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The Introduction of FM Sound Broadcasting in Britain

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I am an electronics engineer, NOT a professional historian - but I am now part of history since the subject of my paper is part of my personal experience!

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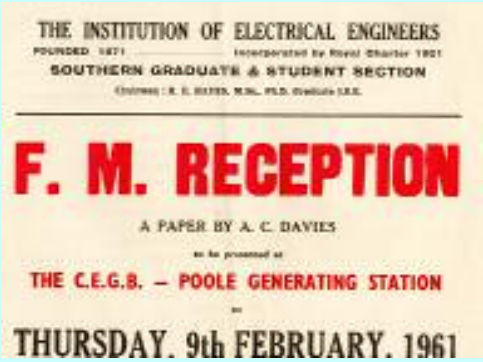
What I was doing in 1961


THE INSTITUTION OF ELECTRICAL ENGINEERS
SOUTHERN GRADUATE & STUDENT SECTION

F. M. RECEPTION

A PAPER BY A. C. DAVIES

THE C.E.G.B. — POOLE GENERATING STATION

THURSDAY. 9th FEBRUARY. 1961

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What I was doing in 1961


I.E.E.
FORTHCOMING NORTH EASTERN GRADUATE AND STUDENT SECTION ACTIVITIES
GOLDEN JUBILEE YEAR
F. M RECEPTION

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GRADUATE AND STUDENT MEETINGS


A. C. DAVIES.
The Institution of Electrical Engineers
SOUTHERN CENTRE

IEE Programme Booklet 1961

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Some British History

➔ Pioneering introduction of TV

The world's first high-definition broadcast TV service

➡ began in **1936** from Alexandra Palace (405 line standard).

*This was well ahead of all the "**competition**" (USA and Germany)*

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➔ **Alexandra Palace now**

Photos: ACD, April 2005

Some British History

- Pioneering introduction of TV in **1936** from Alexandra Palace

But ……

- Very late introduction of broadcast VHF/FM sound service.

began in **1955**, long after USA, Germany, and others.
It started with little enthusiasm, regarded by authorities as "an unwelcome complication" compared to LW/MW AM

Why so late? **How** was the introduction done? **What** happened subsequently? **What if** a difference choice?

Frequency Modulation : concepts and (mis)understanding

First proposals for FM were ~**1900**:

- hope for a reduction in bandwidth compared to AM !!!!!
- many misconceptions, led to rejection of FM by many experts

Edwin Armstrong (USA) – in **1936** – demonstrated conclusively the real advantages of FM for broadcasting and showed how to implement the Transmitters and Receivers

Armstrong's controversial life and contributions, and tragic suicide, have been well documented already.

Edwin H Armstrong (USA):

RCA antenna tower
1923

1938: antenna for Armstrong's Experimental FM sound transmissions in USA (W2XMN transmitter)

European broadcasting environment, 1930-1950

A few high-power National broadcasting stations – typically state-controlled content

A few (*unlicensed or discouraged*) high-power commercial stations transmitting across National boundaries

(e.g. Radio Luxembourg, LW, then 208m from 1950)

USA broadcasting environment, 1930-1950

Many low-power Local broadcasting stations,licensed nationally (by FCC) but content linked to advertising

UK Post World War II broadcasting environment, 1945-1950

Unacceptable levels of interference on LW/MW
(especially sky-wave reception from Continental Europe after dark, and LW interference from unsurpressed electrical motors, thermostats, etc.)

Lack of channels for development of broadcasting
(geographical frequency re-use not easy because of high-power transmitters)

A need to develop VHF sound broadcasting seemed evident - but ……

should it be AM or FM or something else ?

economy was ***'in recovery'*** from war, so finance not readily available (either for TX or RX development and manufacture).

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1945: BBC Engineering Department began tests to decide the relative merits of AM, FM for VHF use

1951: BBC began comparative test transmissions from **Wrotham, Kent**, using a transmitter built in 1949

(a) conventional AM

(b) wideband FM

(c) AML (= AM with an impulse-noise limiter in a wide-band receiver)

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January **1954**:

Report of **TV Advisory Committee** *(established by British Government in 1935 to oversee TV development)*

Recommended the use of FM (by a narrow margin) – apparently with little enthusiasm.

Includes 6-page minority report (by C.O. Stanley, owner of Pye Company):

"….VHF broadcasting has been a failure in practically every country …..."

He advocated narrow band AM

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Original Wrotham Transmitter mast,

143m height

Photo: BBC Research Dept

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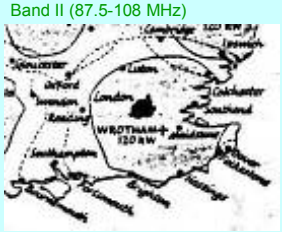
Wrotham VHF antenna:

2m diameter, 32 metre long cylinder, 32 vertical slots

Horizontally-polarized, 25kW (later 120 kW)

Band II (87.5-108 MHz)



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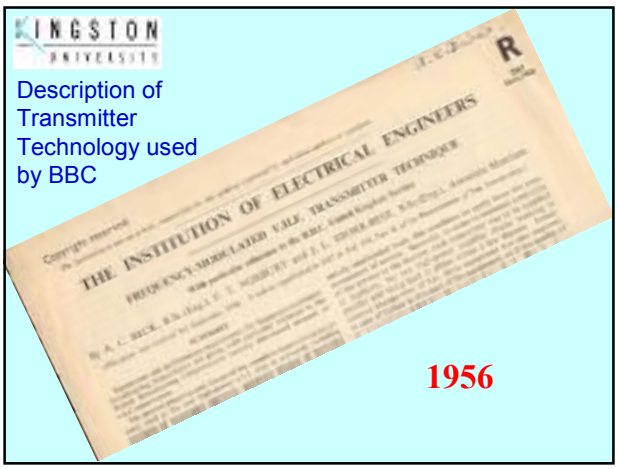
Description of Transmitter Technology used by BBC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1956

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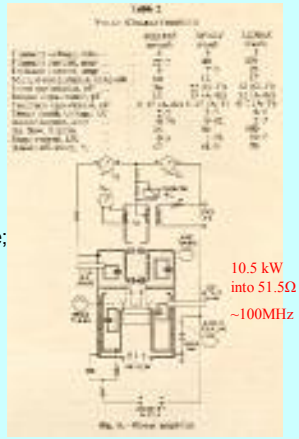
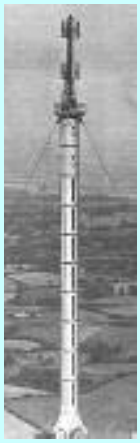
Three transmitter outputs combined into a single antenna

Three air-blast cooled valves:
1.5kW tetrode
→ 2kW triode
→ 9 kW triode;
(grounded-grid)

2.5 kV to stages 1 and 2
9 kV to stage 3

Filament Heater (V3):
625W at 5V





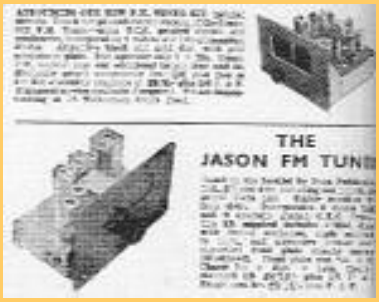
Wenvoe, Wales (Glenfô, Cymru)

More complex terrain, and need to provide services in English and Welsh

FM Receiver availability in 1955:

Initially, many imports came from Continental Europe, since VHF/FM was introduced in Germany at the end of WW II (because insufficient channels were offered on LW/MW)

Do-it-yourself Home Construction kits for 'FM Tuners' were popular – most used CV138 (EF91, Z77) h.f. pentode valves.



Such F.M. Tuners typically needed 250 V dc and 6.3 V ac for the valves, and an audio power amplifier and loudspeaker.

Commercial (ready-made) FM Tuner from DYNATRON

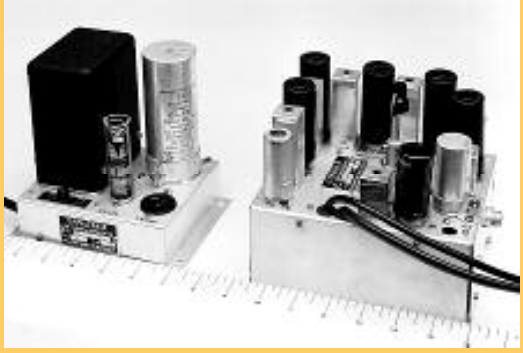


Photo: BBC Research Dept

Typical quality radio receiver at time of introduction of VHF/FM service in Britain

Philips model 643A with piano-key band-selector and rotatable ferrite antenna for LW/MW and 'magic eye' tuning indicator

www.thevalvepage.com/radios/philips/643a/p643a.htm

No printed circuits

No transistors

Vinyl long-playing 33 rpm and extended-play 45rpm records had recently been introduced in Britain, and created public interest in 'better quality' sound – and perhaps prepared the way for more appreciation of FM broadcasting.

Bang & Olufsen 507LP, 1952

www.beoworld.co.uk/vintage/507lp.htm

Transistors suitable for high frequency or high power were not commercially available for a few years.

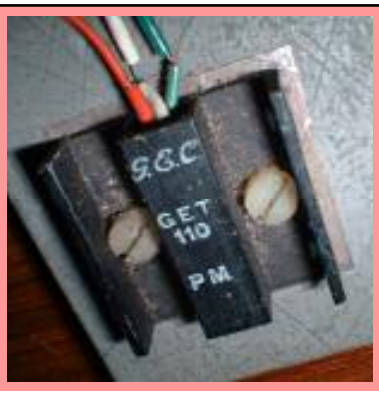
$h_{fe} \sim 100$

$f_T \sim 70$ MHz

$Ic \leq 10$ mA

PNP

OC170: became available for IF amplifiers at 10.7 MHz



GET 110: became available for audio output stages: two in push pull could provide ONE WATT !!

Transistor Portable Radio – LM / MW only

for 'home construction'

approx. **1960**

Transistor Portable Radio – LM / MW only – for 'home construction' in approx. **1960**

Rear view:

Printed circuit construction, but transistors not suitable for VHF

Transistor Portable Radio – LM / MW only – for 'home construction' approx **1960**

Early AM/FM all-transistor Portable (for USA/Canada market)

1968

Early AM/FM all-transistor portable (for USA/Canada market)

Your new Lloyd's Model BN53 is a 10 transistor AM-FM receiver operable either on self contained batteries or from any standard AC 117 volts 60 cycles outlet. Its construction utilizes space age electronic techniques to create a compact precision instrument of outstanding performance and dependability.
A high sensitive superheterodyne circuit matches maximum selectivity with high sensitivity.

Early AM/FM all-transistor portable (for USA/Canada market)

Early AM/FM all-transistor portable (for USA/Canada market)

Interior

Later developments

1966: Regular Stereo Broadcasts commenced in UK

(cf. USA start in 1961)

1981: Start of the introduction of higher transmitter powers and mixed-polarisation transmission to improve reception by portable radios and vehicle radios

Recognition that there would be no further development of AM, and that FM would be the predominant method for Sound Broadcasting.

Cross-Polarization Antenna for FM

Photo: BBC Research Dept

Later developments

1996: 'BBC Transmission' was 'privatised':

Most responsibilities taken over by

Castle Transmission International

(now 'Crown Castle International')

(BBC Research Department still exists)

Now: BBC transmits FM sound from 200 UK sites with powers from 4 W to 250 kW

Shared-services sites

Low-power FM transmitter (500W)

(Purin Hill, Fife)

(Mike Smith web-site: mds975.co.uk)

How they look now!

White protective cylinder encloses UHF TV antennas

VHF FM Band II antennas are the section below the white cylinder (with Band III DAB antennas too)

Transmitter mast erected in mid 1980s

(*photo, ACD, January 2005*)

at

Wenvoe, Wales (Glenfô, Cymru)

What if Britain had rejected FM in 1955 ?

Suppose VHF/AM had been chosen instead.

1. **Out-of-line with the rest of the world**
2. **VHF/AM sound was used in the British 405 line TV standard from 1936. The transmissions were effectively superceded by the introduction of PAL (with FM sound) in 1964, but transmissions continued until 1985**
3. **Quality and S/N ratio might have been adequate**

BUT

No Capture Effect with AM, so far fewer high-power transmitters would have been possible, and much less frequency re-use

What about the Future

After FM …….. ?

1. DAB (digital audio broadcasting) ; use of coded OFDM
2. Broadband Internet Streaming Radio
3. …….. ? ? ?

Quotation from **1963**:

"`.. a change may be made to such techniques as Pulse Code Modulation, which have theoretically even better signal/noise properties.`"

(from A.C. Davies, 'F.M. Reception', *IEE Students' Quarterly Journal,* Vol 33, p145)

Acknowledgements:

BBC Research Department for photos and access to documents

Mike Smith (mds975.co.uk) for permission to use Purin Hill photos

Alexander Popov

Thank you for your attention