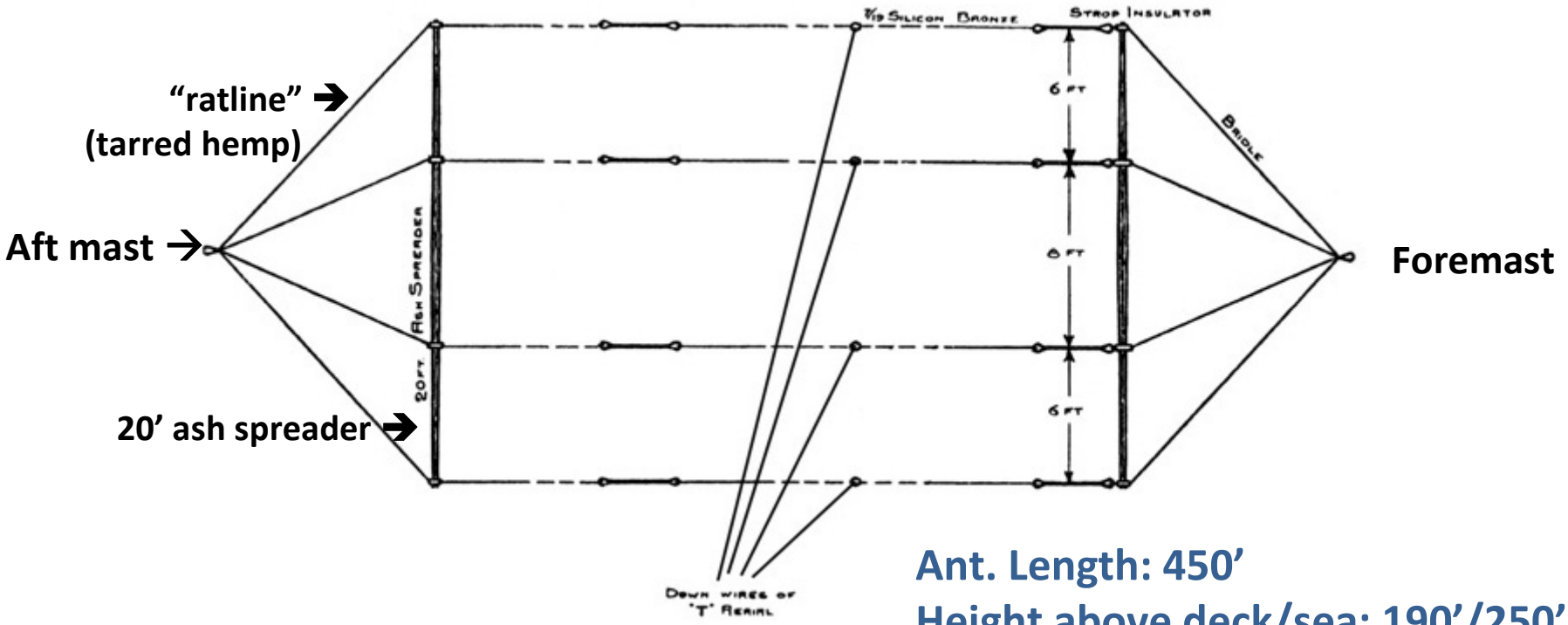
Two balanced “Twin T” antennas



Titanic: 53,310 tonnes; length 883’, beam 92’, 46,000 hp

2,224 persons (and two radios) on board

Titanic's Marconi Twin T type aerials
2 pairs of wires , two feedlines to radio



A "Gain Antenna"?: yes, on long axis

Ant. Length: 450'
Height above deck/sea: 190'/250'
Type: multiwire "T" with 4 down wires
Feed: in exact center of T
F_r = about 930 kHz (325 m)

Titanic's Radio

Main TX: 5 kW synchronous rotary spark, the most advanced spark system in use.

Installed, tested, aligned, operated by R-Os Jack Philips (25), Harold Bride (21) at Harland + Wolff, Belfast

Fully functional 2 April, 1912

Call: MGY

Power in: 100-110 VDC @60A

Wavelengths: 600 m "longwave" + 325m "shortwave" (500 + 930 kHz)

Signal: musical 840 Hz

Minimum guaranteed range: (day: 250 mi) (night: 2000^{+} mi, not guaranteed)

Main RX: Marconi MultiTuner + Marconi Magnetic Detector / Fleming valve detector + standard telephones

Auxiliary TX: 1.5 kW plain spark using 10" coil. Charger + batteries

Guaranteed range: (day) 40 mi

Auxiliary RX: Coherer/bias + Inker/printer (no tuning at all)

“Plain Spark” rig

Output: damped wave (NOT CW) hiss/buzz

Titanic had plain spark backup TX

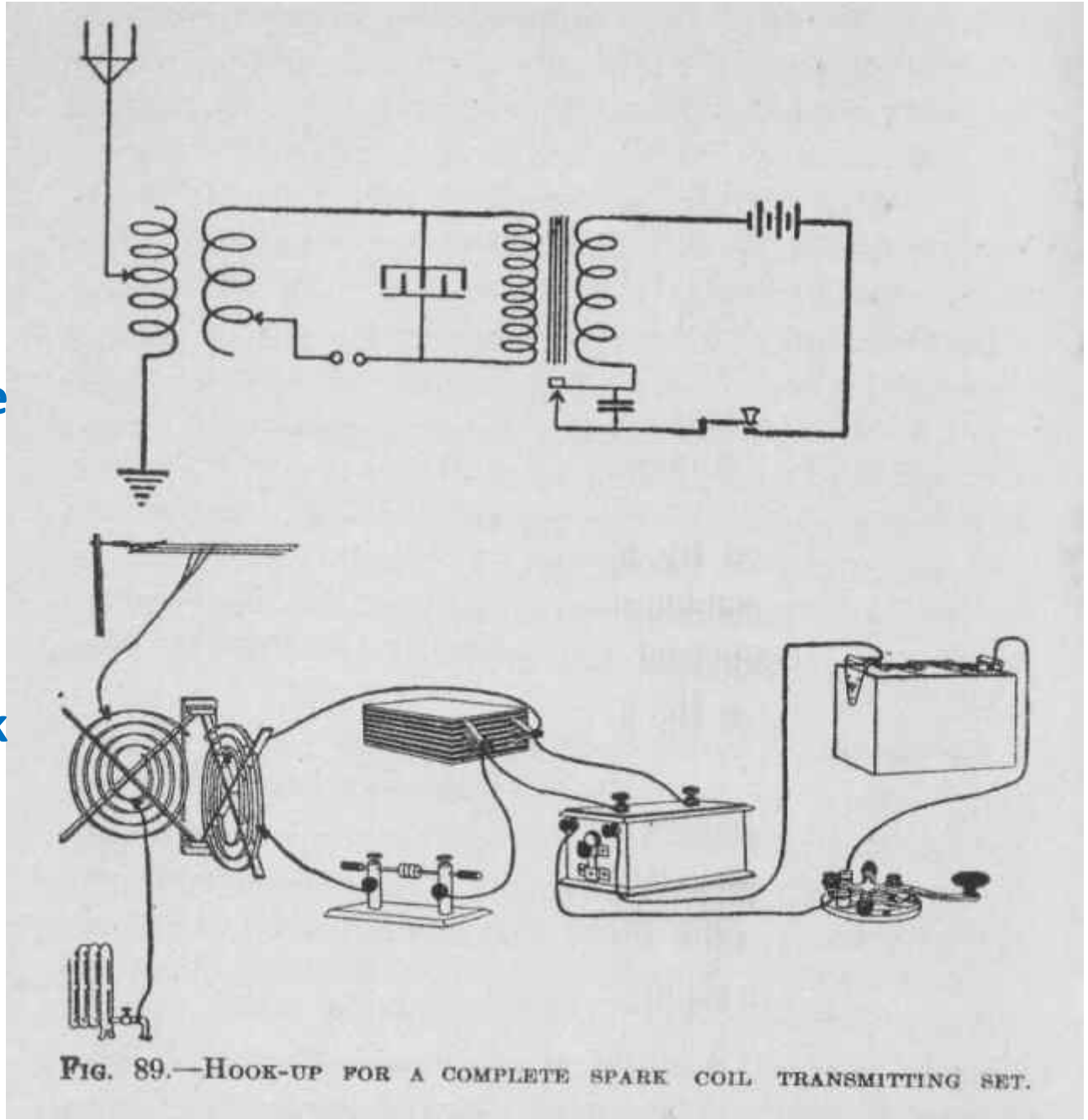
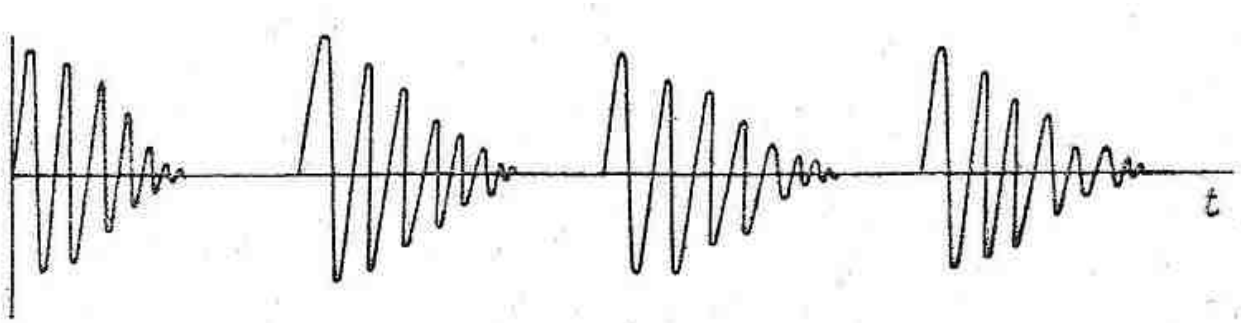
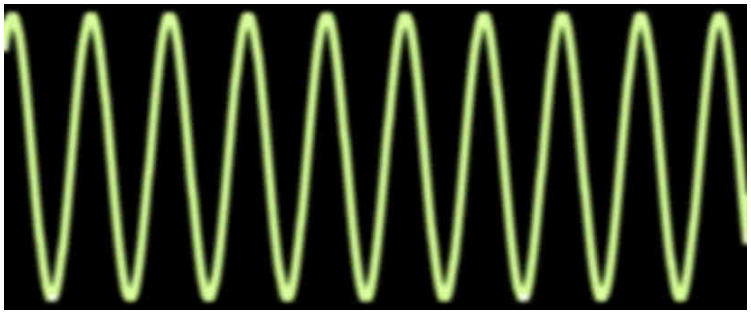


FIG. 89.—HOOK-UP FOR A COMPLETE SPARK COIL TRANSMITTING SET.

Damped wave
"DW" or
"plain spark"
used 'til 1920s ➔

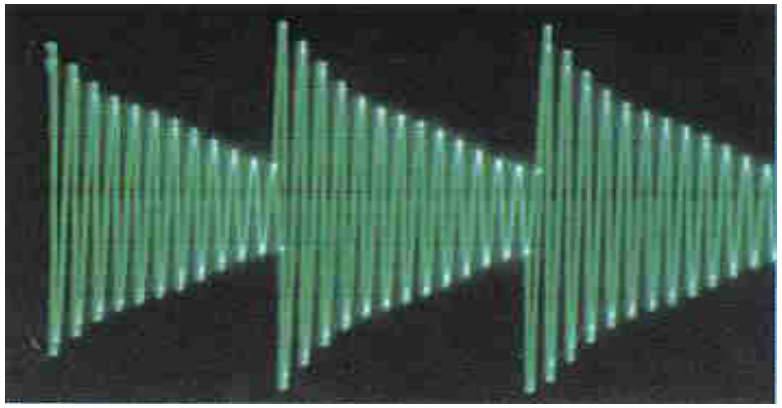


Modern TX
continuous wave
"CW" ➔

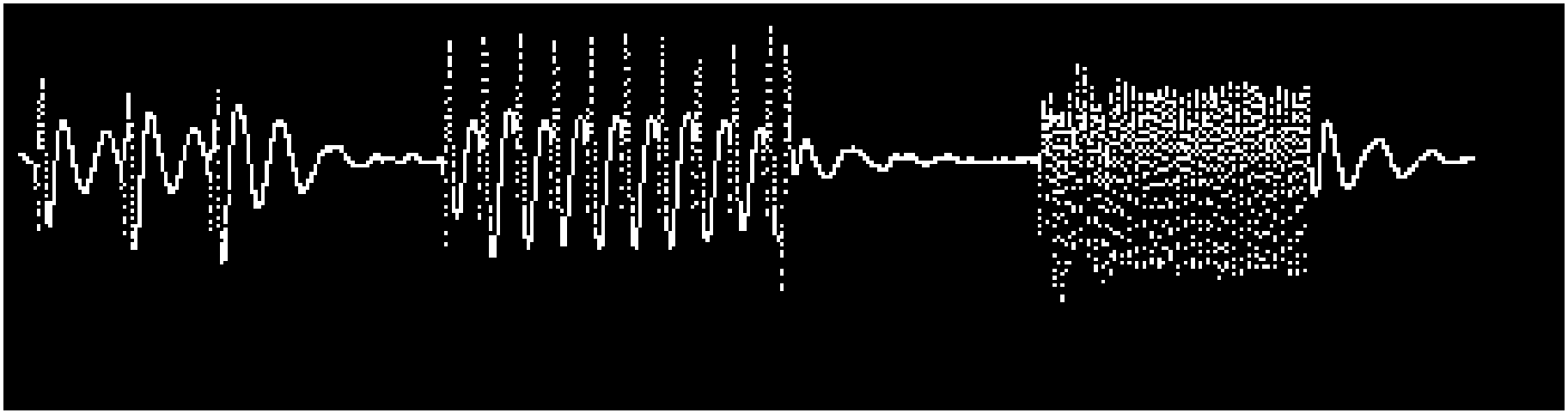


Titanic's synchronous 840Hz
"modulated" rotary spark ➔

"Modulated, damped,
continuous wave"



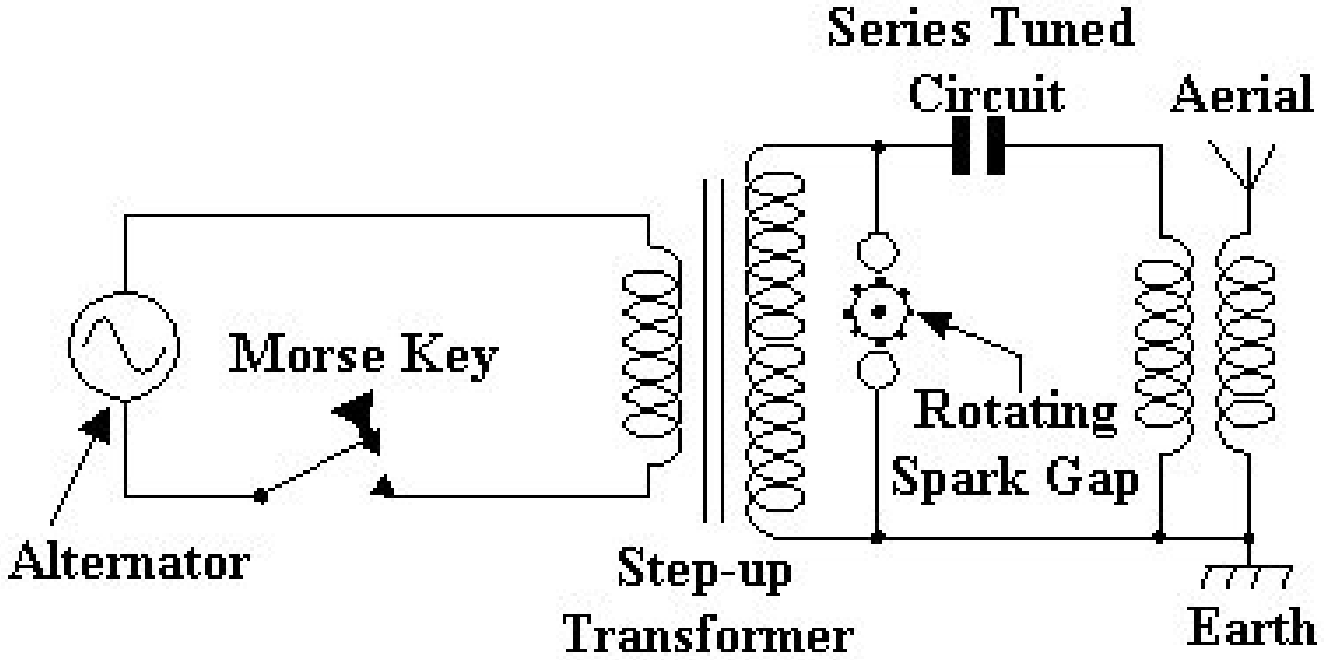
Scope patterns of three spark “E”s



60Hz **120Hz** **750 Hz**

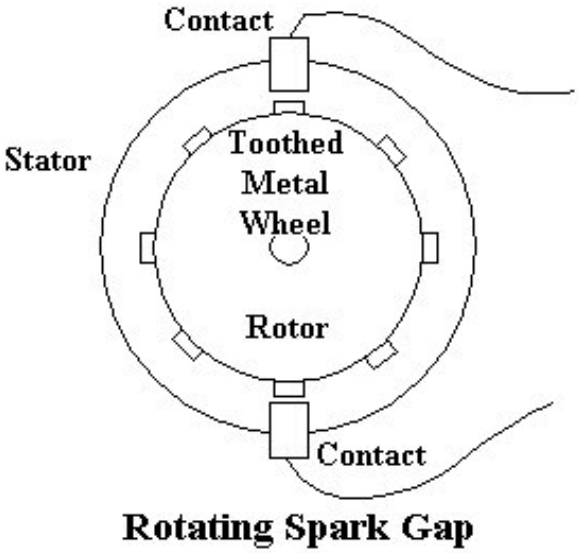
Spark <u>frequency</u> increase ➔ big improvement in tone + efficiency!

Non-Synchronous Rotary Spark-Gap Tx: DW not CW!



More sparks/second = better performance

Much better performance if: alternator voltage peaks synchronized with rotary spark gap



Rotating Spark Gap

Titanic's Marconi 5kW synchronous rotary spark Tx (non-RF part)

+/- 100-110 VDC mains (Tx draws about 60A)

300 VAC @ 420 Hz; 5 kW M-G output

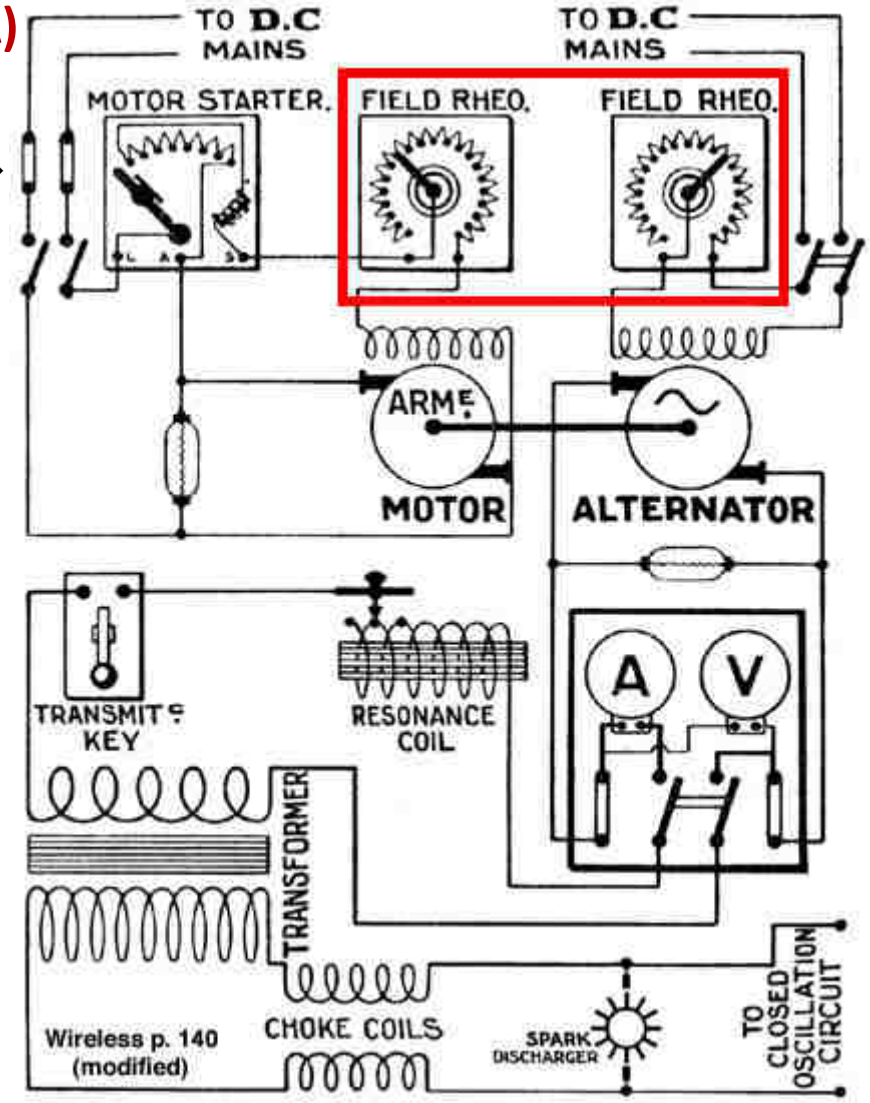
6300 rpm x 8-pole alternator x 16-stud rotary spark discharger ➔840 Hz musical note

When Keyed: 10-14,000 VAC to rotary discharger and primary oscillator L + C

Motor Field Rheo: sets motor power/speed + signal tone

Alternator Field Rheo: adjusts high voltage : adjusts spark quality

Key current: about 17 Amps @ 300VAC (actually relay used)



TX power supply

Motor monitor missing!

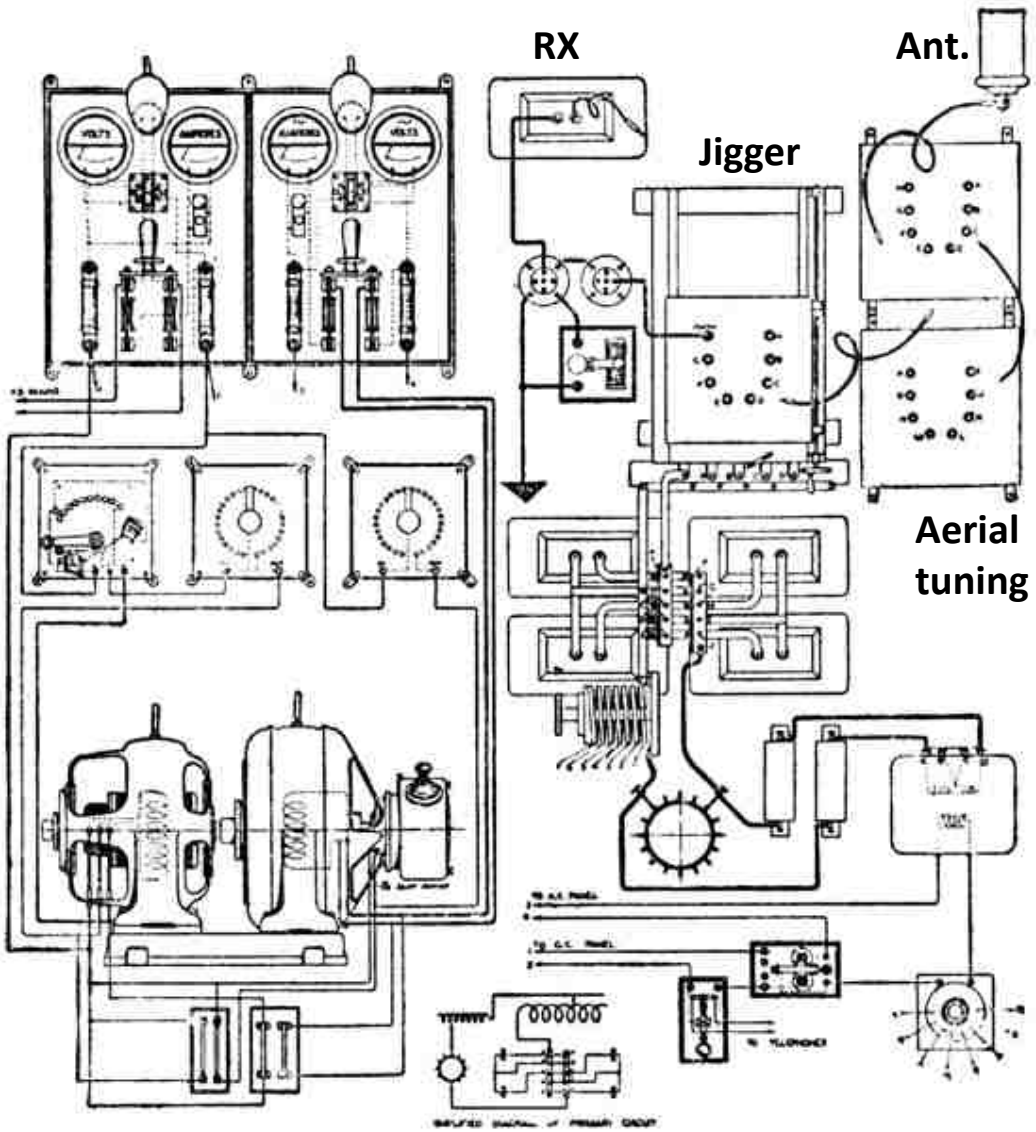
Olympic/Titanic rotary spark TX (mostly correct)

-DC motor: minimum 10 hp

-300VAC, 6300 rpm , 17A alternator (keyed circuit)

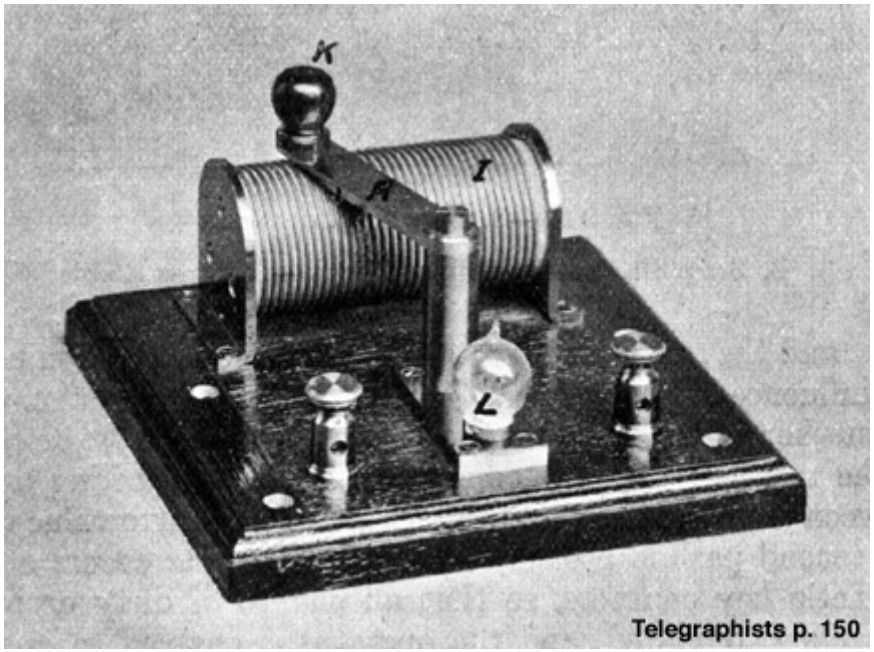
-10-14 kVAC , 0.5 A secondary voltage across rotary spark gap.

-840 Hz musical note from 8-pole alt. and 16-stud rotary spark gap.

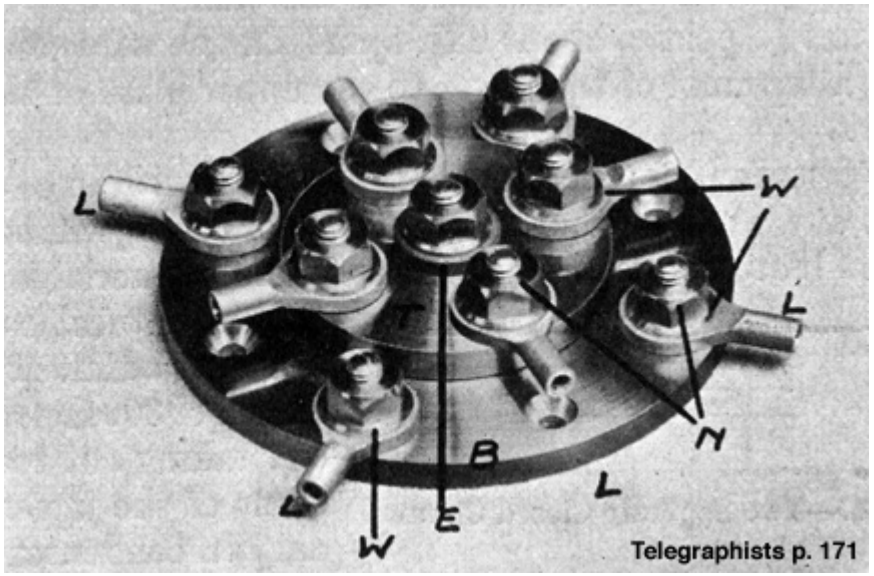


5-Kw. Set Connections.

-mature, sophisticated engineering...in 1912 amateur hands... a super-station!



“Tuning Lamp” (RF current/tuning meter)

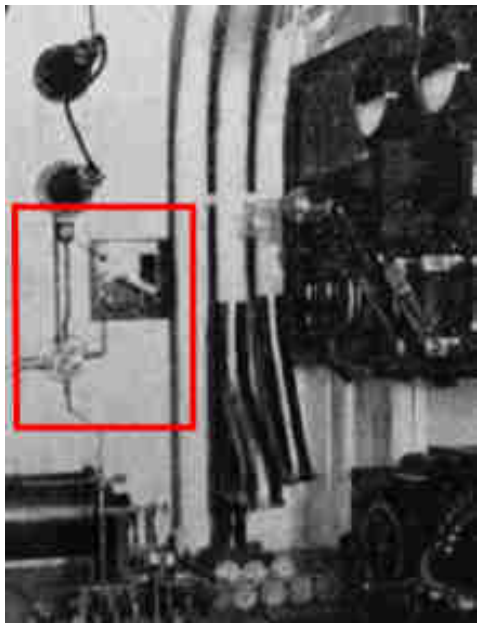


“Earth Arrestor” spark gap-the TR switch (.01” mica-insulated gap)

QSK!!

Marconi magnetic Key relay (1910)

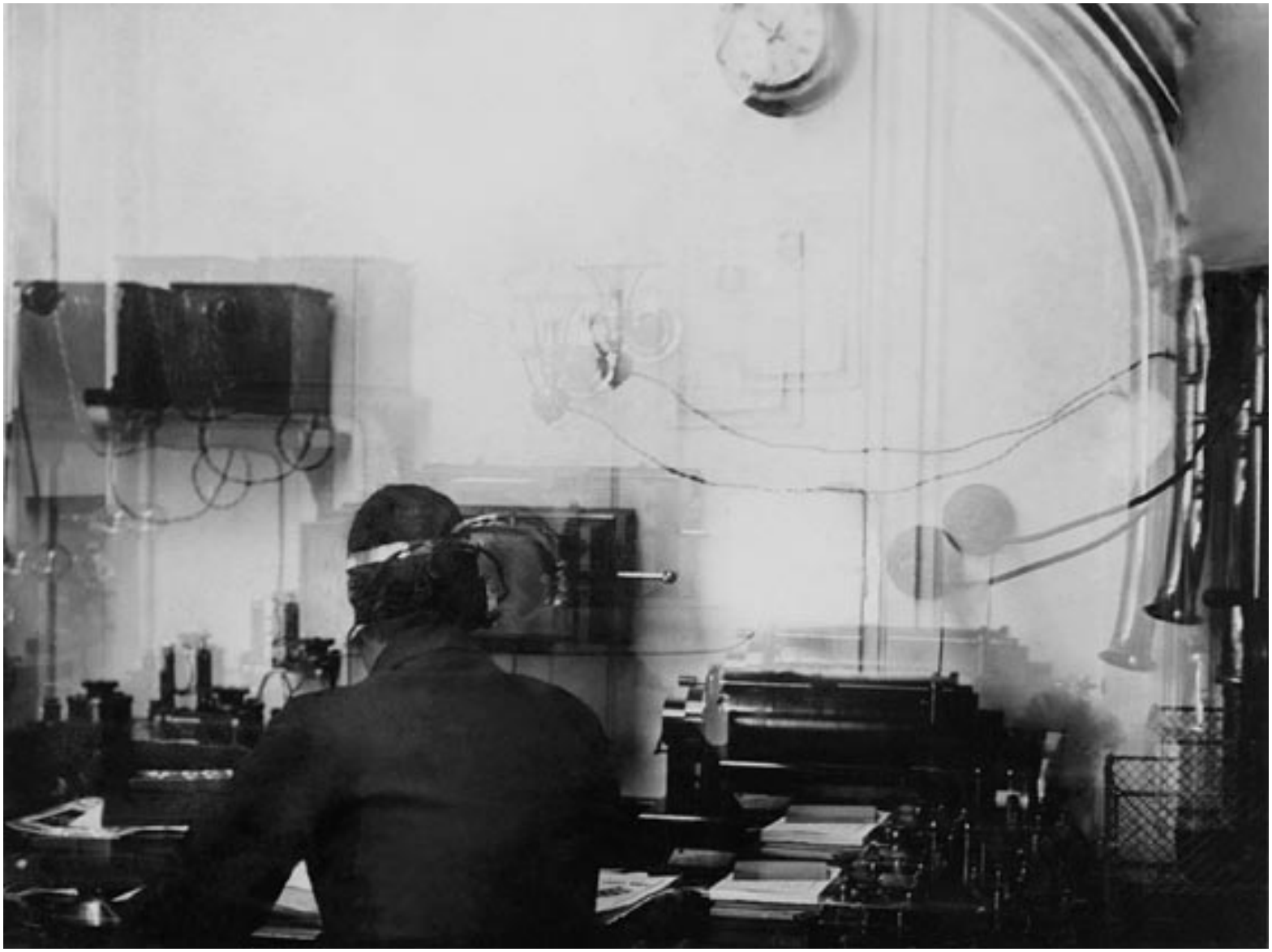
On Olympia ➔



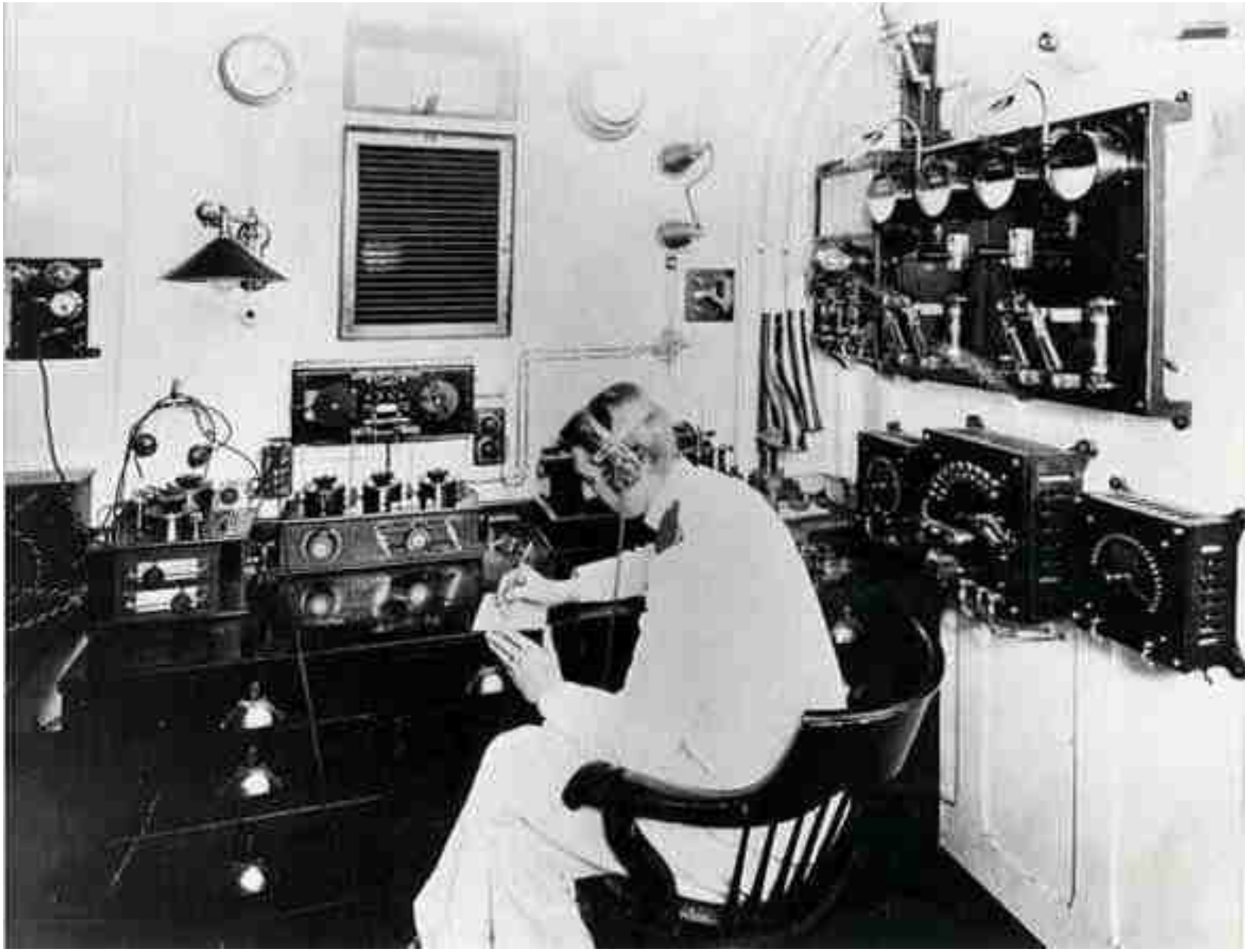
The “Guillotine Key”

Marconi key used for Titanic’s 5kW rotary spark main TX

What’s the side lever for??



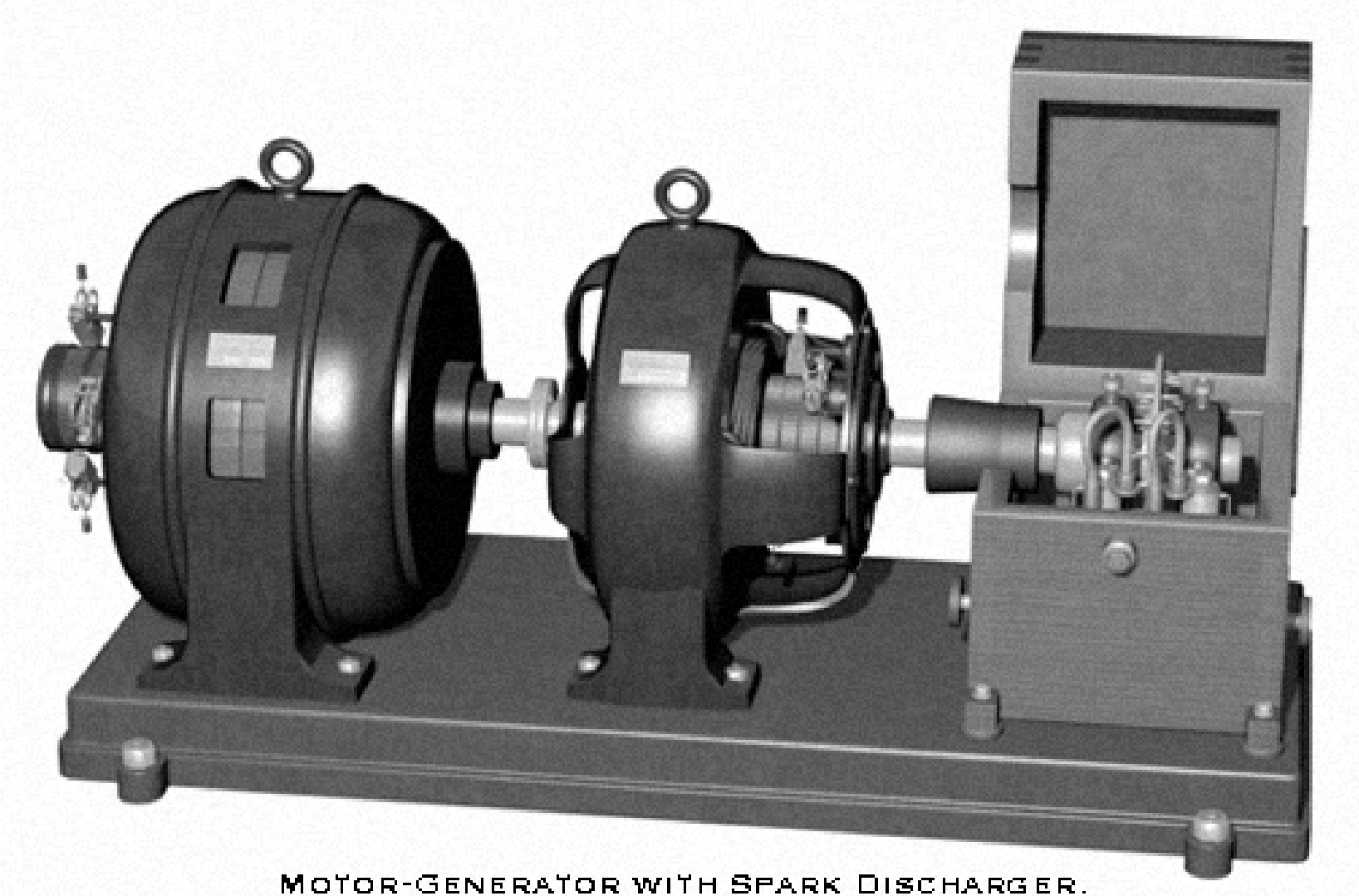
Only known picture of *Titanic*'s radio room. Back of H. Bride's head. Taken by debarking passenger at Queenstown, Ireland



***Olympic*'s radio room**

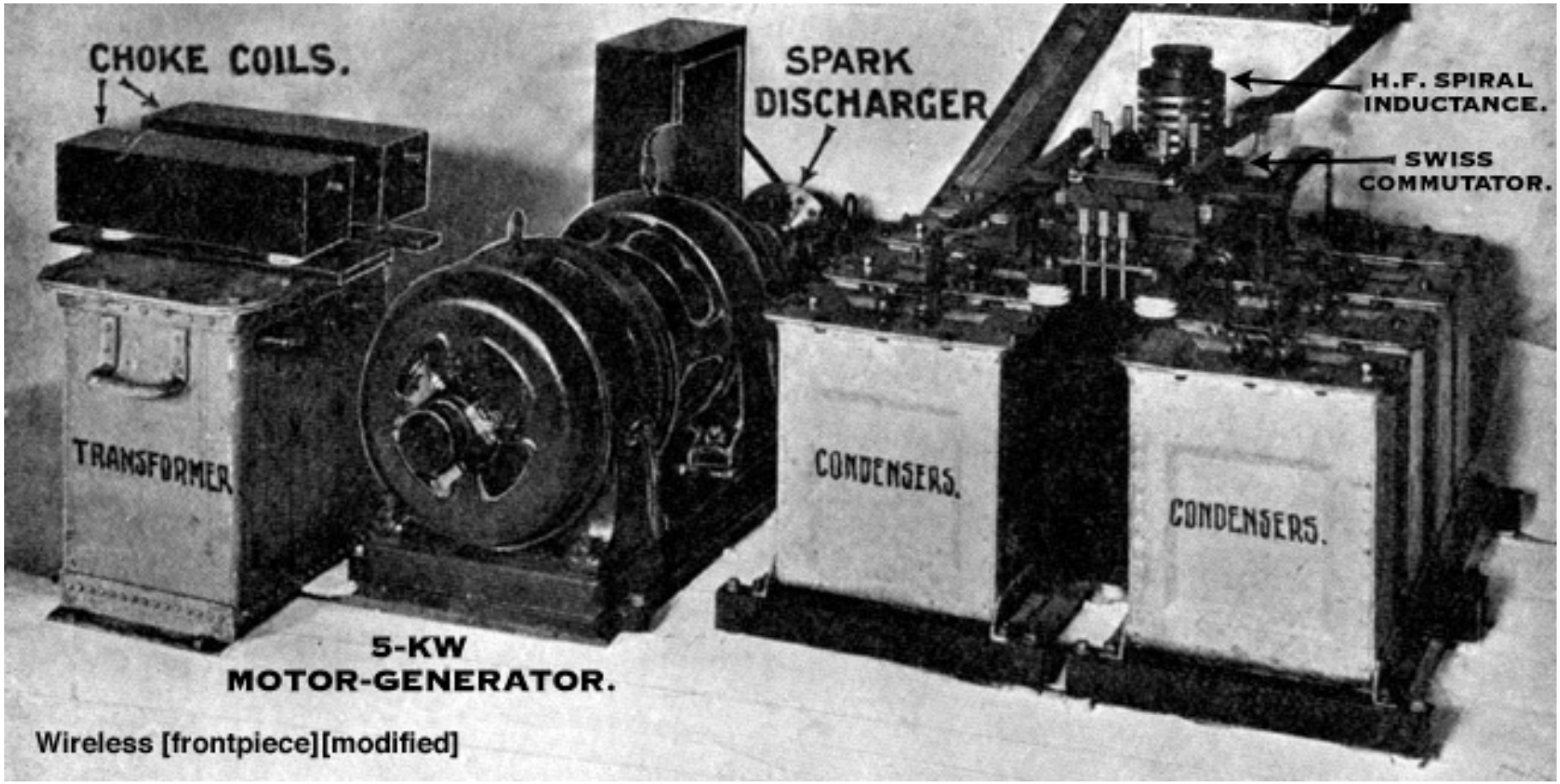
***Titanic* movie set**

***Titanic* radio room…movie set**



MOTOR-GENERATOR WITH SPARK DISCHARGER.

Marconi 5kW “M-G Set” with mechanically synchronized rotary spark gap (“disk discharger”) in protective box



“Silent room” Tx hardware

From “Ghosts of the Abyss” 2002

Re-creation of rotary disc discharger in Titanic’s silent room

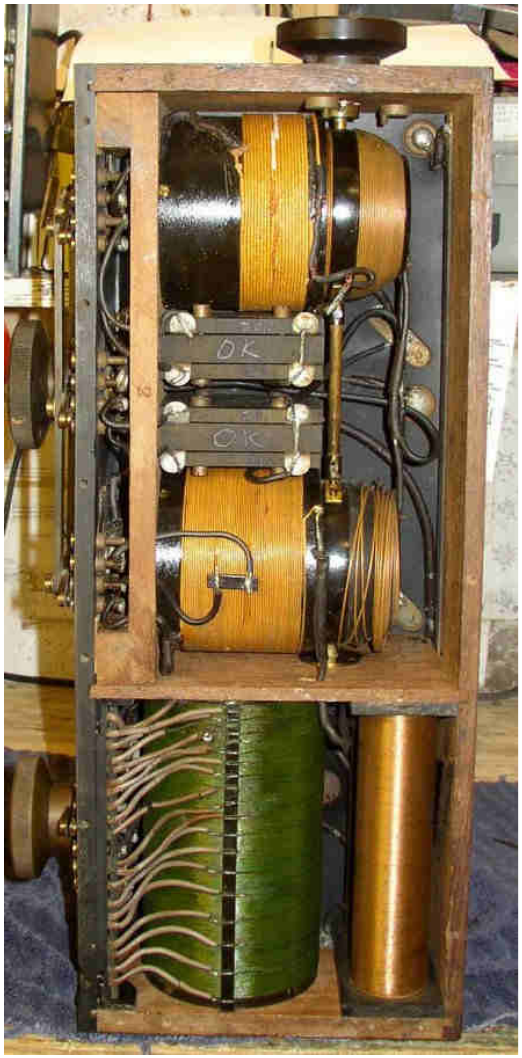
The real thing...2002

Marconi Multiple Tuner: tunes 2600-100m (120 kHz-3 MHz)

G. Marconi invented/discovered tuning. Pat.# 7777 in 1900

Vari-caps➔

Ant. match➔



Pat. in 1907 by Marconi , widely used 1907-1918. Usually used with a “Maggie”

Will match variety of antennas at wide range of freqs to detector

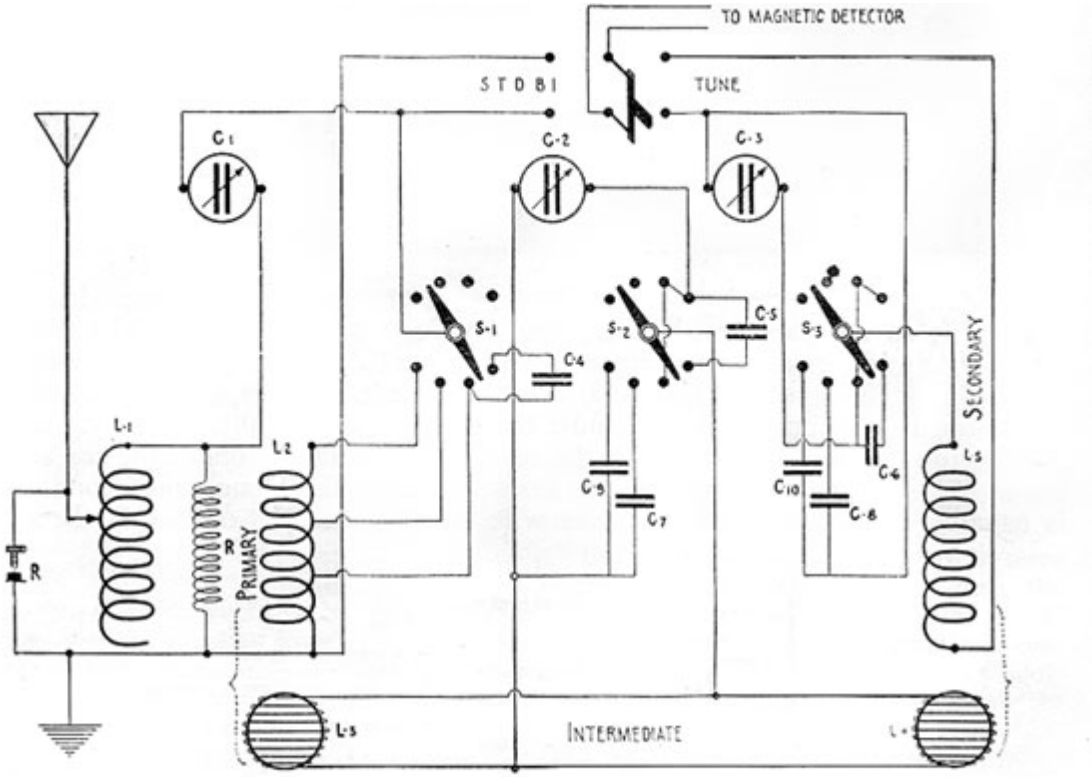
Selective OR sensitive…not both!

Marconi Multiple Tuner Designed by C.S. Franklin 1907

Gave far better selectivity than anything before

Tunes: 100-2600 m (3000 -120 kHz)

Efficiency (low loss): Very important!!

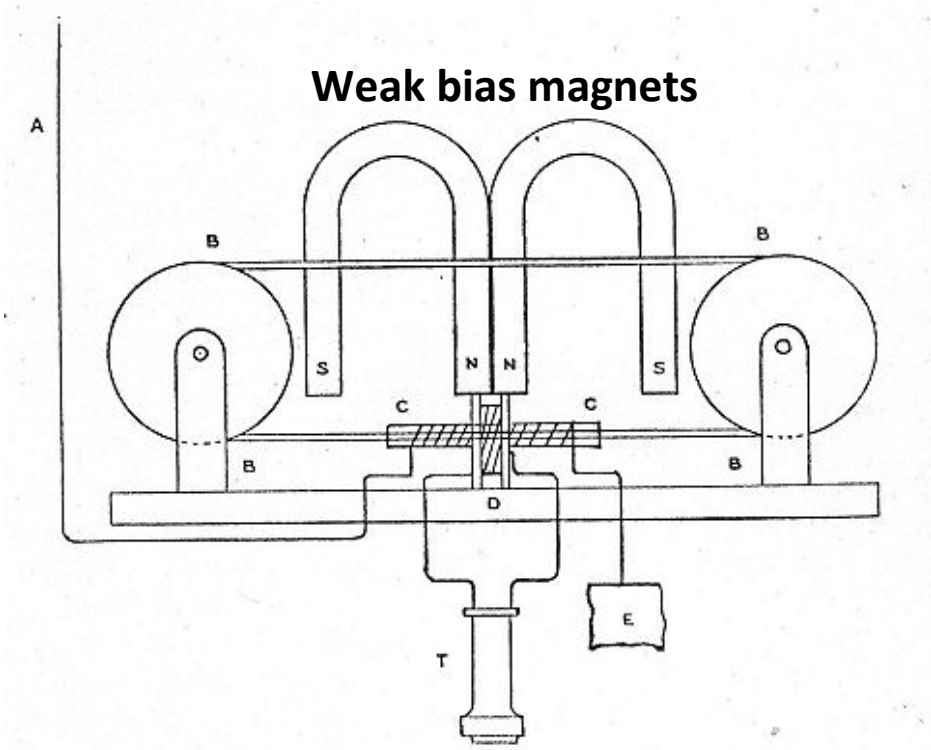


For wave lengths from 80 to 150 meters.	Condensers C-4 and C-1 are in series. Condensers C-5 and C-2 are in series. Condensers C-6 and C-3 are in series.
For wave lengths from 150 to 600 meters.	Condenser C-1 is in series with the antenna. Condenser C-2 is in shunt to the intermediate circuit. Condenser C-3 is in series with the magnetic detector.
For wave lengths from 1,600 to 2,000 meters.	Condenser C-1 may be in or out of the aerial circuit as required. Condenser C-7 is in shunt to condenser C-2. Condenser C-8 is in shunt to condenser C-3.
For wave lengths from 2,000 to 2,600 meters.	Condenser C-1 is in or out as required. Condenser C-9 is in shunt to condenser C-2. Condenser C-10 is in shunt to condenser C-3.

The Marconi “Maggie” magnetic detector. Ops really liked it’s sensitivity…better than the backup Fleming valves

The “Maggie”, invented by Ernest Rutherford 1895
Developed by G. Marconi 1902…much more sensitive than coherer
Marconi Co. “official” detector 1902-1918

A.RF from tuner
B.B. silk-wrapped 40 ga iron wire, moving in endless loop by clockwork driven pulleys
C. Input magnetization coil
D. Output pickup coil
E. Ground
T. Telephone (headphones)



Works by non-linear hysteresis (only one side of AC input wave magnetizes the iron wire)…and hence produces an output signal (acts like a diode)

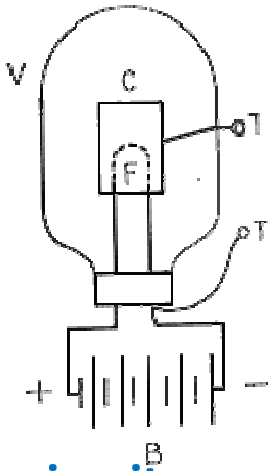
On Titanic: no coupler: Valve detector plugged into Marconi triple tuner and big T antennas

In theory, better sensitivity than Maggie

-a “soft” (gassy) tube

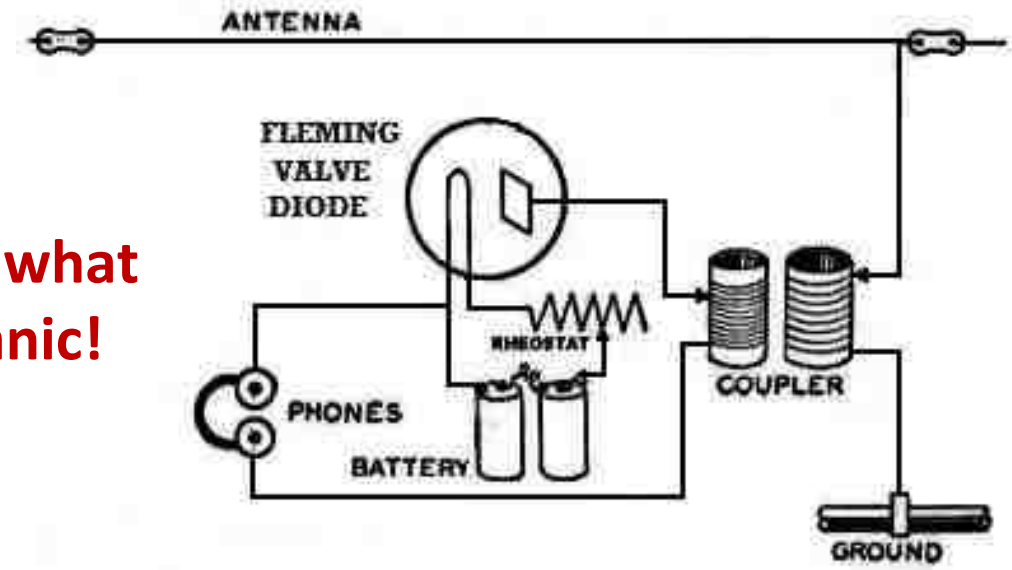
-poor reliability

-Marconi version used 2 valves in a full-wave circuit



Fleming valve

Not exactly what was on Titanic!



How did the Titanic's radio system perform??

(Marconi Co. guaranteed reliable day-time 250 mile comms)

In sea trials off Ireland (2-3 April)

-Solid contacts at night with Tenerife (1900 mi), Port Said (2600 mi).

-Consistent daytime contacts with ships + coastal stations > 400 miles away.

On the voyage

-Hundreds of messages delivered for passengers 7-14 April to UK shore stations, then Cape Race, NF.

-Failure on 13 April….kept ops up all night fixing 5kW TX. A 14kV rubber-covered wire was shorted to ground. Both ops were exhausted by night of 14 April.

-After striking berg (14 April), good comms with at least 12 ships, (copied by at least 24 ships) and Cape Race before sinking on 15 April.

Geography and timing of Titanic's one voyage and sinking

Last signal ("CQD") cut off by flooding engine room and dying generators at 02:17 Titanic time (00:27 NY time). Philips stops to pull main knife switches in silent room and flees. Top deck is awash. She sinks 3-4 minutes later.

Disaster Timetable (Titanic time, 1h 50m in advance of NY time at sinking QTH)

10-14 April: 250 trivial passenger Marconigrams sent
14 April 9:50 PM: "We are stopped and surrounded by ice" …C. Evans, Californian
11:50 PM: Berg sighted by Titanic lookouts
11:50:37 PM: Titanic strikes berg (500 yds @22.5 kts)
14-15 April 11:58, 12:14: Cap't. Smith visits radio room
15 April 12:15: CQD CQD CQD de MGY 41.46N 50.14W (sent 6 times)
12:15-12:45: many responses (ships + shore) ➔ extensive traffic
12:25: Carpathia (MPA) calls Titanic, "Cape Cod has msgs for you"
12:27: Titanic (MGY) "Come at once. We have struck berg. It's a CQD om"
12:45: MKC MKC SOS SOS SOS de MGY MGY MGY (MKC=Olympic)
02:17: last sig heard from MGY ("CQD de MGY" cut off abruptly in middle)
02:20: Bow breaks away, Titanic sinks

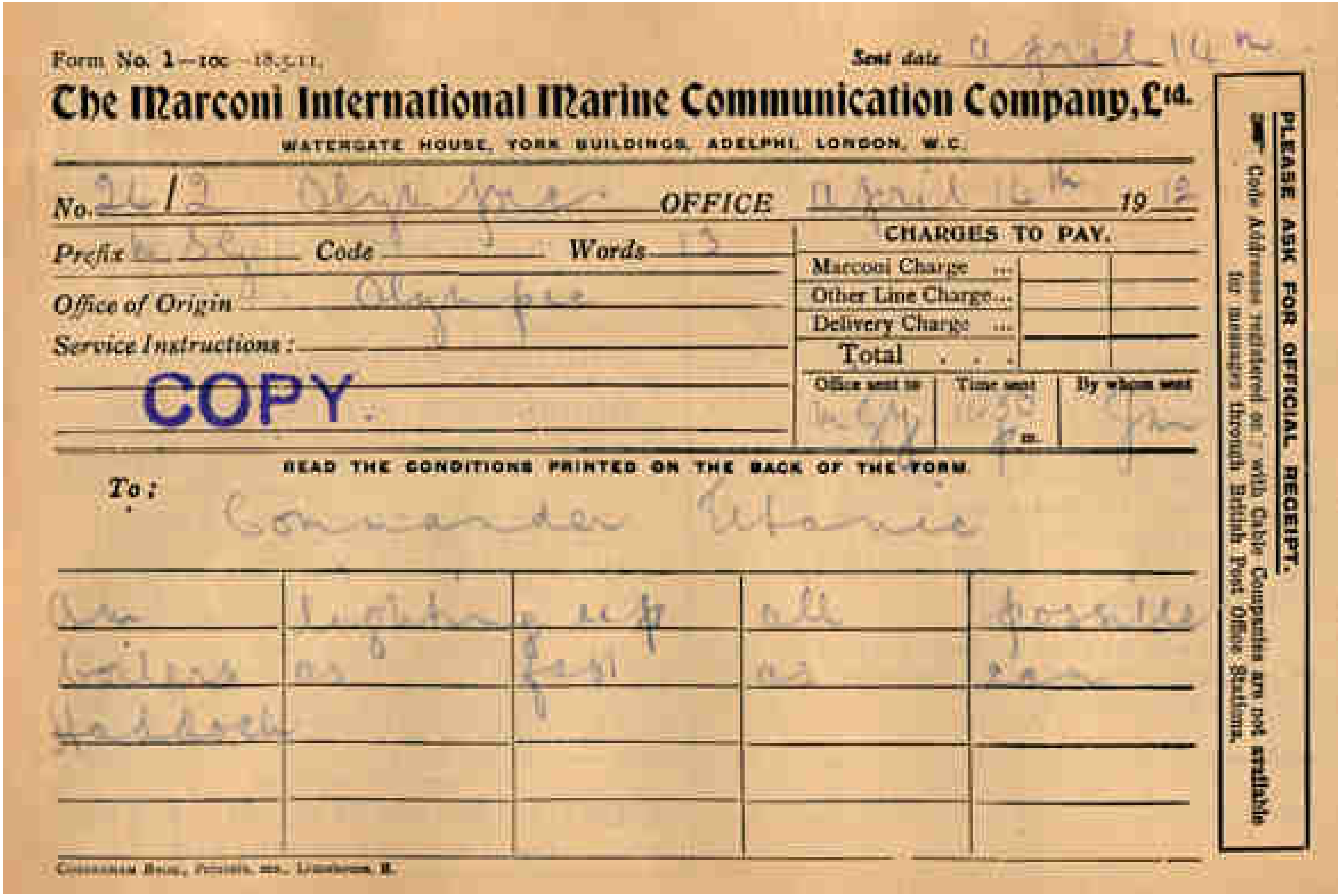
24 ships + 4 coast stations reported copying Titanic's CQD

Cape Race, NF (MCE)
Sable Is. NS (MSD)
Siasconset MA (MSC)
Sea Gate NY (MSE)

Jack Phillips, 25, senior op (SK)

Harold Bride, 22, jr. op

MKC responding to MGY



Form No. 1—10c—15.5.11.

Sent date April 14th

The Marconi International Marine Communication Company, Ltd.

WATERGATE HOUSE, YORK BUILDINGS, ADELPHI, LONDON, W.C.

No. 2612 Olympic OFFICE April 14th 1912

Prefix MSG Code Words 13

Office of Origin Olympic

Service Instructions:

COPY

CHARGES TO PAY.

Marconi Charge ...		
Other Line Charge ...		
Delivery Charge ...		
Total . . .		

Office sent to	Time sent	By whom sent
MGY	10.50 p.m.	

READ THE CONDITIONS PRINTED ON THE BACK OF THE FORM.

To: Commander Titanic

Am lighting up all possible boilers as fast as can Haddock

PLEASE ASK FOR OFFICIAL RECEIPT.

Code Addresses registered at, with Cable Companies are not available for messages through British Post Office Stations.

Goodman Bros., Printers, etc., London E.

RADIO "IF ONLYS"

#1 7:50 PM 14 April: SS Mesaba sent message to MGY; "Stopped. Sea packed with ice",
-prefaced with "Ice report" instead of "MSG" so sat under Phillips' elbow and was not sent to Captain Smith prior to collision.

#2 9:05 PM 14 April: C. Evans (Californian) "SOM, we are stopped and surrounded by ice"
Phillips "D D D D I am working Cape Race" (faster ships had msg priority)
This is famous "shut up!"

#3 10:55 PM 14 April: C. Evans (Californian) had been on duty from 7AM, so switched off at 11:35 PM and went to bed. 11:50 Titanic lookout sees iceberg. Californian 11 mi from Titanic!

#4 15 April, 12:05 AM: Phillips began sending CQD. Heard by many distant ships
12:20 AM: Charles Groves, 3rd Officer on Californian 11 mi away tries to listen to receiver, but doesn't know how to start magnetic detector clockwork.
At that moment Philips (Titanic) was calling constant CQD.

#5 15 April 12:30-02:10 Watch and Cap't. Lord of Californian see lights + rockets of Titanic 11 mi away, don't awaken Evans to check on radio, or go to check.
Thought ship couldn't be Titanic.
Titanic's appearance very distorted…due to cold water mirage.

More radio "If Onlys"

#6. 13 April: Tx broke, so Philips spent 6h of his rest finding + fixing fault. Therefore was very tired on night of 14-15th.

#7. 10-14 April: Bride + Philips sent 250 trivial passenger messages which interfered with iceberg warnings, other ship comms… made ops tired.

Six days later.

"Collapsible B" lifeboat that saved Bride's life….and on which Phillips died is found. Boat and men are from Mackay-Bennett out of Halifax.

Titanic **collapsable lifeboat as it approaches** ***Carpathia*****: April 15, 1912**

***Titanic* survivors on deck of Carpathia-"Women and children first"**

Harold Bride, debarking from *Carpathia*

In pain, from badly injured feet, Bride worked for many hours on *Carpathia's* radio to give Cottam a chance to rest.

Why was third officer C. Groves unable to turn on the Californian's maggie and hear Titanic's CQD???

Californian 3rd officer
C. Groves

C. Evans, Marconi
op on *Californian*

H. Cottam, Marconi
op on *Carpathia*

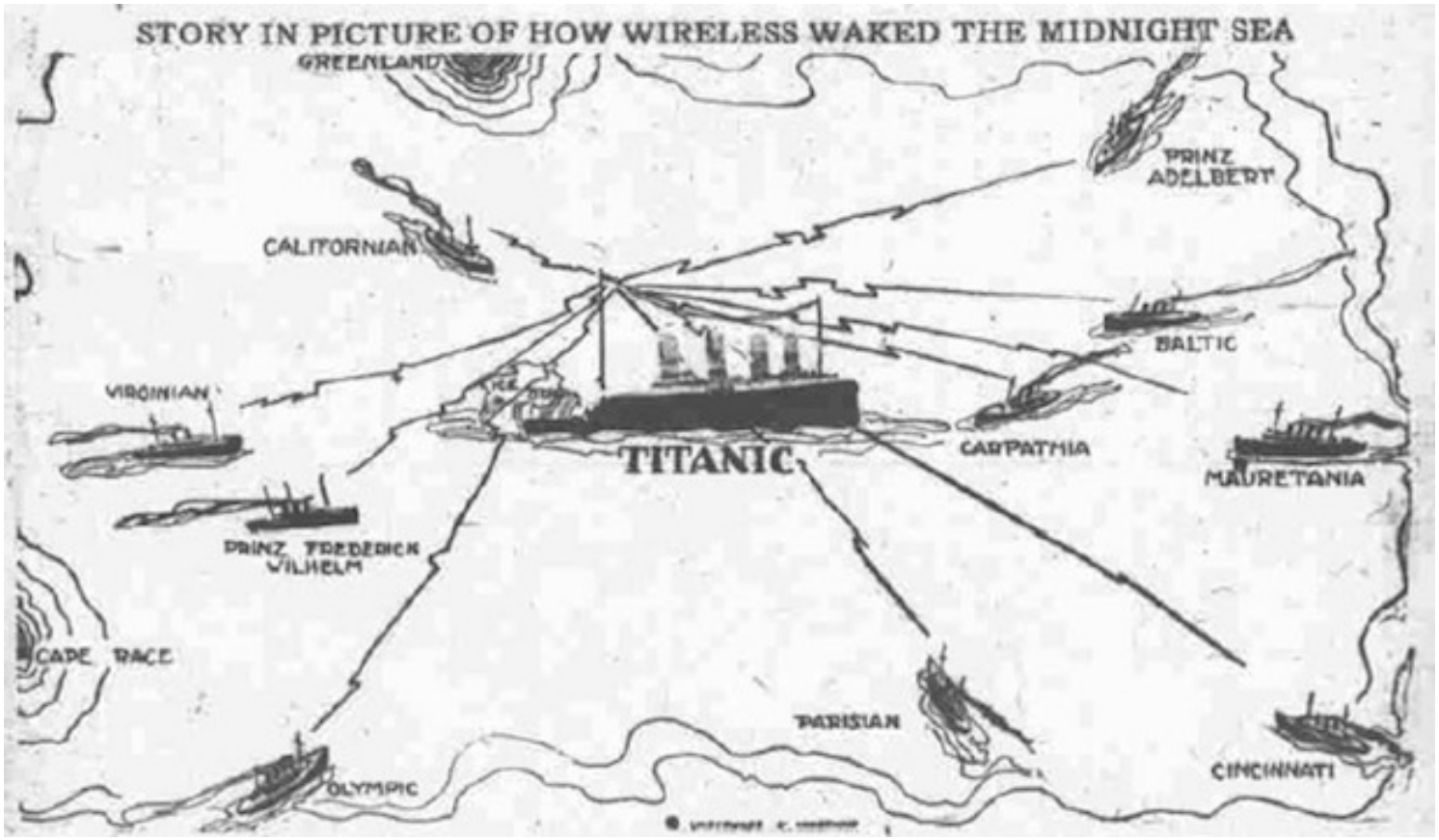
What did the Titanic disaster do to radio?

710 people saved by radio: proved again how useful it was

Radios: all performed well.

Radio Operators: all performed well or heroically: Cyril Evans, Harold Cottam, Jack Philips, Harold Bride

BUT: 1514 people died → inadequate operating system/regulations



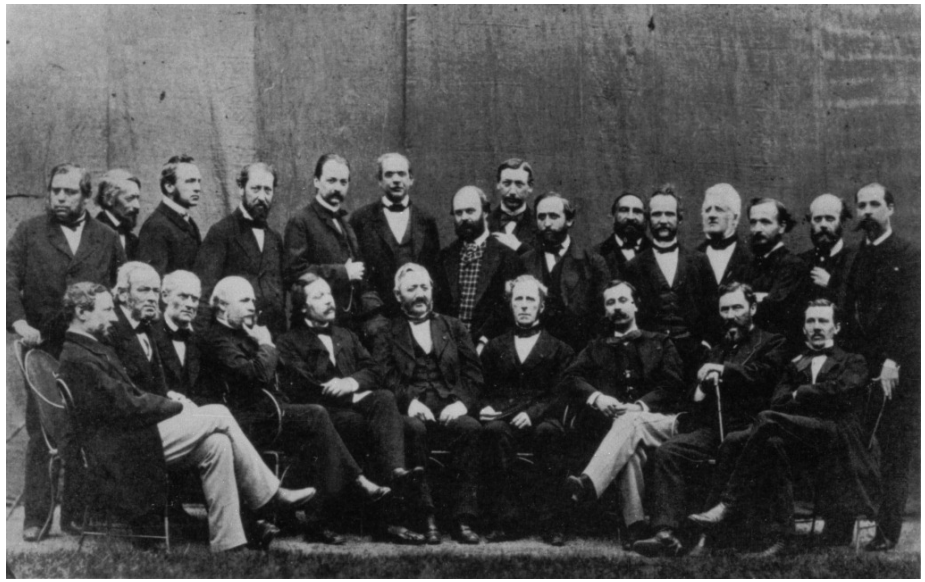
ITU -International Telecommunications Union: 1865 → today

-Controls, manages, establishes standards for all international communications

-held 1912 International Radiotelegraph Convention in London

-4 June-5 July, 1912 just 6 weeks after Titanic sinking

-waited until British and American Boards of Inquiry finished



International Radiotelegraph Conference of 1912, London

-national callsign assignments
-wx and time station frequencies
-Q-codes
-24h radio watches for all larger ships
-pauses in longer messages for emergency traffic
-3 min silent periods for emergency traffic

Radio room clock → (with 3m silent periods + Autoalarm timer)

-shaped todays comms!

US Radio Act of 1912

-passed in August, compatible with ITU regulations

-all radio stations + operators must be licensed

-all seagoing vessels must maintain 24h radio watch

-600 meter (500kHz) is distress frequency, emergency messages have top priority

-2 three-min silent periods/h for distress calls

-SOS will be standard distress call

-private stations (amateurs) get “200 meters and down”, ie, all frequencies above 1.5 MHz!

Conclusion: radio regulations enacted as a result of *Titanic* disaster probably saved more lives than were lost on the *Titanic*

de MGY MGY .....SK