DECCA NAVIGATOR

WHAT IS DECCA NAVIGATOR?

The Decca Navigator System, herein abbreviated as **DNS** for convenience, is a hyperbolic radio navigation system which was established in the United Kingdom after World War 2 and later used in many areas around the world. It operated by measuring the phase differences between continuous signals from a master and slave stations. These differences were then related to a hyperbolic lines printed on a chart. By plotting the readings from two pairs of hyperbolas at any particular instant, users could plot their position instantly.

The system used groups of at least three shore based transmitter stations called chains operating in the 70-130 kHz radio band. Each chain comprised of one Master and two or three Slave stations, usually located 80 to 110 km from the Master station. The accuracy of DNS ranged from 50 meters during daytime to 200 meters at night. It could decrease up to 800 meters as the distance from the baseline increased. Accuracy was also affected by seasonal effects which generally reduced the accuracy by a factor of 6 to 8. The maxium daytime range for DNS was 300 to 400 miles with a reproducibility of 200 meters. At night, accuracy was guranteed out to 240 nm by the British Admiralty.

For a comprehensive look at Decca, select the following:

This was the corporate logo of The Decca Navigator Company as imprinted on a system manual. (*Graphic courtesy The Decca Navigator Company)*

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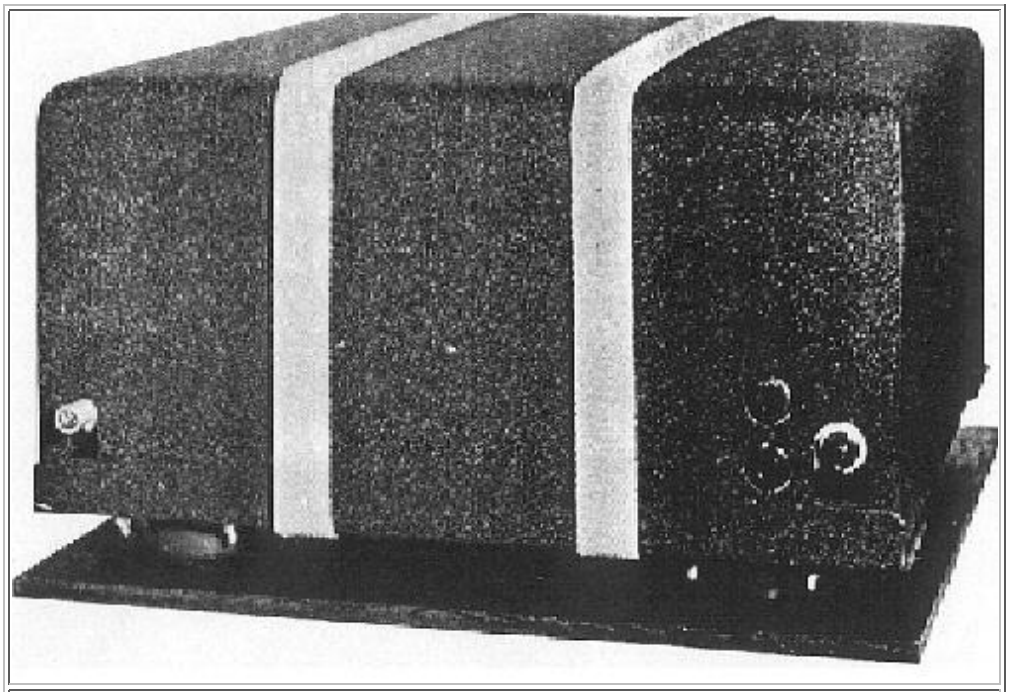
AIRBORNE RECEIVERS & INDICATORS

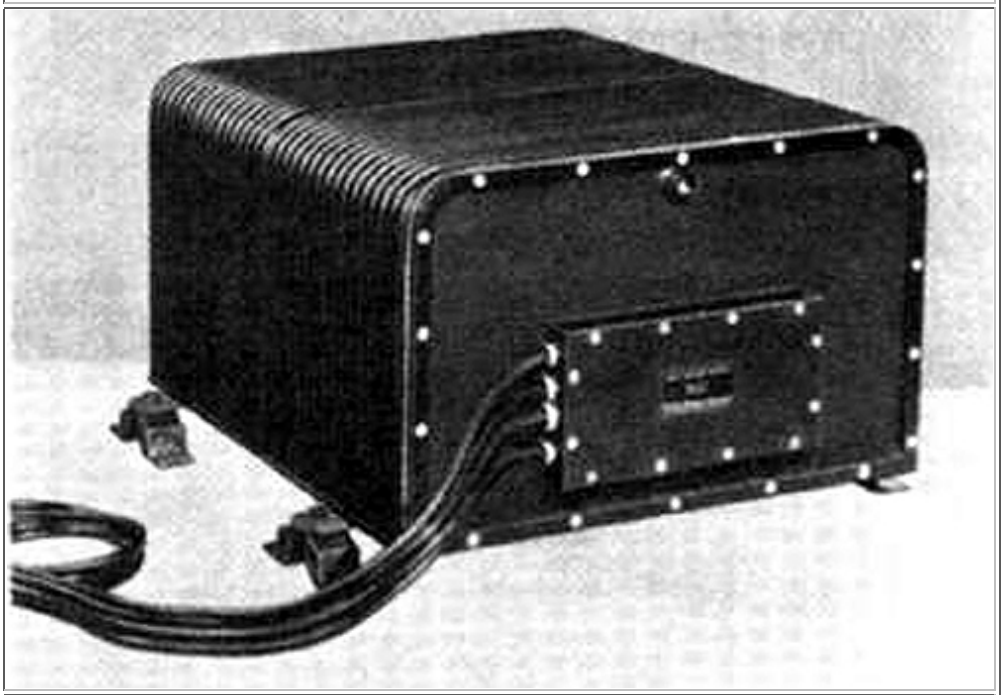
(Survey and special-purpose receivers, e.g. Type 990 (RAF Mk 1 Air) not included in this document).

Mark 6, 7, 8, 9, and 10 were all airborne-only receivers. Mk 4 was available in both airborne and marine versions

Mark IV Receiver



Mk IV - Front View *(Photo from the collection of Walter Blanchard)*



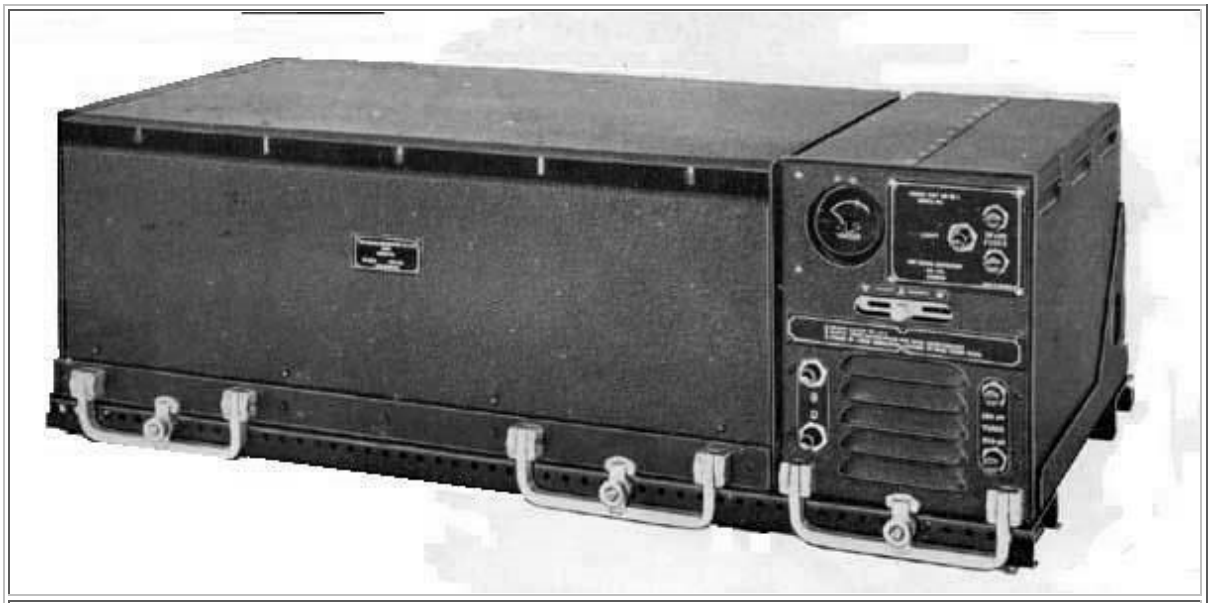
Mk IV - Rear View *(Photo from the collection of Walter Blanchard)*

Type: **Mark IV** (MkIVA airborne version shown above)
Input Power Requirements: Airborne - 80 VAC at 1000 cps at 80 watts.
12 VDC at 90 watts.
24 VDC at 90 watts.
Marine - 110 VDC at 90 watts

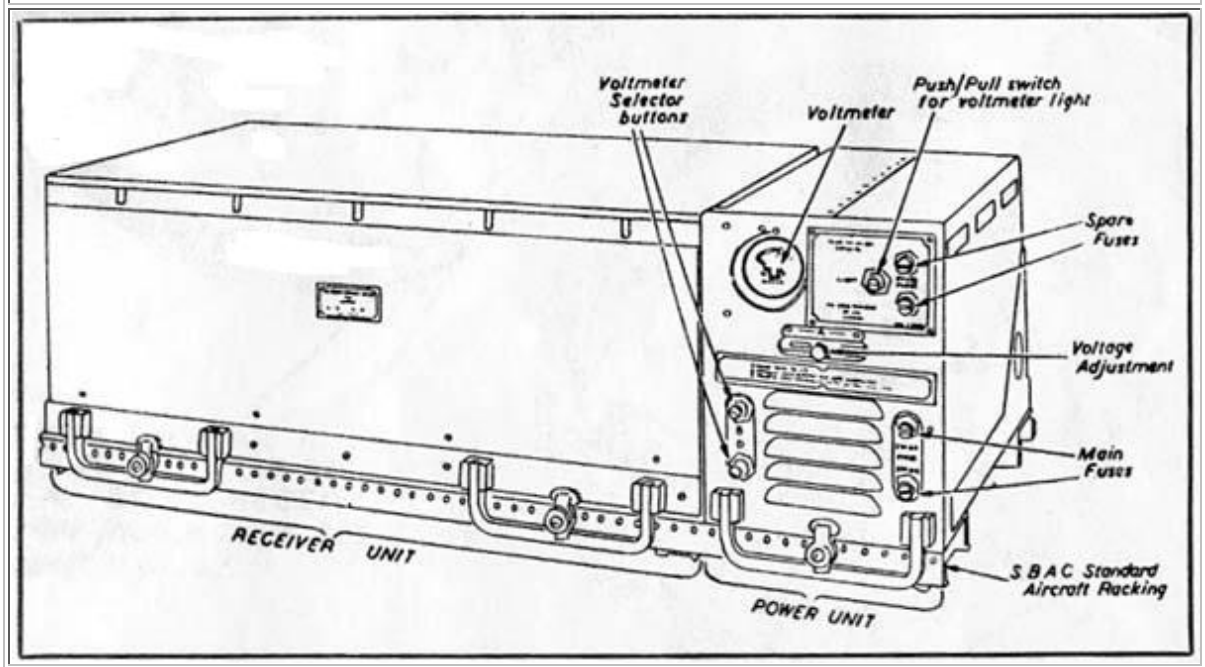
Display: 1 set of decometers
Number of Channels: 4 (Master, Red, Green and Purple)
Dimensions: 15.5 x 15 x 7.5 inches
Weight: 25
Quantity Produced: ??
Purpose: Airborne navigation
Comments: Receiver in production as of 1946. Sub-designated QM 's 6,7,8,11,13 depending on chain and frequencies. The very first Mk 4 receiver was fitted to M.V. ROGATE (Stephenson Clarke Shipping) on Feb 26, 1947

Variant: MkIVA was used for airborne navigation.

Mk 6 RECEIVER



1949: Decca Mk 6 Aircraft Receiver. *(Photo from the collection of Walter Blanchard)*

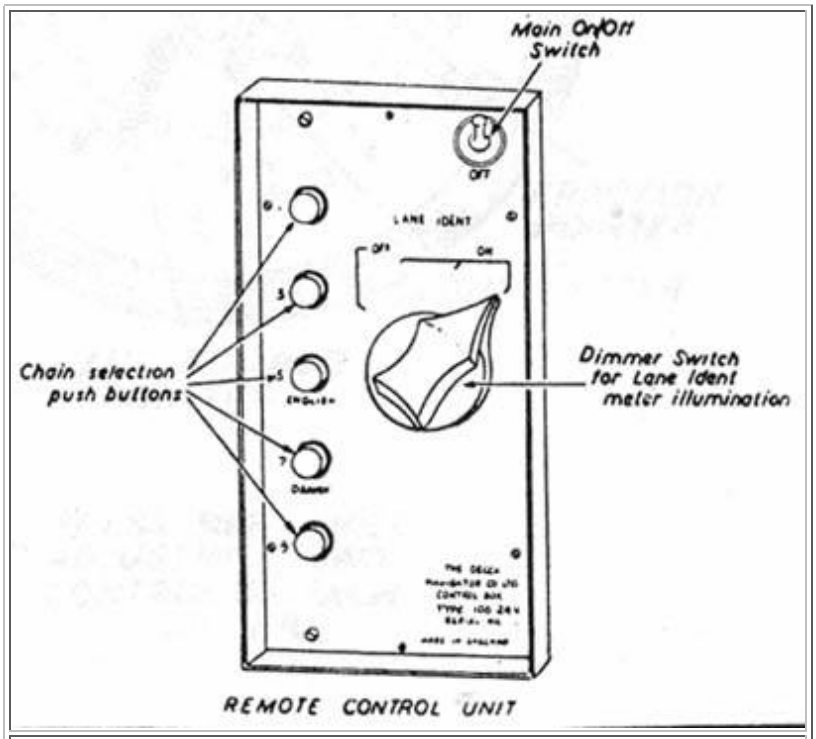


This diagram shows the external controls of the MK 6 receiver. *(Image from the collection of Walter Blanchard)*

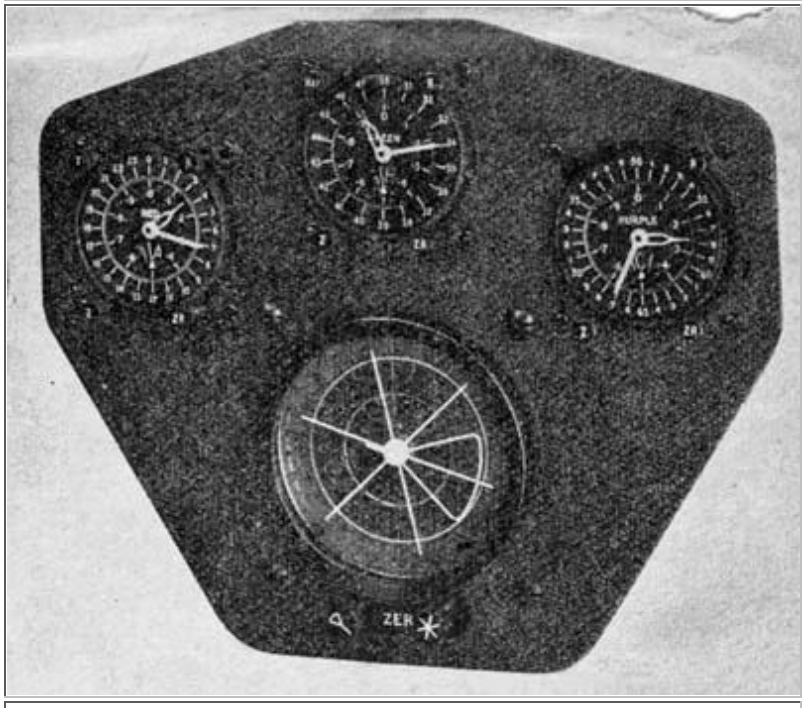
SPECS

Receiver Dimensions: 21" W x 8.5" H x 11" D.
Receiver weight: 24.5 lbs.
Capability: Can receive up to 5 chains. Remotely controlled from cockpit.

Power Unit Dimensions: 6"W x 8.5"H x 11"D
Power Unit weight: 19 lbs.
Power Input 24 VDC@ 12.5 amps
Comment: Airborne receiver electrically similar to Mk. 5



Pilot's remote control for the Mark 6 receiver. *(Decca Navigator Company image)*



1949: Mark 6 decometer panel. *(Courtesy "The Aeroplane", June 1949)*

FLIGHT PLOTTER

To simplify the problem of navigating in all types of aircraft, Decca came up with a solution in the form of a presentation suitable for pilot navigation.

Simple route graphs prepared by the Decca Navigator Company for all European air routes were inserted in the Flight Plotter and the pilot only needed to turn the knobs of the Flight Plotter to bring the perspex cursor to correspond to the Decometer readings at any point on his flight, to obtain, without further effort, not only a position fix, but also range and bearing from destination. The pilot was entirely free to make any deviation from route when circumstances necessitated and was able to use this simple and efficient method of navigation throughout his flight.

1949: Decca Flight Plotter. Click to enlarge. It bears no model or part identification because it was the very first one that Decca produced. The complete Flight Plotter illustrated here contains the Route Graph for the Metropolitan Control Zone, which enabled the pilot to continuously and accurately plot his approaches along the corridors to the principal Metropolitan airfields in Europe. Weight of the Flight Plotter is 4.5 pounds and its dimensions are 12"W x 14" H x 2"D. (*Decca Navigator Company image)*

This device, in conjunction with the Decca Navigator Mark VI receiver and the existing Decca chains of the day provided a realistic and practical aid to navigation in Europe.

SAMPLE ROUTE GRAPHS FOR THE FLIGHT PLOTTER

Click to enlarge. This is the Route Graph for the area north of London enabled range and bearing from Luton Control Point to be obtained at any time during the flight. This. Route Graph was used for general flying in this area and for all routes running into the London Control Zone from the North East area. *(Graphic courtesy Decca Navigator Company)*

Click to enlarge. The Route Graph shown here is for a typical European air route such as Brussels to London. *(Graphic courtesy Decca Navigator Company)*

FLIGHT LOG

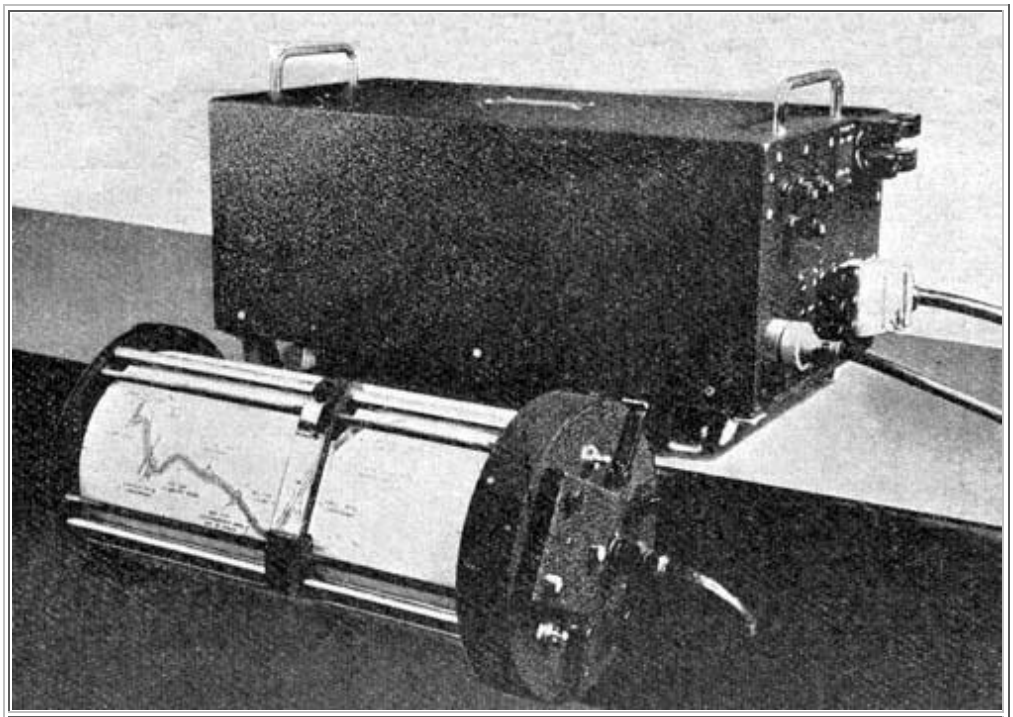
The Decca Flight Log was a logical extension of the Flight Plotter and was made possible by the use of the new map projection technique used in the Flight Potter. The map of the route to be flown was carried on a cylinder, measuring 16 inches in length and 7.5 inches in diameter. As the cylinder was rotated about its axis by the drive unit, it was traversed by a Perspex scale. A marker carried by this scale made, on the map, a continuous recording of the track of the aircraft over the ground.

As was the case with the Plotter, the map could be varied to suit particular requirements. Complete flights of up to 300 miles could be covered on one map, with separate diagrams to cover the approach pattern, traffic holding procedure, etc.

Decca co-ordinates would not normally be marked in on the map but would be printed in the appropriate colours on the reverse side. If it was desired to check the Log for accuracy, the inside of the drum could be illuminated, to make the co-ordinates visible. Readings could then be taken from the receiver and plotted in the usual way on the map. A time plotter was also provided for optional use. When switched on, it caused the pencil marker to deviate at given intervals and thus provided a record not only of the track flown by the aircraft, but of the time taken over various sections throughout the flight.

Apart from the obvious value of the Log for navigational use, it had an important application as a flight recorder. The installation of a Log in the rear of an aircraft used for navigational training, for instance, would enable a complete picture of the pupil's flight to be obtained and a post morteum could be held if necessary. Similarly, aircraft operators would find the installation of a Log useful as a means of checking the movements of their aircraft.

In 1949, the Flight Log only existed in prototype form and flight trials had not yet commenced. It had, however, been extensively tested in road trials, and some impressive results were obtained. In one test, a vehicle equipped with the Flight Log had a run down the Kingston By-pass (in the UK). The engineers watched the Log draw a line accurately down the centre of the road marked on the map. They did however, notice that telegraph and trolley bus wires sometimes caused serious deviations. At short ranges, this would make road use of the instrument impracticable. It was anticipated that Flight Log would be available by 1950.



Essential components of the Flight Log were a torque amplifier, a drive unit, a display unit, and the Mark 6 Decca Navigator Receiver which fed the drive unit. In 1949, only prototypes of the Flight Log were available. (*Decca Navigator Company photo)*

Mk 7 RECEIVER

Airborne receiver using locked oscillator; phase comparison directly at slave frequencies.

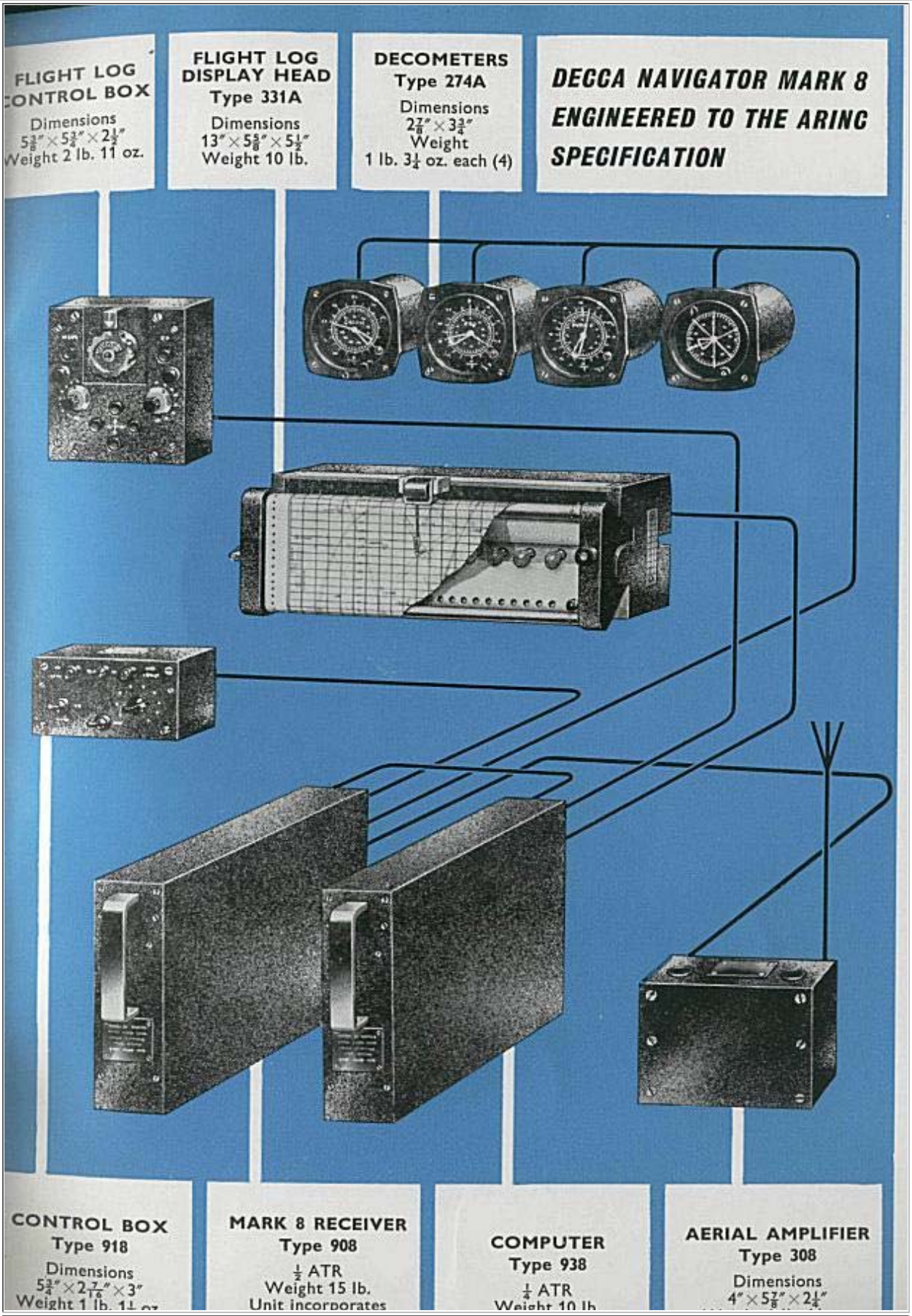
Mk 8 RECEIVER

Airborne receiver same as Mk. 6 but fitted in standard SBAC racking.

This receiver was used by the RAF. In 1955, eight Valiants and ten Shackletons were fitted with Mk 8 receivers and flight logs for “Operation Grapple”, the nuclear bomb tests at

Christmas Island. It was also by (former) British European Airways on their Argosy freighter aircraft. The Ledex switch assemblies used in the Mk8's were often the root cause of many problems although the tubes seemed to have a very long life span and were not changed that often.

Variant: Mk. 8A - Airborne receiver based on Mk. 8 but fitted in smaller half-ATR ARINC racking.

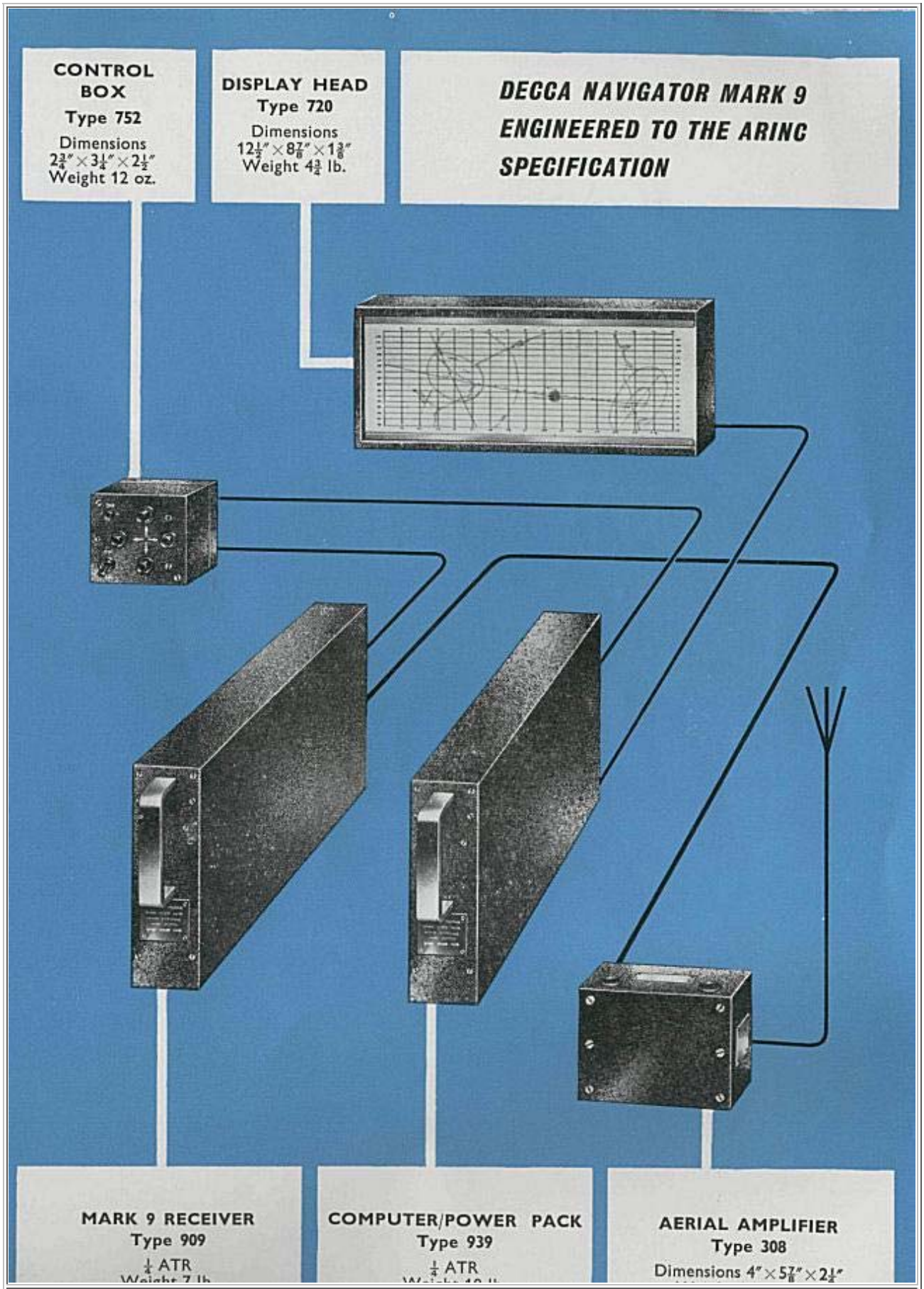


Mk 8 receiver components. Source DECTRA marketing brochure. *(Photo courtesy Decca Navigator Company)*

	
Closeup of the RED Mk VIII aeronautical decometer. Type 274-Z. P/N 10Q316774. *(E-bay photo)*	Rear view of GREEN Mk VIII aeronautical decometer. Type 274Z. P/N10Q16773 . *(Photo courtesy Denis Chouinard)*

Mk 9 RECEIVER

Airborne receiver without Land Identification feature.

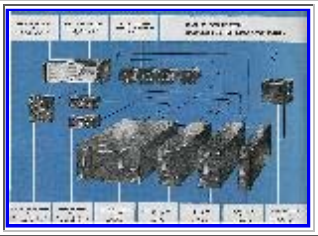


Mk 9 receiver components. Source DECTRA marketing brochure. *(Photo courtesy Decca Navigator Company)*

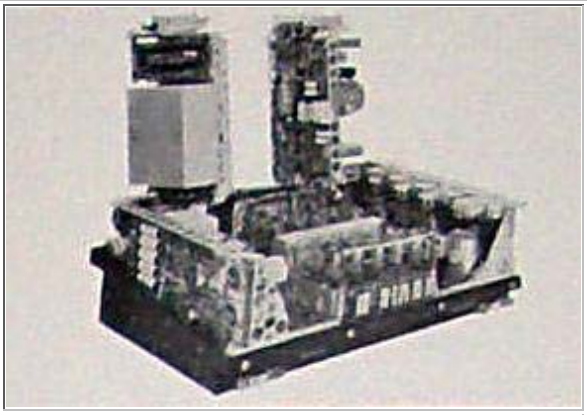
Mk 10 RECEIVER

Major new design of the airborne receiver for use in the DECTRA system . It employed locked

oscillators on all channels; automatic Lane Identification using the Multipulse method; had the zone identification feature; phase comparison at 1F (14 kHz).



Mk 10 receiver components. Click to enlarge. Source DECTRA marketing brochure. Mk 10 receiver dimensions/weight: 24 in W x 15.5 in D x 9.25" H / 50 lbs. *(Photo courtesy Decca Navigator Company)*



Mk 10 receiver with cover off and two modules extended for service. *(Decca Navigator photo)*

Mk 11 RECEIVER

First solid-state receiver. Used with the Omnitrac/Harco system. Employed electromechanical tracking filters and digital outputs.

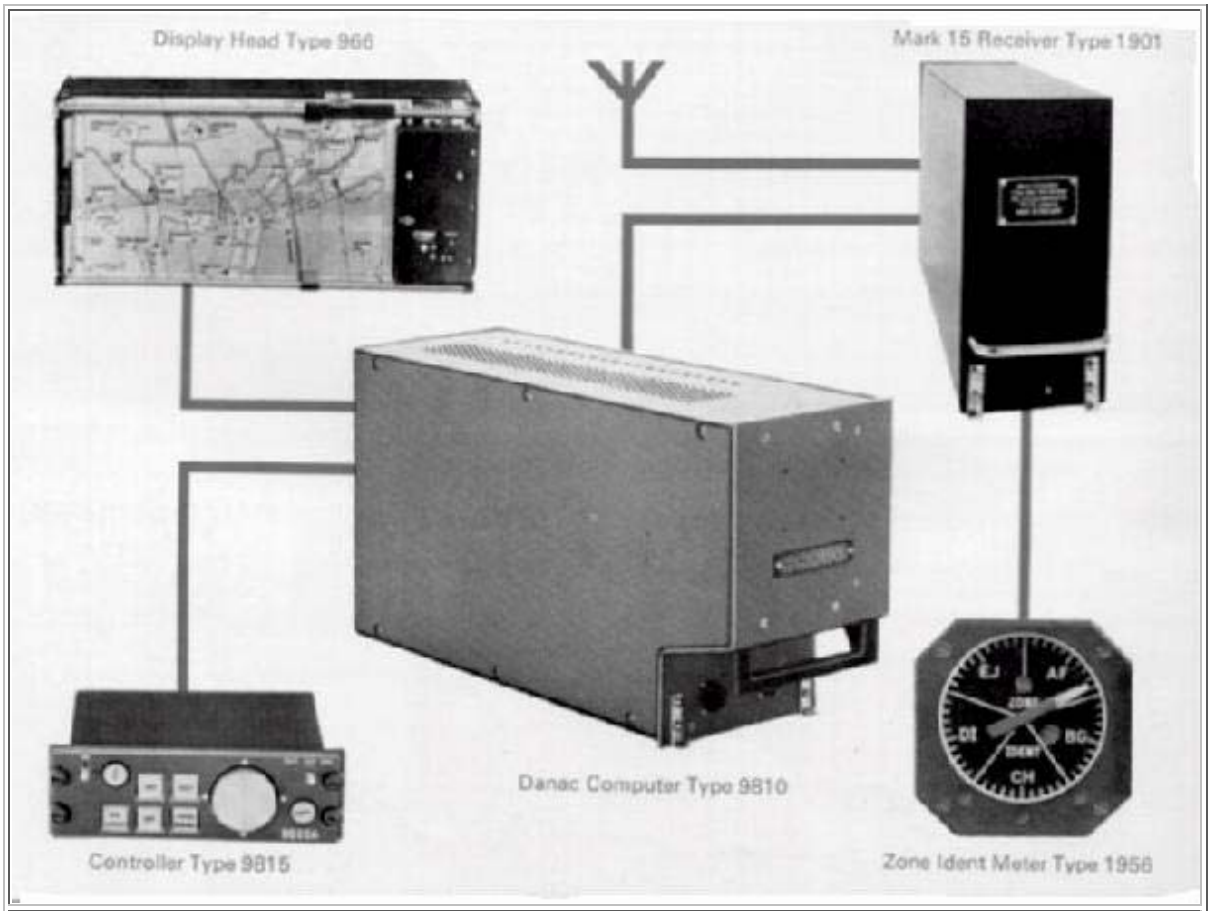
Mk 14 RECEIVER

This was an airborne receiver prototype using locked oscillators s on all channels and outputs at 1F for external phase comparison. No Lane Identification or Zone Identification.

Mk 15 RECEIVER - DANAC

This was a development of the Mk. 14 receiver for use in DANAC incorporating full Land Identification and Zone Identification. Used with computer types 1910 or 9810.

The Mk15's were used on British European Airways Trident aircraft, and were also a standard fit in many UK registered Jet Ranger helicopters. On the Mk15's, various transistors often failed along with crystals. One of the most common "squawks" was that the radio would not sync up, primarily either on Red, Green or Purple. This was due to either crystal aging or mechanical damage (drop shock) and hence no sync.



Mark 15 receiver system. *(Photo from the collection of Walter Blanchard)*

DANAC stands for **D**ecca **A**rea **N**avigation **A**irborne **C**omputer. In this system, the position-fix information delivered by a Decca Navigator receiver is continuously presented, via the computer, on a Flight Log pictorial display. This product was introduced in 1969.

The system is largely automatic, but permits the user to monitor all stages of operation. A basic principle is that the computer, during initial setup and under certain other conditions, requests the user to confirm that he accepts the displayed position of the aircraft. If the position is not acceptable he can adjust the display using the prescribed procedures.

A) In addition to the Danac units, the Mark 15 system has an antenna amplifier Type 1995
B) The additional units of the Mark 19 system are:-

Antenna amplifier Type 1995
Mark 19 receiver Type 1904
Receiver controller Type 8954
Decometers (red, green, purple) Type 274
Lane identification meter Type 275
Zone identification meter Type 1956

Although Danac can work in a restricted mode with Decca chains of the early type (known as V or sometimes Mark V chains), of which a few remain in service, it is intended for use with MP chains. This term stands for the multipulse (also known as Mark 10) signals which the chain radiates every 20 seconds. The MP signals perform an automatic function in the receiver known as "notching" or automatic lane setting, with the object of resolving ambiguities that could otherwise permit the displayed position to be in error by some fraction of a zone, and also provide zone identification. More on MP in the Decca Transmitter section.

Mk 16 RECEIVER

It was the same as Mk.15 but with phase comparison circuits built-in; it had fractional zone outputs for the OMNITRAC system.

Mk 16 saw service during the early days of testing the supersonic Concorde aircraft and more specifically, during the period of Concorde's Inertial Navigation System certification. It was built in a ¾ long ATR case and was essentially a Mk 15 with the navigation computer bolted on the back. Specially selected components were incorporated in this radio and it did track even when the aircraft was flying supersonic.

Mk 17 RECEIVER

This was a Mk. 16 receiver modified for use with the DECTRA System.

Mk 18 RECEIVER

This was an experimental, batttery operated "mini DECCA" system for the British Army.

Mk 19 RECEIVER

A multi-purpose unit for military use which incorporated both Mk. 8 and Mk. 15 facilities. It could be retro-fitted into Mk. 8 racking. Mk 19 was used by RAF.

There was also a special military receiver known in Decca as the "Type 990" and known by the RAF as "Mk 1 (Air)" . It had special anti-jam and other features. Quite a lot of them were built and fitted into Canberra aircraft in the late 1960's.

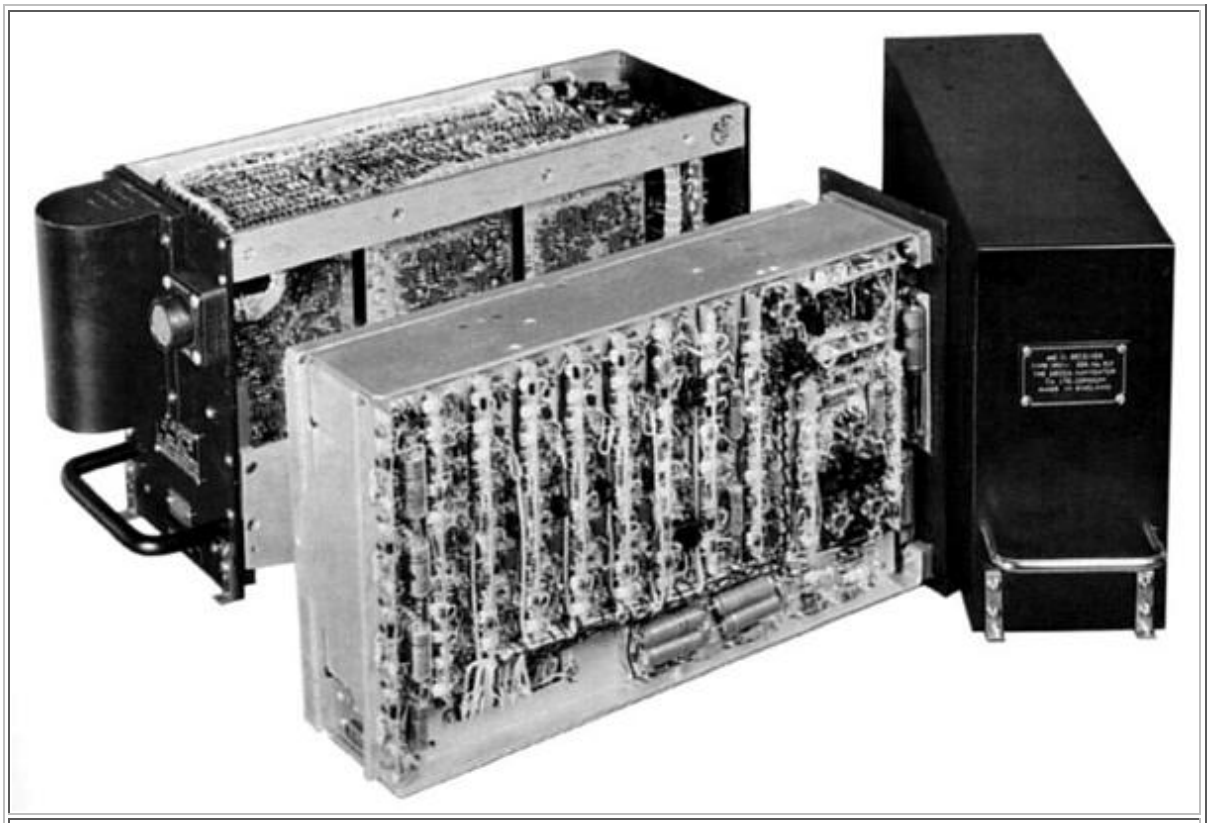
Receivers such as the QM5, QM9 and QM10 could only receive the standard 'V' type transmissions. Mark 12 receivers were designed to receive both Mark V and the newer Multipulse (MP) transmissions.

Due to the need to have stable, accurate monitoring site performance, a lot of research went into antenna design. An active antenna was designed for station monitoring that had a graphite coated radome designed to reduce
interference from charged water particles. The Mk 21 used a short, stubby, cylindrical antenna, approximately 24 inches overall and 3.5 inches diameter. This included a head amp and was connected via a single cord to the receiver.

Monitoring vehicles were fitted with Mk 12 and Mk 21 receivers for purposes of monitoring chains. These used a mixture of antennas including a lab-made custom design comprising of a 2 foot of 6 inch pipe with a metal sphere cap (not recommended for low headroom parking).

There was a later version (Mk30 perhaps) receiver that used a ring of LED segments to form the decometers but it not clear if these ever went into production. The analog Decometer-type display always seemed to be more reassuring than static lights.

This was the airborne version of the Decca receiver called Dectrac Mk 19/15A3 s/n 175 built in 1980. *(Courtesy of web page: http://perso.libertysurf.fr/webmeynier/aero/80084.htm)*



Mark 19 receiver and computer type 1910. *(Photo from the collection of Walter Blanchard)*

This is the receiver control unit (Type 8954) for the Mk 19 airborne Decca receiver *(Photo courtesy Decca Navigator Company)*




The Model 961 flight indicator was part of the Mark 19 system and was used by the RAF mainly in helicopters and the Hawker Siddeley Andover Transport aircraft. The unit depicted (s/n 209) was manufactured in May 1974. Click on photo to enlarge. *(Photos by Santiago Insua)*

MODERN EQUIPMENT

By the end of the Decca system, the receivers were designed with built in processors. The display would read latitude and longitude directly thus dropping the need to procure and use lattice charts.

Two examples of direct reading Decca receivers are the Model SAH-1D (left) and the Navigator DR-702. The model SAH was sold to the Japanese market hence the reason for the Japanese characters on the keypad. *(Photo courtesy of the Sena Co, Ltd, Tokyo, Japan).*

Additional references or credits:

1) Walter Blanchard <wblanch(at)ntlworld.com>
2) Danac Operating Instructions Manual, June 1979. Decca Navigator, New Malden, Surrey
3) Extracts from *Decca's Genealogy* provided courtesy Walter Blanchard, Royal Navigation Institute.
4) Stuart A Wolf <stuart.wolf(at)nats.co.uk>
5) James Morrison Decca photos. http://www.flickr.com/photos/jamesm/107572653/in/set-72057594120797676/
6) DECTRA marketing brochure published by the Decca Navigator Company.
7) Denis Chouinard <denischouinard(at)enter-net.com>
8) Santiago Insua <hwasp(at)hotmail.com>
9) Matthew Parker <parkermat(at)hotmail.com>
10) David Jones <dsjjones(at)bellsouth.net>

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June 2/08

DECCA NAVIGATOR - CHAIN DESCRIPTIONS

DECCA'S GLOBAL CHAINS

The following table illustrates the growth of the Decca chains world wide. By 1976, Decca had grown to more than 50 chains. Eventually the popularity of GPS started to erode the base of Decca Navigator users. By 1996, there were only 30 chains left. If anyone can provide missing data, please contact Jerry Proc E-mail: jerry.proc (at) sympatico.ca

Some stations had a name board at the front gate, while others had no markings apart from the normal danger and keep out signs. Chains were identified predominantly by their service area. Individual sites were normally referred to by the nearest large town. **Almost all sites were located in the middle of nowhere so an exact reference was difficult except for latitude and longitude.** Actual site names may be very hard to find on any generally available maps. To simplify matters, all stations in Northeast Europe are shown in accordance with the List of Interference Sources in the NELS coverage prediction tables. Since the datum from which decimal co-ordinates is drawn from is unknown, the figures shown should be assumed to be approximate.

The group that was responsible for the placement of the chains was the Systems Planning Group of the Decca Navigator Co. They were based in a small, separate office building and used all kinds of maps and geophysical data to plot predicted coverage and accuracy. They prepared outline charts, calculated the station goniometer settings and used the results of chain monitoring exercises to make adjustments to the pattern prior to operational use. They also published error correction data for the chains which could be applied based on the time of day to achieve maximum user accuracy.

COUNTRY	YEAR OPENED	DATE CLOSED dd/mm/yy	I.D. & NAME	NOTE
Australia	07/1972 1970	1987-1989 1987-1989	8E - Dampier 4A - Port Hedland	4
Bahamas	<1964	Early 70's?	?	
Bangladesh	Late 1950's	>1985	6C - Bangladesh	
Canada	1957 1958 1957 1964 1957 Aug 19,1957	1958 03/1984 1964 10/1982 12/1986 03/1982	9C - Quebec 9C - Anticosti 6B - West Newfoundland 6B - Cabot Straits 2C - East Newfoundland 7C - Nova Scotia	-- -- 4 -- 6
Denmark	1948	31/12/1999	7B - Danish Chain	
England	1946 1951 1975 1952	31/03/2000 31/03/2000 31/03/2000 31/03/2000	5B - English 3B - North British 2A - Northumbrian 1B - South West British	
Finland	1971	31/12/1999	6E - Gulf of Finland	4
France	10/1953 1955	1991 1956?	8B - French ?? - Southern French	5 3

Germany	1952	03/1992	3F - German	8,9
India	1962 1964 1976	1992 1992 12/2000	7B - Bombay 8B - Calcutta 2F - Salaya	6 6
Indonesia	1975	--	Proposed but not built.	
Iran	1960	01/05/1980	5C - North Persian Gulf	4,6
Ireland	05/31/1973	05/2000	7D - Irish	
Italy	1959 1969	? 1969(?)	?? - NATO evaluation chain ?? - Sicily evaluation chain	
Japan	07/1967 05/1985 03/1979 05/1969 04/1982 03/1976	03/2001 06/1993 06/1993 03/1998 06/1993 06/1992	9C - Hokkaido 2C - Hokuriku 8C - Kanto 7C - Kita Kyushu 4C - Shikoku 6C - Tohoku	
Netherlands	1968 1972	31/12/1999 31/12/1999	9B - Frisian Islands 2E - Holland	4
Nigeria	1976	1982 or 83 -- 1982 or 83 --	8F - Lagos 3A - Mid Western 7F - Rivers 2B - South Eastern	1 1 1 1
Norway	1968	01/1997 See Norway text for detailed info.	7E - Finnmark 9E - Helgeland 3E - Lofoten 4E - Trondelag 0E - Vestlandet	9 7, 9
Scotland	1975 1956	31/03/2000 07/04/2000	8E - Hebridean 6C- North Scottish	
South Africa	08/1973 07/1973 10/1972 10/1972 1972	31/03/2000 31/03/2000 31/03/2000 31/03/2000 31/03/2000	6A - Cape 8A - Eastern Province 4A - Namaqua 10C - Natal 9C - South West Africa	
Spain	01/1969 03/1980	January 1995 January 1995	4C - North West Spanish 6A - South Spanish	10 10
Strait of Hormuz	1978	--	Proposed but not built.	
Sweden	06/1962 06/1962 10/1957 1970 02/06/1967	31/12/1999 31/12/1999 31/12/1999 31/12/1999 31/12/1999	5F - North Bothnian 8C - South Bothnian 4B - North Baltic 0A - South Baltic 10B - Skaggerak	6 4,6 -- 4 --
United Arab Emirates	1961	1999	1C - South Persian Gulf	6
United States of America	1958 1970	Prior to 1985	5C - New York City ?? - California	

		?		
Vietnam	1962/63 ? 1967	12/1968 12/1968	?? - South Chain ?? - Central Chain	

NOTES FOR TABLE:

YEAR can mean the date that the contract was signed to build the chain or the date when the chain came into actual use or the date they were formally accepted. These dates have been researched to be as accurate as possible in spite of not having any official documents for reference. Where possible, I have tried to explain it in the text.

1. Only two were built - Lagos and Rivers.

2. Item 2 deleted.

3. This chain had very short service life. Does anyone know the exact reason?

4. This was a two slave chain as of June 1973 with the Purple Slave missing. In the Mk 19 receiver, a switch allowed the operator to disable the unused channel so the decometer would not produce bogus readings.

5. This was a two slave chain as of June 1973 with the Green Slave missing. In the Mk 19 receiver, a switch allowed the operator to disable the unused channel so the decometer would not produce bogus readings.

6. This chain radiated Mark 5 type transmissions only as of June 1973.

7. All of Norway's chains could not have been built in the same year. The date of 1968 came from Decca Navigator News without any other qualifier.

8. The date the contract was signed.

9. The ID for this chain was re-assigned at some point in the chain's service life. Please refer to the individual chain for details.These updates are provided by John Beattie the former Corporate Marketing Manager for Marine Policy for Racal-Decca Marine from 1982 to 1993 and then a consultant to them.

10. Dismantled August 1995.

CHAIN ID's

There are 11 groups of basic frequencies, numbered 0 to 10. In each of these 11 basic groups, 6 master frequencies, lettered A to F, are derived to provide for existing and future chains. Thus, in Group 0, normal master frequencies in kHz are:

0A - 84.100
0B - 84.105
0C - 84.110
This group is separated nominally by 90 Hz (in reality around 80 Hz) , Then the series starts:
0D - 84.190;
0E - 84.195
0F - 84.200.

The frequency interval between each numbered group is 180 Hz. (ie [2A] 84.4550 - [1A] 84.2750 = 180 Hz difference). Group 10 includes only the A, B, and C frequencies. Please refer to the Decca frequency table Figures 1 and 2 for more information.

Decca MARK 12 or MARK 21 receivers could be switched to each of these 63 frequencies. Earlier receivers could only be switched to the numbers only, where they will receive A, B, or C frequencies, but could not receive the D, E, or F transmissions.

Because Decca Navigator only depended on the ground wave, it was possible to reuse chain ID's (ie frequencies) around the world. Chains sharing the same channel had to be at least 2,000 km apart. Any time a two slave chain was planned, Red and Green were used since that combination offered the best accuracy pattern under all conditions.

DESCRIPTIONS LISTED ALPHABETICALLY

AUSTRALIA

The ***Port Hedland 4A*** chain was established in May 1970 by the Australian Department of Shipping and Transport, a government agency responsible for the the maintenance of navigation aids along more than 12,000 miles of coastline at the time.

LOCATION	DESIGNATION	FREQ	COORDINATES
Turner River	Master	84.820 kHz	20° 33' S 118° 29' E
Mundabullangana Station (shared)	Red	113.0933 kHz	20 °25' S 118° 04' E
De Grey River	Green	127.230 kHz	20° 21' S 118° 59' E

When the number of iron ore carriers using the ports in northwest Australia increased, it was deemed necessary to install another Decca chain. As a result, the ***Dampier 8E*** chain was established to provide precision navigation for shipping in the Cape Dampier area off Western Australia for 300 miles of coastline. The Dampier chain also provided coverage for Port Walcott (20.5833° S, 117.1833° E).

LOCATION	DESIGNATION	FREQ	COORDINATES
Woodbrook (inland from Roebourne)	Master	85.635 kHz	20° 53' S 117° 08' E
Mardie Station	Red	114.180 kHz	20° 59' S 116° 21' E
Mundabullangana Station (shared)	Green	128.453 kHz	20° 25' S 118° 04' E

Installed as Multipulse chains from the onset, both chains were collapsed around the 1987-1989 time period.

BACKGROUND

Australia had always taken a deep interest in the Navigator system and, as part of Decca's expansion campaign, sale personnel gave a number of presentations including a major symposium in Sydney organized by John Lucken.

The final opportunity came in a rather roundabout way. In the 1960's, Japan's shipbuilding and motor car industries were expanding rapidly and as Japan has no natural source of iron and steel it was necessary to import large quantities of ore. Australia, although thousand of miles away, was the source selected. Japan had its own Decca Navigator coverage and many

of the ore carrying vessels were already equipped with receivers. The ore carriers were large and the channels in Northern Australia were twisting and narrow. Decca was clearly a logical solution to the problem therefor two chains were built - one in Dampier and the other in Port Hedland.

Dampier proved its worth to the large bulk iron ore carriers which navigated a narrow, twisting, 20 mile channel through off-lying shoals. Besides covering the .'confluence of shipping routes off Cape Dampier', the chain provided accurate navigation in the approaches to Port Walcott, a new iron ore facility being developed in the area.

The decision to install Dampier was announced by the Hon. Peter Nixon, Australian Minister of Shipping and Transport, speaking at the first Australian Coastal Nav Aids Symposium held in Canberra in December 1971. To meet an urgent operational requirement, the Dampier Chain was built from scratch in seven months using 1880 type equipment and went into operation in July 1972. Norman J. Clarke (Nobby) from Decca's Chain Implementation Department oversaw the construction and commissioning of the two chains and then joined the Australian Department of Shipping and Transport. His family emigrated to join him there and they now live near Sydney.

Amalgamated Decca Surveys Pty Ltd also proposed chains for Wallal Downs, Derby and Gladstone but these were never built. The frequencies and coordinates shown above came from the Chain Basic Data (DN Systems
Planning Dept. New Malden) whereas the names came from the proposal.

Any breaks or disturbances of normal Decca transmissions were broadcast as "Decca Warnings" by the coast radio stations in the vicinity. These were Perth Radio (VIP), Carnarvon Radio (VIC), Broome Radio (VIO) and Darwin Radio (VID)

A map of the Australian chains can be seen here.

BAHAMAS

This was known as the AUTEC chain and was built for the United States Navy The acronym means Atlantic Undersea Test and Evaluation Center. It's still around today and based on Andros Island, Bahamas. AUTEC's purpose is to be the U.S. Department of Defense and Navy range of choice for conducting undersea warfare testing and measurements in the Atlantic. Decca was used to provide accurate position fixes to support the research which was being conducted on the AUTEC range.

Back then, the chain was run from the New York office of Decca Navigator Systems Inc (DNSI) but installed by the personnel from the UK. DNSI was the company established in the USA to give Decca a presence in North America thus providing a single point of contact for all the activities being pursued in the '60's and '70's.

This chain ran successfully as a Mk10 system with 820 control racks but had big problems with salt deposits on the insulators thus degrading performance. Decca tried all sorts of things like MS4 silicon grease but nothing really improved the situation until the rain washed off the salt. Eventually the stations were abandoned and the equipment was shipped to the UK for refurbishment and redeployment. . No information is available on the approximate opening or closing dates for this chain.

Bill Gaston of Marco Island, Florida and Christopher Rose, a former Decca employee have identified the locations of the former Decca stations. The Master was located on Pipe Cay in the Exumas. The Better Boating Association (BBA) Bahamas Chart Kit 4th Edition even has it noted on page 49. Another reference lists a Decca station on Great Exuma Island which is

considerably south of Pipe Cay. Golding Cay, off the coast of Andros Island and Eluthera are the other two sites. Golding Cay is a rock in the ocean, not much bigger than a football field and situated at the entrance to South Bight, on the east side of Andros Island.

LOCATION	DESIGNATION	FREQ	COORDINATES
Pipe Cay (Central Exumas)	Master		24 14' 46"N 76 31' 20"W
Great Exuma Island (2 km NW of Georgetown)	Red		23 32' 00"N 75 46' 20"W
Golding Cay (off Andros Island)	Green		23 13' 12"N 77 36' 10"W
Eluthera Island	Purple		?

Christopher Rose of Orléans, France briefly describes the conditions. "Our accommodation was composed of portacamps - very makeshift. We were originally supplied by a yacht, then a converted coast guard cutter and finally once a month by a seaplane. The staff did three month shifts on the cays then had a two week break working at head office in Nassau. We were a mixture of British and Americans I think, all ex-servicemen, but so was everybody in those days. Rotations were slow as people did not like being moved around too much. I once spent more than two years in one station in Vietnam. I heard a story from the Persian Gulf of somebody driving
his replacements off with his rifle."

Dan Ahart, a serious traveller, describes what he saw on Pipe Cay. "Our first stop was the abandoned U.S. Navy DECCA station on Pipe Cay. The station has been abandoned for about 20+ years, but it was once a communications station of some sort. I don't know what DECCA stands for, but knowing the military's penchant for acronyms, it probably has something to do with defense communications. The layout looked very familiar to me because I spent some time at similar stations when I served in the Air Force. It had the standard military generator building supplied by diesel fuel via an above ground pipe from a remote storage tank. Closer to the pier was the all purpose building, which included living quarters for at least five and maybe as many as nine personnel and an electronics equipment room. Adjacent, was the foundation of the antenna tower. Interestingly, the boiler for distillation of fresh water had not been removed".

Select this link to see a map of the Bahamas chain.

BANGLADESH

Bangladesh Chain 6C

LOCATION	DESIGNATION	FREQ	COORDINATES
Comilla (near Chandpur)	Master	85.185 kHz	23° 26' 60"N, 91° 12' 0"E
Dohazari (near Chittagong)	Red	113.580 kHz	22° 09 46 N, 92° 03 31 E
Khulna (near Jessore)	Green	127.788 kHz	22° 34' 60"N, 90° 13' 0"E
Mymensingh	Purple	70.988 kHz	24.7°N , 90.4°E

BACKGROUND

The Bangladesh chain was originally a Mk V survey built in what was then East Pakistan in the late 1950's for the hydrographical resurveying of the massive Ganges Delta after each monsoon. This was done with a fleet of boats using echo sounders during daylight hours. The huge changes of the river courses and sand banks after each monsoon made river transport difficult and severely hampered one of the main means of transportation in the country. This resurveying was used to expedite re-use of the waterways after each monsoon.

The war of Independence in the early 1970's seventies led to the formation of the new country of Bangladesh, and during the war, the Decca chain went off the air. After cessation of hostilities, it was refurbished as a Mk10 chain as part of British Government aid programme. One of the stations, Red, near Chittagong, had been destroyed in the fighting, so the opportunity was taken to re-build on a new site about 20 miles south at Dohazari. All the other stations used the existing buildings.

At the time of re-building there were tremendous difficulties. The Red station was reputed to have been built with the first cement to come into Chittagong after the war. Malnourished children were everywhere and smallpox was endemic. Smallpox was actually finally eradicated from Asia by the World Health Organization while the chain was being built. Chandpur, close to the Master station, had one of the last of the world's smallpox outbreaks. Decca engineers did not have enough fuel to boil the drinking water, but luckily potable water came from a deep tube well and was reputed to be good.

While one Decca engineer was alone at the Red station, a battalion of the Bangladesh Rifles came into the compound to take the station over as a billet. When he walked out from the inspection bungalow to greet them, they hastily backtracked out of the gate - probably surprised to see a European in such a remote location.

The Dohazari Red slave was at the end of the railway line south from Chittagong. When the Decca station was being built, there was no timetable posted. Decca arranged for a runner to be posted on the station platform. Whenever a train arrived, he would run into the Decca compound to announce its arrival.

During the stability survey, Decca used the Government inspection bungalow at Jessore as a monitoring point, because it had a trig point (coordinates) at the corner and its position was therefore known. The monitoring station was set up in a bedroom, but they were hastily removed when the President came to town and slept in the room.

The monitoring station antenna was finally installed on the roof of a civil servant's house in Dhaka, the capital, and the whole chain was run by the Bangladesh Inland Waterways Transport Authority (BIWTA). All stations ran on local generators and had masts of 150 feet using T-array aerials. Transmitters and phase racks were thermionic, even after the re-furbishment. Being so close to the equator, the *skywave effect* was enormous. Starting around 16:00 hours, accuracy degraded rapidly. The chain was reopened by Judith Hart, Minister of Overseas Aid in the British Labour government, in 1975. This chain had the distinction of being one of the few (or the only) chain used for inland water navigation. The chain was still in use in 1985. *(Does anyone know the exact date that it closed?)*

The name of the capital "Dhaka" caused endless confusion when Decca employees tried to explain who they worked for.

A map of the Bangladesh chain and photos can be viewed here.

CANADA

The contract to build Canada's four Decca chains was signed in 1957 and by 1958, it is confirmed that one of the chains was in full operation and in use by The Royal Canadian Navy. The other chains became operational shortly thereafter and entered a lengthy acceptance period .

John Adams of the Canadian Coast Guard provides this summary of the Decca Navigator chains, "Following several years of testing, the first official Decca navigation service in Canada was established in 1961. The service consisted of four Decca chains". It is believed that 1961 is the official acceptance year for all the chains. The Canadian licencee for Decca navigator was Computing Devices of Canada, Ottawa Ontario".

Cabot Strait Chain 6B

LOCATION	DESIGNATION	FREQ	COORDINATES
Grindstone, Iles de La Madeline Islands, Quebec	Master	85.180 kHz	47.350ºN, 61.933º W
Channel Port-aux-Basques, NF	Red	113.5733 kHz	45.633ºN, 59.233º W
Antigonish, N.S.	Green	127.7700 kHz	45.733ºN, 61.900º W

There was no Purple slave for this chain. This service was discontinued in October 1982.

Nova Scotia 7C

LOCATION	DESIGNATION	FREQ	COORDINATES
Chester, Nova Scotia	Master	85.3700 kHz	44.533ºN, 64.233ºW
Alma, New Brunswick	Red	113.827 kHz	45.560º N, 64.933º W
Jordan Bay, Nova Scotia	Green	128.055 kHz	43.700º N, 65.233º W
Ecum Secum, Nova Scotia	Purple	71.142 kHz	44.967º N, 62.150º W

7C was the first Canadian chain. Service was discontinued in March 1982

In the Nova Scotia chain, the transmitters were manned 24 hours per day. To ensure operational readiness, the transmitters were "rotated" at both the master and slave sites in sequence. Starting at 12:00 noon, the operational transmitter at the Master station was dropped and it became the spare. The one that was the standby unit now became operational. The one that was previously the spare became the standby unit. At 10 minute intervals, the same sequence followed at the Red , Green and Purple slave sites. On subsequent days, the the sequence continued to ensure that all three transmitter "modules" were on-line at regular intervals. Of course if a transmitter was down for some serious maintenance, the round-robin sequence would have been shared among two transmitters only. Rotating the transmitters at noon was done for a reason. It was deemed that the "atmospherics" were most stable at this time of the day in the VLF band and doing it then would minimize any potential disruptions to the users of the system.

Anticosti Chain 9C

LOCATION	DESIGNATION	FREQ	COORDINATES

Port Menier, Anticosti Island, Quebec	Master	85.725 kHz	64.450º W, 49.850º N
Shippegan Island, New Brunswick	Red	117.157 kHz	64.683º W, 47.850º N
Natashquan, Quebec	Green	128.587 kHz	61.817º W, 50.183º N
Sept Iles, Quebec.	Purple	71.437 kHz	66.617º W, 50.150º N

John Molloy-Vickers provides a background note for this chain. "There was an evaluation chain (9C) covering Montreal to Quebec City and it was installed in November 1957 by Decca Navigator and CDC. It was Mk10 chain with 820 control racks intended for airborne use on the terminal approaches to Montreal's Dorval airport. The 1958 Montreal ICAO meeting killed it and it the chain was moved to become the Anticosti Chain 9C".

This service was discontinued in March 1984.

East Newfoundland Chain 2C

LOCATION	DESIGNATION	FREQ	COORDINATES
Port Blandford, Newfoundland	Master	84.4650 kHz	48.350º N, 54.167ºW
Pouch Cove, Newfoundland	Red	112.6200 kHz	47.7667ºN, 52.7667º W
St Lawrence, Newfoundland	Green	126.6975 kHz	56.917º N, 55.383ºW
Comfort Cove, Newfoundland	Purple	70.3875 kHz	54.867º N, 49.350ºW

This service was discontinued in December 1986.

BACKGROUND

The St Lawrence Seaway was the starting point for Decca's expansion into North America and four chains were built for the Canadian Government. These chains provided excellent coverage and were widely used for fishing operations. It was an early and important development for the company..

According to an article in Decca Navigator News (Sept 1976), Decca Radar Canada Limited and The Decca Navigator Company (Canada) Limited were set up in 1953. An extensive sales and service organization to meet the demand, particularly for radar was established with headquarters in Toronto and was followed by a steady expansion.

In 1957 the manufacture, rental and servicing of shipboard Decca Navigator receivers passed to Computing Devices of Canada under a prior North American licensing arrangement. With the transfer of some Decca personnel from Decca Canada and the UK, Computing Devices Company (CDC) formed a marine electronics sales and service organization in the Atlantic Provinces and at the same time were also appointed representatives for Decca Radar equipment for this area of Canada. Concurrent with these developments, Decca Navigator chains of transmitting stations were erected in Eastern Canada, and as a result of proving trials, four Decca Chains were purchased by the Federal Ministry of Transport to provide

better facilities for increased shipping expected with the opening of the St Lawrence Seaway in 1959 and to assist the development of the Eastern Seaboard fisheries. The Canadian fishermen in particular rapidly equipped their vessels and CDC commenced manufacturing receivers.

At the same time, a heavy investment was made by CDC in providing service stations even in remote parts of Newfoundland and Nova Scotia.. Computing Devices added to their marine product range and operated under the divisional title of ComDev Marine. By 1976, some 500 local fishing vessels were equipped with Mk 12 or Mk 21 receivers.

Decca Radar (Canada) Ltd, since its establishment, had achieved great success in meeting the demand in Canada. In addition to a wide range of shipborne radars - no less than 28 new Decca equipment types were introduced for the '70s - the Company had been active in developing and supplying advanced equipment for Vessel Traffic Management facilities and for engine room control and monitoring systems.

When the Canadian chains closed for good it was noted that the Nova Scotia chain was only one transmitting the old 'V' format yet the other three chains had been upgraded to Multipulse. By the end, certain tubes had became very scarce and the only source for new tubes by the early 1980's was in Czechoslovakia.

Select this link to see a map of the Canadian chains.

DENMARK

DANISH CHAIN 7B

LOCATION	DESIGNATION	FREQ	COORDINATES
Samsø Island, Denmark	Master	85.365 kHz	55.950° N, 10.583° E
Møn Island, Denmark	Red	113.820 kHz	54.950° N, 12.467° E
Højer, Denmark	Green	128.048 kHz	55.017° N, 08.717° E
Hjørring, Denmark	Purple	71.138 kHz	57.450° N, 10.050° E

BACKGROUND

Denmark was The Decca Navigator Company's first overseas chain. After the English chain 5B was built, it was realized that more receiver rentals would be required in order for the new company to prosper and profit. With this in mind, the Danish chain was built and operated by Decca with a subsidiary company in Copenhagen. Immediately the overall Decca coverage was roughly doubled. So too were many of the operating expenses. Although the number of rentals did not double, the significance of the overseas development was considerable, laying the groundwork for expansion in the rest of Europe.

Around 1990, the Danish Government purchased the Danish Chain 7B from the Decca Navigator Company Ltd for a low price. Later, after arbitration between Racal and the Danish Government, a Danish court increased the amount of compensation. After the purchase, the Danish Government levied User Charges on their fishermen who used Chain 7B.

Select this link to see the Danish chain.
Photos of the Møn Island station (off-site link) can be viewed here.

ENGLAND

ENGLISH CHAIN 5B

LOCATION	DESIGNATION	FREQ	COORDINATES
Puckeridge, England	Master	85.000 kHz	51.817° N, 00.083° E
Norwich (aka Shotisham), England	Red	113.333 kHz	52.550° N, 01.333° E
Lewes, Sussex (aka East Hoathley), England	Green	127.500 kHz	50.917° N, 00.150° E
Warwick (aka Wormleighton), England	Purple	70.833 kHz	52.200° N, 01.367° W

BACKGROUND

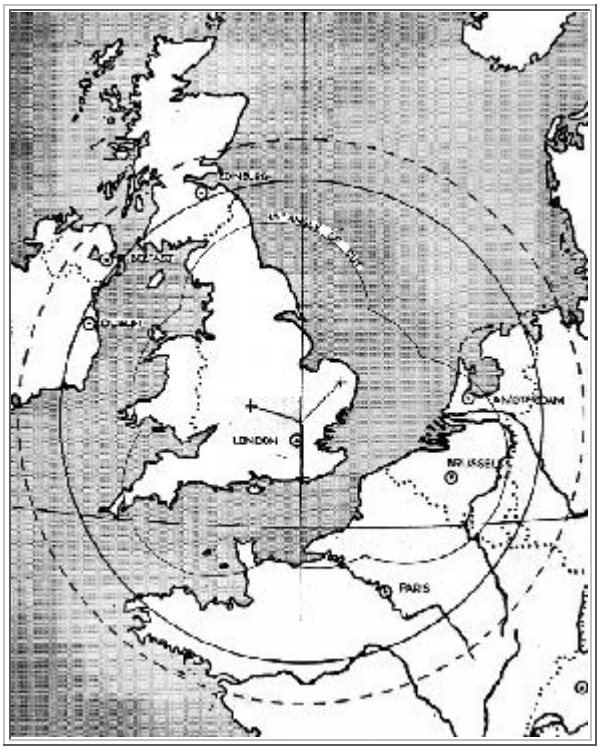
The first chain of Decca Navigator stations was established in southeast England in 1946. All stations had unbroken transmissions, 24 hours per day.

With its short base lines and high radiated power, it performed well and despite its lack of Lane Identification, it provided excellent service to the early users. It was the English chain which established the reputation of Decca for both accuracy and reliability. Furthermore, it was this chain that provided the "test bed" for the development of Decca and was the centre for much of the promotion of the system.

It was in these early days that the foundations of the receiver rental/maintenance system were laid. An effective organization was set up in the UK and, as time went on, this organization spread world-wide. The effectiveness of this network was a great contributor to the spread of the System overseas. In the promotion of every overseas chain, there were air and/or marine demonstrations of the system using the English chain. As a sales "tool", the chain was invaluable.

Overall maximum dimensions of a typical transmitter site were 1100 feet by 700 feet but the actual ground area occupied by the station was slightly less than that (750 ft. by 150 feet.) The buildings for the transmitters were simple, single storey, prefabricated units set on a concrete foundation.

The mast and aerial system on the Decca Navigator Ground Station was of special design and had an unusually high degree of efficiency at the low frequencies employed. Field strength measurements showed that the radiation efficiency was some 45%. Transmitter output, being at 2 kilowatts, meant that 900 watts could be expected as radiated power. This power level was deemed sufficient to overcome unfavourable reception conditions.



COVERAGE: This map of the UK illustrates the coverage of the English Chain. With respect to the master station located just north of London, the solid circle indicates 300 miles distance while the dashed circle is 350 miles. That was roughly the range deemed for reliable reception of Decca signals during daytime. The British Admiralty designated a range of 240 miles from London as being the furthest reliable distance. From this map, dated 28/8/46, it is very evident why Decca was only useful as a coastal navigation aid.

After it was found the English chain could not cover the whole of the UK 24 hours per day because of skywaves ruining lane identification, the transmitter power was stepped down and for the last 25 years of operation, the effective radiated power was only in the area of 40 to 100 watts.

Donald W. Rayner Sr. worked at the Red slave of the English chain in Norwich between 1946 and 1948. He recalls this period with great clarity. "Notice on Petty Officer's bulletin board at RN signal school, Leydene, Hants in Jan, 1946 - *Seeking to hire W/T ratings being released from post war service. Applicants to contact Decca Navigator in London.*

I, and one Norman Thomas, a 'Geordie' Both applied and later were assigned to a site located on the 'Kidner' farm, Poringland/Shotesham All Saints near Norwich, Norfolk. We were met by a John Mears who became station manager and a contact man from DECCA in London. With this minimum staff, and a local contractor, construction started. Throughout the ensuing months the station took shape. It would be close to the end of 1946 before we got to transmitting.

During this time we had a visit from one, H. Toller Bond who was identified as being the head of design and engineering. On one visit he brought a gentleman identified as a 'Mr. O'Brien' the American inventor of the system. He was a US amateur radio enthusiast who had presented his ideas to the US military during the war and was turned down. Being a friend of a Mr. Schwartz who was president of British DECCA Records in London, he went over and sought his help.

The Royal Naval Signal school where Toller Bond was on staff became involved in design of the system. I believe the RAF may also have been involved since I met several company officers who had been ex-RAF. Preliminary testing of a temporary 'chain' occurred during the Normandy landings, pinpointing areas for close support for troops on the ground but I have no direct knowledge of this activity. When operations started, we hired additional staff.

Seven in, all with Mears, being Station Manager. I got tagged as Assistant Station Manager We were assigned a small new ‘Fordson' van for transport. Our shift hours were "different" . A night shift was defined from 6PM to 8AM with 2 days off afterwards. Since the manager had a penchant to be absent for days, hence my unpaid promotion to Assistant Manager.

Equipment breakdowns were frequent as were trips to London repair shop. The special receivers were housed in a separate small building that was completely encased in fine wire mesh and grounded with the antenna mounted on its roof. Output cables were under concrete to the main transmitter building. Two large diesel generators were housed in a separate building with one running at all times due to power outages occurring frequently. We had an underground diesel fuel tank and a gasoline tank used for the starter motors mounted on the diesel generators.

Domestic notes: We were all housed in private homes locally but these were mostly farm cottages for farm workers. We asked for housing. Decca sent the company Sec. Treasurer to discuss our needs. Nothing happened. This action eventually prompted me and my wife to leave and emigrate to the United States for better job opportunities.

In 1993 I visited this old site. The main 138 foot tower was gone replaced by a smaller antenna system.Other changes included the elimination of the diesel generators.. The staff consisted of one operator and a small house for him and wife. With the station due to close, both were planning to return to India, their homeland. On a personal note, I was never an engineer....just a happy go lucky ham interested in electronics. Those large high power, low frequency transmitters with their glowing rectifiers fascinated me.

I was 25 then. Now I am 82 (2003) and living in this seniors village nestled in the foothills of the Allegheny mountains in Pennsylvania. I’ve seen it all and done it all in ham radio. It's been a blast".

NORTH BRITISH 3B

LOCATION	DESIGNATION	FREQ	COORDINATES
Kidsdale, Scotland	Master	84.645 kHz	54.700° N, 04.417° W
Clanrolla, N. Ireland	Red	112.860 kHz	54.500° N, 06.333° W
Neston, South Wirral, England	Green	126.968 kHz	53.267° N, 03.050° W
Stirling, Scotland	Purple	70.538 kHz	56.067° N, 04.067° W

Coverage of the Irish Sea. Stirling was also the Red slave for the Northumbrian chain. Photos of the North British Chain can be viewed here.

NORTHUMBRIAN 2A

LOCATION	DESIGNATION	FREQ	COORDINATES
Allerdean Greens, England (a.k.a. Berwick)	Master	84.455 kHz	55.700° N, 02.033° W
Stirling, Scotland	Red	112.607 kHz	56.067° N, 04.067° W

Peterhead, Scotland	Green	126.683 kHz	57.517° N, 01.850° W
Burton Fleming, Yorkshire, England	Purple	70.379 kHz	54.133° N, 00.317° W

BACKGROUND

This chain was established to cover a gap in the North Sea and the Firth of Forth. Along with the Hebridean chain, it used re-furbished 820 series, thermionic valve equipment bought back from the USA. The USA had two experimental chains - one in California used for airborne trials, and one around the Bahamas reputed to have been used for submarine navigation. It is not certain which chain ended up where.

The Northumbrian chain had two shared stations - Stirling and Peterhead. This meant that the masters at Kidsdale and Orkney had to be synchronized. In the end five chains were synchronized to allow slave sharing.

Decca trivia - What was the population of Allerdean Greens at the time? Answer - Pop = 6. It was a minor hamlet south of Berwick

Photos of the Northumbrian chain can be found here.

SOUTH WEST BRITISH 1B

LOCATION	DESIGNATION	FREQ	COORDINATES
Bolberry Down, Devon, England	Master	84.280 kHz	50.233° N, 3.833° W
St..Helier, Jersey, Channel Islands	Red	112.373 kHz	49.250° N, 2.083° W
St.Mary's, Isles of Scilly, England	Green	126.420 kHz	49.933° N, 6.300° W
Llancarfan, Wales	Purple	70.233 kHz	51.433° N, 3.383° W

Chain 1B provided coverage for the south and south east coasts of Ireland, Cornwall and the Scilly Isles.

Northern limit	51° 25'N
Southern limit	52° 14'N
Eastern limit	4° 5'W
Western limit	6° 5'W

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David Jones provides some closing notes for Decca, UK. "The final development phase of the UK Decca chains took place in the late 1980's when many sites were updated with a final version of the station equipment. This was a fully automatic and very compact design which permitted all the equipment to be housed in a small shelter. This program was carried out for the UK Government department that operated the chains. After this, many of the original design and support staff were let go. Racal then sold off the Navigator and Marine radar business as part of it's overall break-up of the group. Litton Systems brought most of these
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entities including the Austin Insulator Company. Later, they decided to sell off Austin Insulators since they could not accept the potential liability of having a block of ceramic hold up a massive steel tower even though none had failed up to that point. Austin was purchased by a former Decca Navigator chain manager, Pat Warr.

According to John Molloy-Vickers, "In the early days of the UK chains., we installed a morse key and a Marconi receivers at all the UK station sites. The idea was that a navy man would turn up at the station and start keying the Decca transmitters in the prescribed code which would warn the British nuclear submarines to standby and deliver in the event that the Cold War turned hot. !"

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Richard Caddy was the last Decca employee and was the person who shut off the lights. He provides some follow-on information after the Decca system ceased broadcasting. "When at all came to an end, we dumped almost everything but Walter Blanchard and his amateur radio team had some good pickings. However, I arranged for the complete master station from Puckeridge to be shipped to the Trinity House Museum at Great Yarmouth, along with the single tuned mobile coil house. Jointly, that comprises a complete station. The ex-Berwick master station was shipped to the Northern Lighthouse Museum together with the double tuned mobile coil house. At this time, (Sept 2003) we have two complete Decca stations in mothballs and either could be fired up into a dummy aerial at any time.

When I last spoke to Peter Reilly at Galway in December, 2000 the Irish Government had done nothing about decommissioning their old stations although transmissions were switched off in mid May 2000. The Company also held a good quantity of equipment which went on display in March 2000 at a conference at Church House, Westminster. There is also a good exhibition of Decca equipment aboard HMS Belfast at Tower Bridge so all in all the hardware side of the system is fairly well catered for.

The East Hoathly mast was sold to NTL who chopped 75 foot off the top and used it as a phone mast. In Scotland, the Butt of Lewis and Shetland sites went to the UK Coastguard. The Stirling site was taken over by NLB and the Wormleighton site by Trinity House for transmission of Differential GPS inland. I believe that many of the other sites were demolished".

Select this link to see a map of the UK chains, photos of a modernized Decca station and other stories relating to Decca in the UK.

FINLAND

Gulf of Finland 6E

LOCATION	DESIGNATION	FREQ	COORDINATES
Mäntsälä, Finland	Master	85.2700 kHz	60°30’59.16”N 25°10’42.12”E
Padva, Finland	Red	113.693 kHz	60°00’27.91”N 22°49’30.4”E
Sydänkylä, Finland	Green	127.905 kHz	60°30’37.65”N 27°26’18.23”E
	Orange	116.53566 kHz	

The Gulf of Finland chain was built in 1969-70, and became operational in 1971.
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NAVIDEC was the Decca agent in Finland and was known as "THE DECCA HOUSE" .

A map of the 6E chain can be viewed here.

FRANCE

After WWII, the Société Française Radio-électrique (SFR) sent a mission to the UK in order to find out if any radio devices developed during the war could be be put to use in any peacetime applications. The mission was fortunate in arriving in London on the very day when the secrecy ban on wartime DECCA Navigator was lifted.

The SFR saw that this new system showed great promise in both marine and aeronautical applications. On December 1, 1945 the SFR signed a first agreement with the Decca Navigator Company. On April 8, 1948 , this provisional agreement was replaced by a contract which granted SFR a license to manufacturer and exploit Decca Navigator in the French Union.
Another company of the C.S.F. Group, the Compagnie Radio-Marine was entrusted with the application of the system to the French merchant marine.

On October 6, 1951, after numerous air navigation tests, the Secretary General of Civil and Commercial Aviation decided to install a transmitter chain in France. This chain, constructed by SFR, was opened on October 24, 1953 by M. Paul Devinat, Secretary of State for Public Works and Civil Aviation. The French Navy saw the possibility of using Decca Navigator for hydrographic survey and mine sweeping. Hence, semi-mobile chains were developed and built for that purpose.

Chain 8B - French chains were established primarily to support night air mail flights by the French Post Office.

LOCATION	DESIGNATION	FREQ	COORDINATES
Montluçon	Master	85.5450 kHz	46° 19'N, 2°36'E
Amboise	Red	114.0600 kHz	47° 25'N, 0°58'E
Saint-Germain-Du-Plain	Green	116.9115 kHz	46° 42'N, 4° 58'E
Aurillac	Purple	71.2875 kHz	44° 55'N, 2° 27'E

The St. Germain station was 13 kms east of Chalon Sur Saone. Sometime between 1957 and 1973, the Green had been shut down as being since it was of no real use for marine coverage in the Bay of Biscay.

John Molloy-Vickers who worked on the Green slave recalls his experiences in France. "In 1958, we converted the main chain to Mk 10 from Mk V. I worked on Green at Chalon sur Saone during the conversion and then touring the chain for some months doing troubleshooting. Since I was the only Decca man left there, I had to improve my French in a hurry. I was always being stopped by the Garde Mobile and being searched as there were constant problems with Algerian terrorists and bomb attacks.. The chain was run by the French Ministry of Aviation. It was not the most efficient of organizations in those days. If a fuse blew or a valve went defective, permission had to be obtained from the Chef de Station to do something about it! There were two- one technical and the other for office work It was a classic case of a civil service at its worst although I will say everybody was always very pleasant and it was all very educational. However, we kept the chain going and we had reasonable results from aviation users and the Paris Air Show. There was no real marine interest at that time".

The French Main chain was originally operated by the French but operation was taken over by Decca OPD in 1965 for Eurocontrol trials Under the French, the chain was used for general navigation purposes.

For more information on Decca France, select this link.

GERMANY (3F)

LOCATION	DESIGNATION	FREQ	COORDINATES
Brilon, Germany	Master	84.7400 kHz	51°27'N, 8°43'E
Coburg, Germany	Red	112.9867 kHz	50°20'N, 10° 59'E
Zeven, Germany	Green	127.1100 kHz	53° 17'N 9°16'E
Stadtkyll, Germany	Purple	70.6167 kHz	50° 22'N 6° 32'E

BACKGROUND

The original German chain was set up to assist with the Berlin air-lift and the support of forces in the region and was assigned a chain ID of 9B. Later is was given the chain ID of 3F and upgraded to Multipulse. The chain frequencies shown are those for 3F.

An ex-Decca sales manager who was in an RAF navigator during this period said that the worst cargo was coal. The sacks had to be manhandled in and out of the aircraft thus leaving everything and everybody covered in black, dusty powder. After the initial crisis was over, the chain was probably left in place to support the RAF aircraft in West Germany who already had an installed base of Decca receivers. One activity during the cold war was the patrolling the East German border using Decca equipped helicopters. The chain was still active in 1975.

One of the stations was located in the pretty village of Stadtkyll, south west of Cologne, in the Eiffel region of Germany. David Jones remembers the station when he was there in January 1977. "The German caretaker at the station was a tank driver in WW2 and would speak with pride about the smooth ride inside his Panzer tank as it went through a house". It is believed that the Zeven station was also the Green slave for the German chain 3F.

An interesting note was spotted in a Decca technical publication dated 1973." WARNING - Although the
Frisian Islands chain is using the same frequency as the old German chain, namely 9B, the ground stations are not in the same positions and therefore the old German charts cannot be used with the Frisian Islands chain. See notice to Mariners 1977(p) of 1967 ". John Molloy-Vickers provides an brief history of the German chain which explains the reason for the warning..

"The 9B chain (old German chain) was set up for air use but it gave poor coverage on its north coastal areas. Decca converted it to Mk 10 system somewhere around 1964 in an effort to improve air useage for Mk 19 receivers and their follow-ons. The chain used to be run by German Air Traffic Control (Bundes Flugsicherung) but they were rapidly losing interest as there were few German national users. British Airways liked it and so did the UK Ministry of Defence. When the Frisian Islands chain was installed it took the 9B chain frequency in order to have good coastal coverage and the German chain switched to the half chain frequency of 3F which is only suitable for the later types of receivers. Obviously, any receiver switching to 9B after the changeover and using the original German charts would see garbage! After this change, chain 3F was no longer of any marine interest.

The "new" German chain was also to be run by Decca under contract to the German Ministry of Defence Various additions were installed to cover their particular requirements. The original chain construction used massive Telefunken transmitters (as in radio station type systems) rather than the current multiple modular Decca designs with separate power supply systems. The slaves were unattended at night, instead, relying on a remote alarm system to call in an operator from his home to service any alarm . This was not permitted on a Decca managed station in that era! Back then , the station was sealed and was automatically flooded with CO2 in the event of a fire alarm".

A map of the German chain is available here.

INDIA

Bombay and Calcutta were contracted in 1959 according to Decca records. Bombay opened in 1962 while Calcutta became operational in 1964.

Bombay Chain 7B

LOCATION	DESIGNATION	FREQ	COORDINATES
Savarkundla	Master	85.3650 kHz	?
Bilimora	Red	113.820 kHz	20º45'40"N, 73º02'17"E
Veraval	Green	128.048 kHz	20º57'07"N, 70º20'13"E
Dhrangadhra	Purple	71.138 kHz	23º00'14"N, 71º31'39"E

Calcutta Chain 8B

Stations were located in the States of Orissa and West Bengal.

LOCATION	DESIGNATION	FREQ	COORDINATES
Balasore	Master	85.5450 kHz	21º29'08"N, 86º55'18"E
Patapur	Red	114.0600 kHz	20º45'40"N, 73º02'17"E
Bishnupur	Green	128.3175 kHz	?
Diamond Harbor	Purple	71.2875 kHz	22º10'18"N, 88º12'25"E

Salaya Chain 2F

This chain was installed in 1978 specifically as a navigation aid for the Gulf of Kuchchh marine traffic using 1880 series equipment. Very Large Crude Oil Carriers (VLCCs) brought crude oil from the Persian Gulf to the refineries in the state of Gujarat and in particular through the deep water channel to the off-shore oil terminal at Salaya. Stations sites in the Salaya chain were all near rural villages that were some considerable distance from a major city.

LOCATION	DESIGNATION	FREQ	COORDINATES
Mandvi	Master	84.5550 kHz	22° 52' 26.80"N, 69° 24' 00.02"E
Kuranga	Red	112.7400 kHz	22° 03' 29.92"N, 69° 10' 29.74"E
Dhuvav (Dhuwao)	Green	126.8325 kHz	22° 28' 48.54"N, 70° 07' 43.09"E

Naliya	Purple	70.4625 kHz	23° 15' 04.32"N, 68° 49' 00.03"E

BACKGROUND

It was from India that the first non-European Decca chains were ordered.

The Decca Navigator Co. of U.K. was contracted in 1955-56 to establish a hyperbolic position fixing system in India. The Bombay and Calcutta chains of four stations each were established between This chain used the 820 series tube equipment when first installed between 1958-62. The production of Decca Lattice navigation charts was taken up in 1967 by the Indian navy with the first of the series covering the approaches to Paradeep Port. These were first published in April 1968.

The Director General under the Department of Lighthouses and Light-Ships was the sole authority for administration and management of light-houses and their principal navigation aids such as Decca Navigator. There were three chains in India. The Department of Lighthouses and Lightships is a subordinate office under the Ministry of Shipping and headed by the Director General of Lighthouses and Lightships. The Headquarters of the Department of Lighthouses and Lightships is situated at Noida. Decca's main supporter was Mr. Lahiri of the Indian Lights Authority as it was known at the time.

David Jones describes one incident while in working for Decca in India. "Base lines were relatively short but journey times between stations were measured in many hours depending on circumstances. Our team from Diamond Harbour once made the 50 mile drive back to Calcutta in an elderly Ford car which had a broken fuel pump. Every couple of miles, the driver would stop the car, remove the carburetor float chamber cover and pour in another cupful of gasoline".

In 1992, Bombay and Calcutta were replaced by Loran-C chains of three stations each. The Salaya chain closed as of December 2000.

All three Indian chains can be viewed here.

INDONESIA

In 1974, The Decca Navigator Company signed a contract with Perusahaan Pertambangan Minyak Dan Gas Bumi Negara (PERTAMINA). This organization acted on behalf of the Indonesian Government for the supply of a Decca chain to be installed on the Sumatra coastline in the central area of the Malacca Straits. It was to be called the Dumai Chain.

The layout of the chain was configured to provide accurate navigation in the approaches to the new oil terminals which were being developed at Dumai and Sungaipakning. In addition, it going to provide accurate coverage over the whole central area of the Malacca Straits. The installation of a Decca chain in this important and hazardous seaway marked a significant step forward in the march of marine safety in its day. For the Decca company, there was a lot of concern as to how they were going to erect masts in the swamps with no solid footings. By the late 1970's, all hopes of building the chain were totally dead. Dave Baker of Decca bought all the equipment back from the Indonesians (PERTAMINA) and sold the master and two slaves to the Iranian PSO (Ports and Shipping Organization) for the proposed Strait of Hormuz Chain. Due to the Iranian revolution, the Strait of Hormuz chain was never built . The Purple Slave 1880 cabinet intended for Hormuz instead saw active service as the Purple slave of the Holland Chain in Thorpeness, Suffolk, UK.

Select this link for a map of the proposed Dumai chain.

IRAN

LOCATION	DESIGNATION	FREQ	COORDINATES
Bandar-e Deylam	Master	85.0050 kHz	30°1'7"N, 50° 9'29"E
Abadan	Red	113.3400 kHz	30.4° N, 48.2° E
Bushire	Green	127.5075 kHz	28° 58' 38"N, 50° 51' 9E

In the ***North Persian Gulf Chain 5C,*** all the stations were located in Iran and based around the port of Abadan. Both chains in the Persian Gulf were operated by The Middle East Navigation Aids Service (MENAS). It was established in 1950 to serve the maritime industry in the Arabian Gulf, but it can trace its origins back to 1911 when tanker shipping entered the Gulf to collect cargoes of oil. MENAS, an independent, not for profit organization, while registered in the United Kingdom, has its centre of operations in Bahrain at a base established in 1950 following the donation of land in perpetuity by the then ruler, the late Amir, HH Shaikh Salman bin Hamad Al Khalifa. an entirely independent authority having no national sponsor or commercial owner. Revenue is drawn solely from navigation dues paid on vessels above 2,000 Net Registered Tonnage (NRT) using Gulf waters and, this revenue is invested for the safe navigation of shipping passing through the Gulf. Chain 5C provided coverage for vessels using the waters along the coastline of Iran.

John Molloy-Vickers, one of the installers for the North Persian chain, gives his perspective on the installation. " I spent Christmas 1960 and a few months thereafter in Persia helping to install the North Persian Gulf chain. Nobby Clarke, Ernie Easter and Reg Odams were the principals from our department. The problems were huge. All the equipment for the three stations had been dumped in a yard after delivery to the National Iranian Oil Company in Abadan. Although they had been carefully marked and labelled in the UK, by the time they were ready to be deployed it was nearly impossible to tell whether a crate contained an air conditioner, a toilet bowl or a transmitter.

Equipment was loaded in some cases onto landing craft to send it on its way. It was a major exercise since we had to start from scratch and build complete stations with all facilities for operating staff and servants. We became plumbers, electricians, sewerage experts and medical attendants to the locals in a very short time. We initially lived in tents with scorpions and snakes for company. When we had the living quarters built, goats were slaughtered on the back door step by our Indian cooks etc. Through our interpretter at Deylam I recalled that one of the locals asked for sidecutters. When asked what for, he said to "cut off his wife's finger" to recover her ring before he buried her in the cemetery next door to our station.

One day, I rather stupidly jumped into the Shatt al Arab waterway at Korramshur to cool off and surfaced next to a dead cow. I was keeping a wary eye on the Iraqi guards who always watched us from the other side and I was not looking out for flotsam.

I believe the chain closed on May 1, 1980".

Phil Jones, a former Decca employee who maintained the Persian Gulf Chains in the late 1970's provides this account of the situation in Iran around the time the Shah of Iran fell.

"Things got scary just before the fall of the Shah and the rise of Ayatollah Khomeni. Many of the knowledgeable expatriates simply moved away but the Decca crews were considered essential. Logistical problems arose in Iran where it was never easy to get parts under normal circumstances. Procurement of vacuum tubes was especially difficult. I remember smuggling some in my suitcase on a return trip from UK on one occassion.

Going into towns or villages as a visible Westerner was risky to say the least. During the American hostage crisis, a lot of hatred developed against the west. Once, we had to flee and hide for our lives on a routine shopping trip just to get groceries. Back in those days it was impossible to make a phone call locally, let alone internationally and it took about 3 to 4 weeks to get a letter from home. All our communication between stations was made possible through short wave radio. We all became radio ham experts. By that, I mean we could easily understand each other no matter how garbled the voice was at the other end. Sometimes we did take advantage of this with our regional manager.

When we were were stationed on Lavan Island which was the best location in Iran for day to day living, we would get instructions from our area manager in Khorramshar (near Abadan). If we did not like what he was asking, we could easily say he was fading out and could he repeat that!! After several times of repeating, he would give up but I don't think he believed us. Life in Iran was tough to say the least back then and it gradually got worse as the new Islamic-style regime started to grip the country. Towards the end, getting out of Iran was probably the most dangerous thing for me but that's another story.

The bugs were big and plentiful. (ie camel spiders, scorpions and even snakes). .On the station at Lavan Island, one snake even came to visit me sidewinding under the toilet door. As an ex-boy scout, one has to be prepared but under these circumstances I never knew how to defend myself against an irate sandviper with pants down and a toilet roll! I suspect it was actually planted by a disgruntled local employee - the diesel coolie, who I made do an honest days work each day when I was there. I must say that some of the weirdest and most potentially dangerous experiences happened to me while I maintained the Persian Gulf Chains".

Phil also relates this story about the Master station failure Bandar Deylam. " It happened just before I joined Decca in the Gulf. One engineer was on a *sleeping watch* when the alarm sounded in the middle of the night. He ran into the station and saw that all 807 transmitter amps were blowing fuses fast and furious. As soon as he replaced the fuses they blew again. Then out the corner of his eye he noticed no aviation lights on the mast. The reason - the whole 300 foot mast had come crashing down in the middle of the night. Apparently the construction company used sea water to mix the concrete for the mast anchor blocks (to save money) when the mast was put up several years earlier. So it was just a matter of time before the concrete failed.

After this "incident" the station was completely overhauled. Since it had such a good maintenance history prior to the crash, it was one place where you could actually get a good nights sleep. I guess the duty station engineer who witnessed the mast come down also got a few good nights sleep after that commotion.

Often, going off the air was the result of a diesel failure. Those 28 year old Listers were good but sometimes unpredictable. When I was on a sleeping watch, the thing that often woke me up was the total silence of not hearing the air conditioners running. You would get up in a daze, sometimes you were lucky and the station was still on the air; sometimes not. Going from a deep sleep to being fully awake and in 3 minutes hand cranking an old 6 cylinder Lister (on decompression) could only be done if you were under 30. I think now that would be case of major heart failure!

Looking back I often wonder how those stations were as reliable as they were. Logistics was always difficult. Even diesel fuel delivery at Bandar Deylam was by donkey! "

Phil Jones, by the way, has been involved in home audio since he was thirteen years old. While stationed in the Persian Gulf with The Decca Navigator Company, he designed and built speakers to pass the time away. In the UK, many folks know him as *the dude* who

designed and founded Acoustic Energy (of AE-1 and AE-2 fame), then with Boston Acoustics (Lynnfield speakers), followed by the founding of Platinum Audio. In 1998 AAD (American Acoustic Development Ltd.) was born with a manufacturing plant is located in China. This is where Phil spends his time now. In August 2003, Phil will be moving to the St. Louis MO, to look after his interests in PJB (Phil Jones Bass Inc), an organization dedicated to making very high performance bass guitar amplifiers. One model is all tubes using four 813 transmitter tubes.

A map of the Northern Persian Gulf chain can be seen here.
Also see the U.A.E. section for more information about the Persian Gulf chains.
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IRELAND

The Irish Chain 7D was operated by Bord Iascaigh Mhara (Irish Sea Fisheries Board) for mariners sailing on the west and south coasts of Ireland. All stations were located within Ireland. Chain 7D was formally opened on May 31, 1973.

LOCATION	DESIGNATION	FREQ	COORDINATES
Galway (Oranmore)	Master	85.450 kHz	53.250º N, 08.930º W
Ballydavid	Red	113.933 kHz	52.200º N, 10.367º W
Dungloe	Green	128.175 kHz	54.883º N, 08.383º W
Youghal (Ardmore)	Purple	71.208 kHz	51.950N, 07.750º W

Select this link to see a map of the Irish chains and the towers. The mast at Galway (Oranmore) is apparently gone.

ITALY

ROME: Chain ID: ??

In the late 1950's, the RAF lobbied NATO to establish a Decca Navigator chain in Italy because the RAF had already installed Decca in some of its low-level Canberra B8 aircraft. A two pattern Decca evaluation chain was therefore constructed for the Rome Control Area, however the exact date of its opening is not known at this time. Master and Red stations were situated on the Italian mainland with the Green slave on the island of Sardinia.

Walter Blanchard flew on some of the flight trials and demonstrations. "Apart from demonstrations for Italian civil aviation authorities, we also flew a considerable number of military trials based at the Italian Air Force base in Pratica di Mare, near Rome. The main monitor station for the chain was located there. We used an IAF Fiat G91 fighter with an experimental set-up of three antennas spaced equally round the fuselage to get around the loss of signal when the aircraft performed manoeuvres. The tiny cockpit was even fitted with a Flight Log!. It was a fairly successful trial and later on we transferred the equipment to a USAF F-101 and carried on with trials in the UK. These trials were supported by NATO who were looking for a low-level navigation system in Italy, but nothing ever resulted from them and I'm not sure why. These trials were triggered by the RAF who at the time had installed Decca in some of its low-level Canberra B8 aircraft. I also flew the trials in those aircraft. I believe the costs of the Italian chain were borne mainly by NATO but Decca took advantage of it to perform civil demonstrations as well".

LOCATION	DESIGNATION	FREQ	COORDINATES

Pratica di Mare (south of Rome)	Master	?	41° 40' 0 N, 12° 28' 60 E
SE of Turni, Italy	Red	?	?
Venefiorite (north east) Sardinia	Green	?	?

The continuous growth of commercial air traffic and the introduction of more turboprops and turbojets increased the problem for air traffic control in the Rome Control Area in the late 1950's. Aggravating the situation were relatively inaccurate radionavigation systems which formed the basis of air traffic control in this area. The mixture of aircraft types required complex routing and radar was insufficient to get the whole job done. To demonstrate the capabilities of the Decca Navigator system in the cockpit, two demonstration fights by Decca's corporate Valetta aircraft were arranged for October 14/1959. There were many other flight demonstrations as well.
For unknown reasons, the chain did not persevere so its closing date is not known at this time.

SICILY, CHAIN ID=?

A demonstration chain was set up in Sicily as reported in the November 1969 issue of Decca Navigator News.

For more information on Decca Italy, select this link.

JAPAN

BACKGROUND

Japan was a land of opportunity for Decca because it relies on the sea for its food supply and fishing is a major industry. Because Japan lacks mineral resources, oil and steel have to be imported therefore the sea is very vital to the country's economy.

Japan was an early user of the Decca system having bought its own survey chain in 1960. Also, it was an early European chain user - ships picking up receivers from Mediterranean ports when entering the area and leaving them behind when returning to the Far East.

When Decca made made the initial contact into this marketplace, the company found a few knowledgeable individuals anxious to learn more about the system. There were not many but they were influential. The big names were Shimasue and Kiyono. Mr Kiyono is still very active in Japan and his company, SENA started renting Decca-licenced, Japanese-made receivers starting around 1966.

In the mid-1950's, the basic problem for Japan was a shortage of money but as the country's financial situation improved so did Decca's chances of establishing chains. . In 1964, with Japan just beginning its up-turn of Navigator, Decca signed agreements with the Government of Japan and with a number of commercial organizations. These included Kobe Kogyo (now Fujitsu) as the manufacturing licensees. All of the relationships were most cordial and long lasting. Over the years the Japanese Government built six chains so that the whole of Japan was covered.

Japan holds the distinction of being the last bastion of Decca having closed down the Hokkaido chain in March 2001. This was one year later than the UK closure. Hokkaido was also the first Decca chain to open in Japan.

The SENA Company kind enough to provide details for all six Japanese chains. To see full details on the Japanese Decca chains, select this link.

NETHERLANDS

FRISIAN ISLANDS 9B

LOCATION	DESIGNATION	FREQ	COORDINATES
Finsterwolde, Netherlands	Master	85.720 kHz	53.200ºN, 07.100º E
Hoejer, Denmark	Red	114.293 kHz	55.017ºN, 08.717º E
Heiloo, Netherlands	Green	128.580 kHz	52.600ºN, 04.733º E
Zeven, Germany	Purple	71.433 kHz	53.283ºN, 09.267ºE

BACKGROUND

Bob Peters, who was previously a Decca maintainer, provides some information on the Dutch chains. "I worked 16 years on the Green Slave of chain 9B until the conversion in 1985 which permitted automatic operation and remote control. The stations of the Dutch Chains were not maintained by Decca. Instead a Dutch concern provided maintenance.

The, was built in 1968 for merchant, fishing and yachting purposes and the owner of the F.I.C. was the Directorate General for Public Works and Water Management (RWS) owned and managed the chains. The Frisian Islands Chain covered the North Sea, north of the Netherlands and Germany and west of Denmark.

Bob goes on to describe the power system for the Green slave. Under normal conditions, power to the site was provided by the public power system. (380 volts 3 phase from a 10.000 volt step-down transformer). A 380 volt feed supplied the input for two motor generators whose output was 600 volt DC for the transmitters, 380 volt AC for the phase controls and Rasme, a 220 volt DC output and a 50 volt DC output both for recharging the batteries. During a power outage, the 200 V dynamo became a motor whose power source was the 220 volt battery bank. After some time, a 6 cylinder Lister diesel generator took over. In all, there were two motor generators, two 220 volt battery banks, two battery banks of 24 volts each

Before conversion, the F.I.C. was controlled from the Master station which was manned 24 hours a day while the Green slave was only staffed during normal business hours. Two men worked at the Green slave with a one day on, one day off work schedule. For off-hours coverage, each man was equipped with a special alarm receiver at home. The station raised the alarm by a sudden drop of the power from the 9F transmitter just after the Multipulse period.

Around 1985, all the stations F.I.S. the stations were converted to run automatically and under remote control.
Although a control desk was built into the Master station, all the information was sent to Hoek of Holland over a leased telephone line to a second control desk. The control of chain 2E was therefore located in Hoek of Holland, the entrance to the port of Rotterdam.

Slave station Purple in Zeven, Germany was located between Bremen and Hamburg at coordinates 53° 17' 07"N, 09° 15' 49"E. Providing coverage for the North Sea, it was decommissioned in December 31, 1999. The main antenna had a mast height of 93 meters while the backup was slightly shorter at 46 meters. On hand evidence suggest it was also the Green slave for the German chain 3F.

An interesting note was spotted in a Decca technical publication dated 1973." WARNING - Although the
Frisian Islands chain is using the same frequency as the old German chain, namely 9B, the

ground stations are not in the same positions and therefore the old German charts cannot be used with the Frisian Islands chain. See notice to Mariners 1977(p) of 1967 ". Something obviously happened with the chain assignment,. Can anyone explain this mystery?

HOLLAND CHAIN 2E

LOCATION	DESIGNATION	FREQ	COORDINATES
Gilze-Rijen, Netherlands	Master	84.550 kHz	51.617ºN, 04.917ºE
Heiloo, Netherlands	Red	112.733 kHz	52.583ºN, 04.733ºE
Westdorpe, Netherlands	Green	126.825 kHz	51.233ºN, 03.833ºE
Thorpeness, England	Purple	70.458 kHz	52° 10' N, 01° 37'E

The Purple slave Thorpeness was added after chain 2E was established since it does not appear in the initial chain listings. One correspondent said he looked after this slave from 1991 through 1994. This chain serviced the area of the Netherlands known as *Europort*.

With the help of Decca, large crude oil tankers could enter the Hoek of Holland through a virtual "canal" in the sea. Initially built without a Purple slave, it was eventually added and was located in Zeven, Germany. Until the Purple station was functional, the master station also transmitted the Purple signal. Since there was a bend in this canal and the hyperbolic lines of the Red and Master and Red and Green stations criss-crossed over the canal, a special accessory on the receiver made it possible to use the Red and Green slave only for navigation. Because the Dutch were very keen users of the system, they developed their own high accuracy differential receiver for pilot vessel use. This was known as the "Brown" receiver because Red and Green produce brown when mixed.

On Saturday the 16 April, 2011 at 10.00 o'clock the Decca transmitting aerial of Green 9B was intentionally demolished. Red 2E came down at 13.00 hours, twelve years after Decca was switched off. The transmitter buildings are still there. Green and Master of 9B are used as clubhouses by a motorclub.

To view a map of both Dutch chains and the Finsterwolde mast, select this link

NIGERIA

LAGOS 8F

LOCATION	DESIGNATION	FREQ	COORDINATES
Ikorodu	Master	85.6400 kHz	6 º 39'N, 3º 35'E
Abigi	Red	114.1867 kHz	6º 30'N, 4º 23'E
Badagary	Green	128.4600 kHz	6º 25'N, 2º 56'E
Abeokuta	Purple	71.3667 kHz	7º 17'N, 3º 29'E

RIVERS 7F

LOCATION	DESIGNATION	FREQ	COORDINATES
?	Master	85.4600 kHz	?
?	Red	113.9467 kHz	?
?	Green	128.1900 kHz	?

?	Purple	71.2167 kHz	?

Station names unknown at this time.

MID EASTERN 3A and SOUTH EASTERN 2B

These chains were proposed but not built.

BACKGROUND

The economy of Nigeria has been closely linked to the oil industry and the discovery of considerable reserves brought about many changes there. For many years, there had been exploration programmes using small Decca survey chains but as the development of the industry took place it became necessary to install full.size, non-restricted user chains. Four such chains were initially commissioned.

In the 1970's, important oil developments off the coast of Nigeria were raising the urgency for effective and safe control of marine traffic. Uncontrolled shipping would present a growing hazard to oil rigs, loading terminals and to the large number of tankers coming in to the area. A series of areas prohibited to normal traffic would be introduced to protect the loading terminals and rigs and a system of traffic routing instituted to ensure that the regulations were not violated. Tanker routes to and from the loading areas would be laid down with a zone for coastal traffic inside the restricted areas.

The Decca Navigator company intended to undertake all the necessary work including the selection, surveying and clearing of sites, the erection of antennae and the installation of technical equipment. At the end of the project, complete operating chains would be handed over to the Federal Ministry of Transport to be manned by Nigerian engineers trained by Decca in the United Kingdom. The four chains were intended to give contiguous coverage along the Nigerian Coastline using 1880 type equipment.

The Lagos chain consisted of the Master station at Ikorodu to the North of Lagos, the Red slave at Abigi along the eastern shoreline of the Lagos Lagoon, the Green slave at Badagary near the Benin Boarder, and the Purple slave at Abeokuta, about 60 km north of the master station. These slaves were intended for unmanned operation with planned visits of only once a month and diesel generator maintenance at three month intervals. Diesel generators were the only source of power for the Nigerian chains. A monitoring station was located at Agbowa, about 7 km north of the master station.

According to David Jones, a former Decca employee, only two out of the four chains were ever built and those were a struggle. Rampant corruption and dishonesty plagued the project. Lagos and Rivers operated for a short time but never went into public service. It is believed that the Nigerian Chain was the last Decca chain ever built.

The dramatic changes in world oil prices were paralleled by Nigeria's internal political problems. There were many difficult years for Nigeria and these lead to difficult times for the chains. As a result, the Lagos and Rivers chains shut down before going into commercial service.

Select this link to see the Nigerian chains and a photo of the signing of the contract.

NORWAY

The contract to establish six Norwegian Decca chains was signed in September 1965 and the chains were formally opened on May 14, 1968.

FINNMARK (FINNMARKKJEDEN) 7E

Finnmark was Norway's first chain with the contact having been signed on May 27, 1967

LOCATION	DESIGNATION	FREQ	COORDINATES
Bøerselv, Norway	Master	85.4550 kHz	70º23'28"N, 25º30'14"E
Kirkenes, Norway	Red	113.9400 kHz	69º41'19"N, 30º03'14"E
Vannøy Øst, Norway	Green	128.1825 kHz	70º06'20"N, 20º07'07"E
Nordkapp, Norway	Purple	71.2125 kHz	71º09'36"N, 25º45'21"E
	Orange	116.7885 kHz	

HELGELAND (HELGELANDKJEDEN) 9E

Helgeland was initially 10B then became 9E. The frequencies shown below are for the 9E chain.

LOCATION	DESIGNATION	FREQ	COORDINATES
Dønna, Norway	Master	85.8100 kHz	66.200ºN, 12.467ºE
Røst, Norway	Red	114.4135 kHz	67.533ºN, 12.133ºE
Rørvik, Norway	Green	128.7150 kHz	64.917ºN, 11.167ºE
Mo Rana, Norway	Purple	71.5083 kHz	66.283ºN, 14.167ºE
	Orange	117.2737 kHz	

LOFOTEN (LOFOTKJEDEN) 3E

Lofoten was initially 3F then became 3E. The frequencies shown below are for the 3E chain.

LOCATION	DESIGNATION	FREQ	COORDINATES
Andøya, Norway	Master	84.7350 kHz	69º08'45"N, 16º01'53"E
Vannøy Vest	Red	112.9800 kHz	70º14'51"N, 19º30'05"E
Røst, Norway	Green	127.1025 kHz	67º31'44"N, 12º09'30"E
Narvik, Norway	Purple	70.6125 kHz	68º27'57"N, 17º06'02"E
	Orange	115.8045 kHz	

TRONDELAG (TRØNDELAGKJEDEN) 4E

LOCATION	DESIGNATION	FREQ	COORDINATES
Skarsoy, Norway	Master	84.9150 kHz	63.333ºN, 08.450ºE
Rørvik, Norway	Red	113.2200 kHz	64.917ºN, 11.167ºE
Stad, Norway	Green	127.3725 kHz	62.200ºN, 05.133ºE
Berkåk, Norway	Purple	70.7625 kHz	62.833ºN, 19.050ºE
	Orange	116.0505 kHz	

Stad was shared with the Vestlandet chain.

VESTLANDS (VESTLANDKJEDEN) 0E

LOCATION	DESIGNATION	FREQ	COORDINATES
Aagotnes, Sotra Island, Nor.	Master	84.1950 kHz	60º24'24"N, 05º00'34"E
Stad, Norway	Red	112.2600 kHz	62º11'35"N, 05º07'31"E
Shetland Island, Scotland	Green	126.2925 kHz	60º02'54'N 01º14'33"W
Stavenger, Norway	Purple	70.1625 kHz	58º47'15"N, 05º32'42"E
	Orange	115.0655 kHz	

The village of Aagotnes on Sotra Island in Western Norway was home a Decca site from 1966 to 1999. The chain was closed down on Jan.17th, 1997 at 1200 noon. Stations in this chain used 1,200 watts of power.
Stavanger (Hodne) was closed down was January 22nd, 1997.

The Green slave of this chain was located on Shetland Island in close physical proximity to the Green slave of the North Scottish chain 6C with the Green carriers only 1.485 KHz apart. Can anyone comment as to why Decca did it this way because it's the only example in the entire network?

Norwegian Decca chains can be viewed on the following map.
To see photos of some Norwegian chains, select here.

SCOTLAND

HEBRIDEAN 8E

LOCATION	DESIGNATION	FREQ	COORDINATES
Barra, Scotland	Master	85.635 kHz	56º59'N, 07º25'W
Kentra Moss, Scotland	Red	114.180 kHz	56º45'N, 05º49'W
Butt of Lewis, Scotland	Green	128.453 kHz	58º30'N, 06º16'W
Dungloe, Ireland	Purple	71.363 kHz	54º53'N, 08º23'W

BACKGROUND

The Hebridean chain first transmitted test signals in Dec 1976, and went on the air in 1977. It filled the last remaining gap in coverage around the UK by providing coverage for the North and North West coasts of Ireland, off the Hebrides and improved accuracy in the Minches. It was configured for dual chain operation

Along with the Northumbrian chain, it used re-furbished thermionic valve equipment bought back from the
USA. The USA had two experimental chains - one in California which was used for airborne trials, and one around the Bahamas reputed to have been used for submarine navigation. It is not certain which chain ended up at which site.

The Hebridean chain shared transmitter locations with Dungloe of the Irish chain, and the Butt of Lewis of the North Scottish chain, so only two new sites were needed - Barra and

Kentra. These stations were designed to withstand the fierce winds and they looked like *crofters* houses. They were built by the same Berwick-on-Tweed contractor that built the Northumbrian stations to the same design. Transmitter sharing meant synchronization of all these chains, which was done by using the Rubgy time signal.

The Barra master was built during the glorious summer of 1976, when the locals were amazed at the speed of construction. Having built the Northumbrian stations previously had a lot to do with this. The stations of this chain were all continuously manned because the economics were such that this was a cheaper option than the capital cost of remotely controlled solid-state stations. Of course, the shared stations were already manned and had the full infrastructure in place.

Photos of the Hebridean chain can be viewed in this section.

NORTH SCOTTISH 6C

LOCATION	DESIGNATION	FREQ	COORDINATES
Kirkwall [a.k.a. Dounby], Scotland	Master	85.1850 kHz	50º04'N, 03º15'W
Butt of Lewis, Scotland	Red	113.5800 kHz	58º30'N, 06º15'W
Lerwick [a.k.a. Shetland], Scotland	Green	127.7775 kHz	60º10'N, 01º 11'W
Peterhead, Scotland	Purple	70.9880 kHz	57º31'N, 01º 51'W

BACKGROUND

The Decca station in Dounby started transmitting from a group of wooden huts on September 1, 1955. The base was set up by Ken King, who had been running a station in the south of England. The first person to take charge of running operations in Dounby was Harry Cordock along with Gordon Pirie who lived in Stenness, and Davy Johnstone from Dounby. The last station manager was Jim Anderson, who recalls those early days.

“I joined Decca in May 1956. It wasn't supposed to be officially open until later, but the fishermen were in such a hurry that we opened it when it was still manually controlled. We had to take readings and check other things to make sure everything was all right. After that, you were just waiting there in case anything went wrong. It was a case of diving at the switches and doing something about it if anything happened.”

“Dounby [Kirkwall] was the North Scottish Master station, with ‘slave’ stations in Butt of Lewis, Peterhead and Shetland [Lerwick]. Jim added: “I think there were four engineers to begin with, but it grew to five plus a handyman when we moved into the new building in January 1958. The first and second engineers lived on the premises. Harry Cordock was first engineer, and Duncan Bell was second engineer. When Duncan returned to Edinburgh he was replaced by Ken MacInnes from Stromness. That was when the transmission system became reasonably automatic. You still had to be there, but you could turn your back on it for a few seconds. It was a 12-hour shift system we worked, and every 15 minutes we had to take readings off the receivers. The figures were recorded in logs in triplicate, even though there was a machine recording them as well.”

Tommy Mainland joined Decca in December 1966 in Dounby. He remembers what it was like working a shift system, when living on the station. “When I joined, we used to do 12 hours on a day shift, from 9 in the morning till 9 at night. The next day, you went on at 9 at night and

worked till 9 in the morning, and then you "allegedly" had two days off. I worked that shift pattern for a while, and then eventually we changed that to one week at 9 to 5, a week of 5 till midnight, and a week of midnight till 9 in the morning. It ended up that when we got "sleeping" night watches, we did 24 hours on, and 48 hours off." Jim Anderson remarked: "Eventually the station became more automated, we were able to sleep at nights.

George Grieve joined Decca at Peterhead in January 1967, one month later than Tommy Mainland. George recalled the shift system he had to cope with.

"Peterhead was the 'purple slave' station. We just did 24 hours on, 48 hours off. But during the time off at Peterhead we were always very busy doing the marine servicing side of it - with the navigators on the fishing boats, which we also did up here, but not in such large numbers. If they broke down when they were trawling, they would pull up their nets, come ashore and get it fixed, rather than chance going without it. We installed the equipment on board the boats and serviced it. It was 24 hours a day. They were paying for it, and they expected to get it. If the system broke down at 3 o'clock in the morning, you were expected to be there."

The whole system became totally automated in January, 1994, and the individual stations were left unattended except for maintenance work carried out by a locally-based engineer. In Dounby's case, that person was Jim Anderson. "I've been on call 24 hours a day. I've had to go to the control centre which is based at the lighthouse headquarters in Edinburgh, to do shifts there from time to time. I always come out here once a week, although the requirement was only once a quarter to do the maintenance, but I liked to keep it in good order."

The non-essential staff were kept on until the end of September, 1994 stripping out the entire supply of technical equipment from the main building, and vacating the living quarters, to be replaced by a self-contained air-conditioned aluminum clad cabin alongside, housing miniaturized equipment. Neither Tommy Mainland nor George Grieve felt it hard to leave the Decca station for the last time when they were made redundant at the end of September, 1994. Tommy commented: "It wasn't difficult, because we'd had so little to do for the rest of that year. It seemed strange the building being there, but doing nothing."

In its heyday, Decca could promise a career for life, providing regular training in electrical work and other aspects of the company's many interests. Jim Anderson remembered those halcyon days.

"We had a Decca school which was at Brixham in Devon, and they sent us on courses from time to time. The Admiralty weapons and communications company Racal took over Decca in 1981 or so. It was said that they wanted to acquire Decca's radar company, rather than the avionics side of the business. It was all going fine until a Danish company started making receivers for fishing boats which operated with Decca's navigation charts, but they didn't pay any rental for using the system.

"A court battle followed, Decca lost the exclusivity, and that started the beginning of the end. Income started to dwindle. Eventually, the Ministry of Transport stepped in, and got the lighthouse authorities to take us over. That would have been the early 1990s."

Jim went on to talk about the final switch-off for the station. "The equipment here is of no use to anybody else. That's the end of it. A skip is coming and we'll throw everything out. We have to get rid of the condensers in the coil house, and there's oil in them which has to be checked before moving anything there. Alton Tait is taking over the cabin and the engine, so we'll leave the control gear connected up, and just disconnect our gear from it."
Tuesday, April 4, 2000 marked the end of an era for post-war technology in Orkney, with the complete shutdown of the Racal-Decca navigator station in Dounby.

The Green slave of this chain was located in Lerwick in close physical proximity to the Green slave of the Vestlands chain 0B with the Green carriers only 1.485 KHz apart! Can anyone comment as to why Decca did it this way because it's the only example in the entire network?

Select this link to see a map of the Scottish chains.
Photos of the North Scottish Chain can be seen here.

SOUTH AFRICA

BACKGROUND

In the late 1940's the South African Government conducted a series of tests to determine the effects of the local conditions on the propagation of Decca signals. George Hawker of Decca spent several months in the area and much was learnt. Decca kept good contact with all concerned in South Africa and this was rewarded with the building of five chains in the mid and late '60's.

General Wilmott, the Supreme Commander of the South African Forces and General Martin, the Head of the Air Force were closely involved in the Navigator procurement while Colonel Broadhurst and an engineer named
Wadley conducted the initial trials. It was Wadley who developed the communication receiver which established the technical base for much of Racal Communications equipment.

The South Africa chains were heavily used by both coastal and helicopter traffic. In the early 1970's, Decca established a separate company in South Africa to sell and support it's products. Through expediency, this company became virtually self-sufficient in it's operation and was very well run. Much of the South African Defence Force relied upon Decca products for navigation and communication.

A map of the South African chains, photos and chain data can be viewed here.

SPAIN

Santiago Insua Fernandez, whose father was employed as a Decca maintainer, provides a brief outline of the Spanish chains along with some photos.

North-West Chain 4C

LOCATION	DESIGNATION	FREQ	COORDINATES
San Xoan de Rio, GALICIA	Master	83.8300 kHz	42.383ºN, 07.283ºW
Noia, GALICIA *	Red	113.107 kHz	42.733ºN, 08.917ºW
Boal, ASTURIAS	Green	127.245 kHz	43.450ºN, 06.833ºW
Vitigudino, CASTILLA LEÓN	Purple	70.6920 kHz	41.017ºN, 06.433ºW
* Lousame is the name of the nearest village to the former 4C Red station, but it's a village of only 100 habitants. The principal village in the area is Noia (18,000 habitants) and this is the name that is recorded in all official documents.			

Southern Chain 6A

This chain was designed to serve the narrow waters around Gibraltar and the ports of Huelva and Algeciras. The master station was about 60 miles north of Malaga.

LOCATION	DESIGNATION	FREQ	COORDINATES
Setenil de las Bodegas, ANDALUCIA	Master	85.1750 kHz	36.867ºN, 05.133ºW
Padul, ANDALUCIA (near Granada)	Red	113.5667 kHz	37.033ºN, 03.683ºW
Los Barrios ANDALUCIA	Green	127.7625 kHz	36.183ºN, 05.483ºW
Rociana del Condado, ANDALUCIA (near Seville)	Purple	70.9792 kHz	37.300ºN, 06.600ºW

BACKGROUND

The installation of Decca Navigator in Spain in 1977/78 was a joint venture between The Decca Navigator Company and Marconi Español. Both Spanish Chains had an effective range of 240 miles. All sites used the 1880 series station equipment which was also designed for unattended operation. System monitoring was based on a remote receiver at a small mountain village called Olvera and the data was sent via microwave link to the master station. Much of the ancillary equipment was made or purchased by Marconi and they installed most of it. Once the chain was completed, the Decca vessel, MV Navigator was used for some of the system trials

In Spain, the government decided to have manned Decca sites. The personnel who maintained the Decca chains were employed by the Special Public Corporation, an arm of the Spanish Public Works Ministry. Slave stations had one dedicated maintainer while master stations had four people. Most of the maintainers lived on the station properly along with their families. In 1994, the Spanish Government announced that the Spanish Chains will remain in service until the year 2000. One year later they closed Decca and all the employees of the Spanish Chain were transferred to the Spanish Public Ports. This semi-private corporation was called "Ente Publico de Puertos del Estado Español ".

The North Spanish chain became well known as the one where a station engineer froze to death while trying to reach the building during a winter storm. He was found crouched behind a wall within sight of the buildings.

For photos and a map of the Spanish chains, select this link.

STRAIT OF HORMUZ

Proposed in 1978, the chain was never built due to the Iranian revolution, however the chain appears on a Decca document published in 1982. For additional information and map select this link.

SWEDEN

Both the North and South Baltic chains were in Sweden.

North Baltic 4B

LOCATION	DESIGNATION	FREQ	COORDINATES

Nynäshamn, Sweden	Master	84.825 kHz	58°56’42.95”N 17°57’31.13”E
Åland Islands, Finland	Red	113.100 kHz	60°07’12.43”N 19°49’29.08”E
Ar, Sweden	Green	127.238 kHz	57°54’52.41”N 18°57’29.28”E
Björkvik, Sweden	Purple	70.688 kHz	58°50’46.10”N 16°34’22.26”E

The North Baltic chain was made operational in October 1957. Prior to 1970, the Red slave was located at Rådmansö, but it was moved to Åland in 1970. Ar is a small village at the northwest tip of Gotland Island.

South Baltic 0A

LOCATION	DESIGNATION	FREQ	COORDINATES
Holmsjö, Sweden	Master	84.100 kHz	56.450ºN, 15.667ºE
Sandhammaren, Sweden	Red	112.133 kHz	55.400ºN, 14.183ºE
Burgsvik, Sweden	Green	126.150 kHz	57.017ºN, 18.250ºE

BOTHNIAN CHAINS

By the early 1960's, the old ***Swedish*** chain had become the North and South Bosnian Chains.

The ***North Bothnian 5F*** chain consisted of a master and two slave stations in Sweden while the third slave was in Finland. It came into commercial service in June 1962.

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LOCATION	DESIGNATION	FREQ	COORDINATES
Lövånger, Sweden	Master	85.095 kHz	64°20’55.67”N 21°20’55.20”E
Gamla Karleby, Finland	Red	113.460 kHz	63°51’51.36”N 23°10’58.24”E
Kallax, Sweden	Green	127.643 kHz	65°31’45.86”N 22°04’08.01”E
Järnäs, Sweden	Purple	70.913 kHz	63°28’46.29”N 19°39’13.41”E

The entire ***South Bothnian 8C*** chain was located in Sweden. It came into commercial service in June 1962.

LOCATION	DESIGNATION	FREQ	COORDINATES
Njurunda, Sweden	Master	85.550 kHz	62°16’47.55”N 17°25’31.13”E
Skutskär, Sweden	Red	114.067 kHz	60°37’17.71”N 17°26’34.20”E
Järnäs, Sweden	Green	128.325 kHz	63°28’46.29”N 19°39’13.41”E

BACKGROUND

In 1974, it the Swedish government requested an upgrade for both the North and South Bothnian chains which would give them Multipluse capability. In addition, a new chain configuration was requested by the Board of Shipping and Navigation of the Swedish Government. Decca carried out some special development to provide a dual Slave Station with Type 1880 equipment to permit both chains to be controlled from a single remote Control Station situated at the dual slave station.

The dual Station, comprised of the Purple Slave of the Northern Chain and the Green Slave of the Southern Chain, only used a single main antenna mast. This was the first time that a dual slave with double tuned antenna had been built with Type 1880 equipment. It was also the first example of two chains being controlled from a single Control Station separate from the Master station of each.

The dual slave configuration was a late development in the system but proved itself in terms of cost savings. The station still only had one mast and coil house, but it was fed by two individual sets of transmitters, one for each chain that it served. The station control room would thus be equipped with two full sets of racks and transmitters. In the coil house, a magic circuit of thyristors provided the tuning shift and circuit snubbing for this to take place. Doug Sim , spent a whole day in the coil house at Stirling trying to make the first one of these units work.

The Swedish Decca story is told in a book titled "Deccatiden i Sverige 1947-2000" by *Lars Malmquist*. Translated: 'The Deccatime in Sweden 1947-2000". Published by SMA, Norrköping, 3793-2000.

For a map of the North and South Bothnian chains, select this link.

SKAGERRAK 10B

A contract to build the Skagerrak chain was signed on June 2, 1967.

LOCATION	DESIGNATION	FREQ	COORDINATES
Fjällbacka, Sweden	Master	85.9000 kHz	58.517ºN, 11.300ºE
Jomfruland, Norway	Red	114.533 kHz	58.867ºN, 09.600ºE
Vallda, Sweden	Green	128.8500 kHz	57.483ºN, 11.950ºE
Årjäng, Sweden	Purple	71.5833 kHz	59.350ºN, 12.183ºE

UNITED ARAB EMIRATES

The ***Southern Persian Gulf Chain 1C*** was based in three countries. Locations were:

LOCATION	DESIGNATION	FREQ	COORDINATES
Qarnain Island, United Arab Emirates	Master	84.285 kHz	24º 56' 7"N, 52º50'59"E
Doha, Qatar	Red	112.380 kHz	25º15'40"N, 51º33'54"E
Lavan Island, Iran.	Green	126.428 kHz	26º47'25"N, 53º13'00"E
Ras Zubayyah, United Arab Emirates	Purple	70.238 kHz.	24°20'N, 54°10'E

BACKGROUND

Coverage was needed over virtually the whole of the Persian Gulf which meant that several States had to be involved. Usually these States were not agreeing with each other and often there were bitter rivalries and unhappy memories of past events. No one State could possibly be responsible for the whole of the Gulf.

Fortunately, Decca found a remarkably effective organization operating lighthouses and beacons in the area. It was the Persian Gulf Lighting Service at the time. It was operated by the major oil companies and so it was a "natural" starting point for Decca to introduce the system.

Decca initiated discussions with the PGLS and the major oil companies were deeply involved. Agreements were signed which led to a programme of construction and operation under the most difficult conditions but the end result was a reliable service. This continued until the military operations in the North required the relocation of some of the stations and ultimately their closure. The leading man in PGLS was Captain Webb and he was aided by representatives from Shell and BP and included the late Tom Gaskell, scientific adviser to the BP board.

It is believed that PGLS later changed their name to MENAS (Middle East Navigation Aids Service). The two chains in the Persian Gulf were operated by MENAS. In June 1973, that organization announced the upgrade of the Decca chains to the *Multipulse* standard. Since the two chains were originally installed in 1960-1961, the Multipulse system had been developed in order to provide extended lane identification ranges, particularly at night.

The existing Mk.V equipment at the seven transmitting stations was replaced with Mk.10 Multipulse equipment That also also permit users to take full advantage of the features provided in the new solid state Mk. 21 Decca receiver which started to see service in the merchant marine.

Work on the conversion programme, which included moving the Master station of the Southern chain a distance
of 12 miles from Das Island to Ouarnain Island, commenced on 1st March 1973 and was completed by year's end. The station was moved as the part of the development of an Liquid Natural Gas terminal on Das Island.

To ensure that the Decca transmitting antenna did not pose a hazard to the nearby air terminal while on Das Island, the standard 300 foot high transmission tower was instead, broken down into a three, shorter masts. This provided equivalent functionality and is the only known Decca chain which used such an arrangement. The South Persian Gulf chain was probably one of the few that had stations re-located due to unforeseen urban sprawl

On the new island, the three Decca engineers were the only inhabitants. One day they were visited informally by Queen Elizabeth when the Royal yacht Britannia anchored offshore and the Royal family picnicked on the Decca island - a marvellous piece of true Decca folklore. To help break the boredom, each Decca engineer took turns at throwing a party for the other two.

The purple station was originally established on the beautiful beachfront corniche in Abu Dhabi but was moved in 1974 to Ras Zubayyah in order to facilitate hotel development. Ras Zubayyah was no more than a piece of sand adjacent to the coast. Ras means inlet in Arabic. There was not a living soul for 50 miles around when the station was first built. The station did however, sport a nice swimming pool back in 1978, so a few *expats* would come over have beer occassionally.

Chain 4F, for the Straits of Hormuz, was proposed but never built due the political troubles in Iran after the fall of the Shah in 1979. One Decca manual indicated that the chain was under construction in 1987 but there is no proof of this.

A map of the Southern Persian Gulf chain and some photos can be seen here.

UNITED STATES

AMB Experimental Chain 5C (Multipulse)

LOCATION	DESIGNATION	FREQ
Yorktown Heights, NY	Master	85.0050 kHz
Yaphank, Long Island, NY	Red	113.3400 kHz
Newton, NJ	Green	127.5075 kHz
Red Hook, NY	Purple	70.8375 kHz

BACKGROUND

On January 24, 1958, it was announced simultaneously in Washington and London that the Air Modernization Board (AMB) had signed a contract with the Decca Navigator Company's U.S. licencees , Bendix Pacific to provision an evaluation Decca chain in the NYC area. The main purpose of the chain is evaluation with respect to helicopter operations. New York Airways, who operate scheduled helicopter service from the Idlewild International Airport (now called JFK) to the Pan Am Building in the center of Manhattan.All aircraft will carry a Decca Flight Log

The AMD was formed under the chairmanship of General E.R. Quesada as one result of the Curtis Committee's Recommendations to President Eisenhower. Quesada stressed that "the Decca System has been choosen because it is the only one in a state or operational readiness". He also said that "the pictorial presentation which Decca provides will enable pilots to navigate with pin-point accuracy".

In another development, the United States Coast Guard experimented with the Decca chain in the New York City area. If provided coverage to the entrance and approaches to New York harbour and worked reliably out to 200 miles according to one user. An interesting comment is that during the New York operation there was a major electrical power failure and the City lost virtually all of its power and many of the emergency services were not available. However, the Decca stations with their advanced emergency power supply systems developed by Dougie Boycott continued without interruption.

There was also a chain set up in Georgia for the US Army at Huachuca. Ernie Easter of Decca was instrumental in setting up this chain. It is speculated that this chain was used to test the proposed application of Decca in Vietnam and may also have been used as a training system for aircrew since we know Decca was used in Vietnam.

California Chain (ID ?)

A contract to build an experimental 820 chain near Los Angeles was signed in 1968. Evaluation commenced on June 8, 1970 as noted in Decca Navigator Magazine, August 1970. One of the big headaches for Decca was real estate and getting the masts to fit the sites. Dan Arney, KN6DI, a former commercial pilot says that "Los Angeles airport (LAX) area had Decca coverage for LA Airways. I was also out on a fishing boat out of the Channel Islands near Ventura and it was fitted with Decca."

LOCATION	DESIGNATION	FREQ
?	Master	?
San Clemente Island	Red	?
?	Green	?
?	Purple	?

A map of the NYC and California chains can been seen here.

VIETNAM

CENTRAL CHAIN (CHAIN ID?)

LOCATION	DESIGNATION	FREQ	COORDINATES
Phu Cat	Master Central	?	14° 1' N 109° 2' E
Plei Ku	Red Central	?	14° 0' 11" N 108° 1' 17" E
Cu Lao Re (Island)	Green Central	?	15.38 °N 109.12° E
Tuy Hoa	Purple Central	?	13° 4' N 109° 17'E

SOUTH CHAIN (CHAIN ID?)

LOCATION	DESIGNATION	FREQ	COORDINATES
Van Kiep, near Ba Ria (1)	Master South	?	10° 30' N 107° 10'E
Tây Ninh	Red South	?	11° 18' N 106° 5' E
Phan Thiet	Green South	?	10° 55' N 108° 5' E
Con Son (2)	Purple South	?	8° 40' N 106° 37' E

Notes:

1) This was a small ARVN camp. It was about a mile east of Ba Ria, the provincial capital of Phuc Tuy province.
2) This island was formerly known as Paulo Condore and is situated in the South China Sea, south of Phu Vinh.

The Vietnam chains can be viewed here.

BACKGROUND

Decca Navigator Systems, Inc. was under contract with the United States government to train U.S. helicopter pilots on Decca Navigator using civilians. Decca's employees would travel from base to base, often as "non-manifested" passengers, with the latest technology to assist and train U.S. pilots. While these employees were not members of the military, they were an integral part of the war effort. Decca Vietnam was based in Saigon at the entrance to the heliport at Tan Son Nut air base. The monitor site and control center for both the Central and South Chains was in Qui Nhon, Platoon North HQ.

Ken Penman was a Decca instructor. He recalls " I was in Vietnam from May 1965 until March 1966 and again in 1968 then left around March 1969. When I returned from 'Nam in 1966, I was privileged to become an instructor in the Decca Course, which was being taught by a British chap that was very new to the system. It was a case of "training the trainers". We were to be the first group of military instructors who would teach the system to those who would man the sites in Vietnam. The students mostly came from Ft Monmouth, New Jersey after completing 9 weeks of Fixed Station Transmitter Repair training. Following that was

another nine weeks of Decca training at Fort Gordon, Georgia".

Christopher Rose was employed by Decca in Vietnam. It was a very long time ago, but he remembers some of the details. "Originally the Decca chain installed in the early 1960's (maybe 62/63?) was intended for use by the US Air Force and consisted of Mk V equipment. Later, U.S Army helicopter pilots became the principal users of Decca. There were 3 or 4 civilians posted for the whole chain along with one army major and a sergeant for liaison. For transport, the major and sergeant had one helicopter. Our Saigon office had a VW minibus. The stations had no transport.

In 1967, it was decided to create a central Decca chain. I believe the equipment in both the central and southern chains was now Mk 12. With the buildup of Decca, so did the means of transportation. The military now had two choppers, a light plane plus a whole HQ staff. The stations received a jeep and 3/4 ton truck each. Since Decca was playing more of an advisory role now, the ratio of personnel changed. Now there were 8 military personnel plus 2 civilians for both chains. The Tet offensive of 1968 arrived at the same time that Decca was at peak strength. Someone decided that Decca was not cost effective so the chains ceased functioning at the end of 1968. Originally, Decca had a small, happy, easygoing, cost effective operation which was spoiled as it grew. Some of us held on until mid-1969 servicing the generators that had been given to other units of the army"

The Decca chains in Vietnam were shut down in December 1968 and the stations were dismantled and shipped back to the USA. Red Central was the first station to go. Its racks and coils were transported by Chinook helicopter to Qui Nhon where the equipment was packed up in crates for shipment. All the crates were destined for the Sacramento Signal Depot.

Dennis Buley, the web master for Special Electronic Mission Aircraft web page provides some information about Decca Navigator in Vietnam. " Its use in a one-of-a-kind Caribou aircraft was for two purposes - one of
which was for navigational purposes but that was the secondary purpose. The real reason was that this aircraft was equipped with one of the early Airborne Radio Direction Finding (ARDF) systems whose mission was to generate lines of bearings (LOB) to enemy radio transmitters so that their locations could be pin pointed and destroyed. In order to do that, the location of the aircraft had to be known, hence the reason why Decca
was fitted on this Caribou. I suspect that Decca was not accurate enough because follow-on reconnaissance aircraft like the the U-8 ARDF and early OV-1 Mohawks used the ASN-64 Doppler system made by Canadian Marconi. These were not very good either. The later U-21 ARDF and OV-1D aircraft used the ASN-86 INS made by Litton Industries. TACAN was used to compensate for INS drift".

Chuck Jackson, used the the Decca Navigator system in the UH-1D in 3 Corps VN with the 334th Armed Helicopter Company in early 1967. "As far as I know, it was only used for aerial navigation. It did not prove very successful. Decca was a rather large piece of equipment that blocked the pilots view out the windshield".

Howard Weeks who ran an avionics repair facility in Pleiku AFB Vietnam in 1967 said that "one of the slaves was located there. Many US Army helicopters were equipped with the Decca Navigator but very few used it for some reason that I totally never understood."

Keith Penman, a retired Army Sgt was the Station Chief at Red Central in Vietnam when the system was closed down in December 1968. Red Central was near the Pleiku US Air Force Base and on the road going to
the Montagnard Training Center.

WESTERN EUROPE

In the 1950's, the system steadily expanded in Europe with stations being built in France, Germany, Holland, Spain, Sweden, Finland and Norway together with added coverage in UK for Scotland and Ireland. This European expansion was helped tremendously by Bill O'Brien's Decca team making many brilliant improvements (such as crystalized receivers, Mk V and Multipulse formats) and the popularity of the receiver lease/maintenance arrangements. Decca was getting better and cost only £1.00 a day !

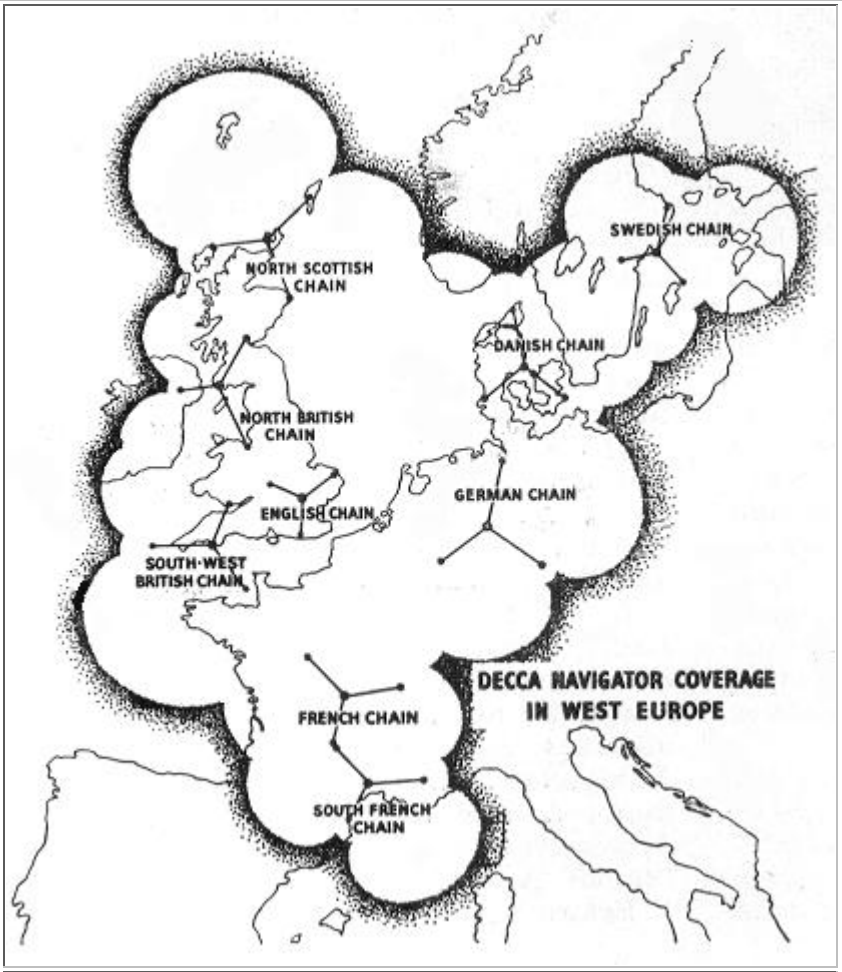

Figure 1 - EXPANSION**:** By 1957, Decca had expanded its European coverage as depicted in the above diagram. The Swedish Chain became the North and South Bothnian Chains. The French chains shrunk considerably after this map was published. *(Courtesy of Meccano Magazine, March 1957)*

Also visit David Sparvell's G4FTC Decca page

Additional References and Credits:

1) Bob Peters who worked worked 16 years on the Green Slave of 9B until the conversion in 1985 and for 10 years on both Dutch chains as a maintenance man.
2) Decca Navigator News: April 1972, April 1974, Sept 1976.
3) Decca Mk 19 Operating Instructions Manual, April 1971. Decca New Malden , Surrey, England
4) Information on the Spanish chains was provided by Santiago Insua Fernandez, email: [hwasp (at) mundo-r.com]whose father was a Decca maintainer and David Jones [e-mail:djones(at)litramfg.com] who performed the system commissioning and antenna tuning at the master station of the southern chain .
5) Information on the Indian chains was obtained from Government of India, Ministry of Shipping:

www.geocities.com/dllmumbai/dnc.htm
6) Hebridean and Bangladesh information provided by Doug Sim, e-mail: Doug.Sim (at) btinternet.com
7) Ireland info courtesy of Commissioners of Irish Lights web page www.cil.ie
8) Orkney closure article courtesy of The Orcadian Times. http://www.orcadian.co.uk/features/articles /decca.htm
Excerpts from story: Signalling the End for Decca by Brian Flett
9) German chain 3F and Zeven info via web page: http://longwave.bei.t-online.de
10) Decca chain ID information obtained from Appendix AP-4 in PDF document http://www.oytnw.org.uk /gps.pdf .
11) Information for the Nigerian chain was obtained from the Sept 1976 edition of Decca Navigator News and the web page of
G4FTC http://www.g4ftc.co.uk/decca/other_decca_stations/home.htm
12) Dan Dawson, a maintainer at the Alma, Nova Scotia station from the late 1970's until its closure in March 1982 provided the information about the Nova Scotia chain.
13) Data about the Japanese Decca Chains was provided by Tsutomu Arai, Director, Sena Co Ltd., Tokyo Japan. Sena became a distributor of Decca Navigator receivers in February 1966. http://http://www.sena-jp.com /E5.html
14) The WUN Newsletter 1/1996 provided much general information about the chains which were still in operation in 1996. See
http://www.wunclub.com . Editor: Ary Boender . e-mail: ary(at)luna.nl
15) 89/113/EEC: Commission Decision of 21 December 1988 relating to a proceeding under Articles 85 and 86 of the EEC Treaty
16) Many frequencies and co-ordinates (in decimal degrees) referenced from NELS Interference Sources. Web site.
http://www.nels.org/userinfo/interference.asp
17) Norway information from: http://www.northernstar.no/decca.html
18) Vietnam contributors:
Christopher Rose: e-mail kitrose574(at)hotmail.com
Dennis Buley. e-mail: dbuley(at)comcast.net
Chuck Jackson. email: cf.jackson(at)mindspring.com
Keith Penman e-mail: pen325(at)charter.net
19) Excerpts from Wilfred St. John White's speech given at Church House, UK on Mar 30, 2000 added to various countries.
20) Refined info on Gulf of Finland, North and South Baltic and North and South Bothnian chains provided by Väinö
Lehtoranta, OH2LX E-mail: vaiski(at)dlc.fi
21) Phil Jones recalled the station locations of the North Persian Gulf chain. E-mail: phil(at)philjonesbass.com
22) Extracts from *Decca's Genealogy* provided courtesy Walter Blanchard, Royal Navigation Institute.
23) Norwich (Red) info via Don Rayner. email: <donaldray(at)charter.net
24) Tony Tranfield contiibuted greatly on the French chain. e-mail: ATRANFIELD(at)aol.com
25) John Molloy-Vikers provided the initial information for the Australian chains and many other locations. E-mail: vickymv(at)stn.net
26) Australian station names provided by Roy Watkins, VK6XV E-mail: vk6xv(at)bigpond.net.au . Roy was OIC of the Decca Australia Navigator chains from 1972 through until 1984.
27) "After the system was shut down in the UK" information provided by Richard Caddy. e-mail: richard.caddy(at)ntlworld.com
28) Bill Gaston <wgaston(at)marcocable.com> and Christopher Rose <kitrose574(at)hotmail.com> provided the missing Bahamas sites. Also used web pages:
http://www.uprm.edu/publications/cjs/VOL29/P165-173.PDF
http://www.svprana.net/Logs/May2003/
29) Pierre Painset <pierre.painset(at)tiscali.fr> web http://pierre.painset.free.fr
30) "David G4FTC" <g4ftc(at)arrl.net>
31) NYC info: Diana Randle <dfrandle(at)earthlink.net>
32) John Beattie <johnbeattie1(at)ntlworld.com>
33) Booklet: Decca and the Rome Control Area.
34) Decca Navigator News August 1970.
35) France - Extract from Télonde Newsletter
36) Bob Peters <peters-vdput(at)quicknet.nl>

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Sept 19/11

DECCA's CORPORATE HIGHLIGHTS

This summary incorporates the most significant events in the history of the Decca Navigator Company.

CORPORATE EVENTS

1914 DECCA name used by Barnett Samuel for portable gramophone.

1928 Barnett Samuel becomes a public company and changes name to The Decca Gramophone Co.

1929 Edward Lewis forms Malden Holding Co to buy Duophone record factory at Shannon Corner for selling-on to Decca. Decca refuses Lewis's offer.

1929 (Feb 28th) Malden Holdings Co.decides to go into record manufacture itself and buys Decca Gramophone Co. to get access to name and marketing organisation.

1932 Decca buys UK Brunswick for whom Harvey Schwarz had been working. Harveystays on to design a new radio receiver for Decca.

1937 W.J. O'Brien in USA investigates methods of measuring the absolute velocity of aircraft. Chooses phase-comparison between pairs of CW stations. US Army and Navy turn it down as too complicated.

1939 September. O'Brien sends Schwarz details of his system to offer UK military.

1939 October Offer refused by Tizard and Watson-Watt in favour of the GEE system.

1941 February/July. Lewis sends HFS to test system in California; 300/600 kHz.

1942 July. Admiralty requests demonstration. W. J. O'Brien comes to UK.

1942 September 16th First marine demonstration at Anglesey. 305/610 kHz. Phase comparison at 1220 kHz.

1943 Frequencies changed to 70-130 kHz; original freqs "too sensitive".Operation at 200 miles demonstrated.

1944 January 21st Second marine demonstration in North Irish Sea.

1944 February 20th Full-scale 3-station trial use in practice landings, Scotland.

1944 March Decca requested to build 27 receivers and three sets transmitter control units.

1944 June 6th Decca used in 21 minesweepers and other vessels in D-day landings.

1944 October Chain moved to Scheldt Estuary. QM2 battery-operated receiver developed.

1945 May 22nd First airborne tests made by RAE Photographic Section Lancaster JA876 using QM1

receiver.

(1945 July. Ground demos to Commonwealth and Empire Conference on Civil Aviation. Demos to PICAO) -
does not correspond to Attwell info.

1945 August. Admiralty requests chain to cover Thames Estuary for minesweeping.

1945 August Chain returned to Southern UK and re-established on South Coast at Sennen, Branscombe and
Southbourne, 140 and 70 miles baselines.

1945 Aug 27 RAE Lancaster JA 876 flies via Anglesey; obtains 400 ft accuracy based on photography.

1945 Sept 12 JA 876 flies to Gibraltar (t.o. 0945, landed 1805) QM still working at Gib but red dial "erratic"

1945 September Decca taken off secret list. Decca buys outright all rights to system for £50,000. World
patents obtained.

1945 November 7th The Decca Navigator Co. Ltd., formed as a subsidiary of The Decca Record Co. Ltd.

1946 July First permanent chain of 3 transmitting stations covering the Thames estuary on air. (No Lane
Identification).

1946 Decca Navigator first flew in an RAF Lancaster. It carried out flight trials ranging down to Gibraltar and
the Azores.

1947 January Ministry of Transport approves Decca for navigational purposes conditional on development of
Lane Identification.

1947 May. International approval to the system given by IMMRAN.

1947 July Demonstration of Mk. 5 Lane Identification system.

1947 Mk VI - first true airborne receiver with Lane Identification and suppressed "plate" aerial. MCA flight
trials commenced.

1948 RAF fits PR aircraft at Benson for OS mapping UK.

1949 Notam advising Mk VI as an authorised aid to navigation. Weighs 100 lbs; First rotating-drum Flight Log.

1949 Prototype Ambassador fitted with Mk 6 and flight log.

1949 Demonstration of Flight Log at Ashbury Pk, NY.

1951 Decca purchases Avro Anson Mk 19 G-AGPB

1951 MCA demonstrates Decca and Flight Log in Marathon and Anson aircraft

1951 Avro Ashton fitted with Decca

1951 Brabazon test aircraft fitted.

1951 Stated to be “over 50" aircraft now using Decca

1952 March BEA fits Viscount 700 fleet with Mk VII receiver and Flight Log
.
1954 March Patent obtained on Mk 10 system of Lane Identification.

1955 Decca adopted for “Operation Grapple” - nuclear bomb tests at Christmas Is. 8 Valiants and
10 Shackletons fitted with Mk 8 rxs and flight logs.

1957 RAF adopts Decca for 2TAF Canberras - Operation “Fledgling”, 990 Rx.

1958 - Decca demonstration aircraft Anson Mk 19 G-AGWE moves from Croydon to Biggin Hill.
- February 10: Decca registers Valetta aircraft G-APKR in February.

1958 - March 10: Decca HQ moves from Brixton Rd to Albert Embankment.

1960 Anson sold; Percival Prince Mk 1 (G-ALWH) purchased

1960 Cambrian, Silver City, BKS Airways equipped with Decca. Silver City Bristol Freighters fitted with Mk 9
receiver and Flight Logs.

1962 BEA adopts Decca for helicopter services - Paris and Scilly Islands.

1963 March Demonstrations of Omnitrac 2/Flight Log/Data Link

1963 June Roller Maps 9275/9475 introduced

1964 US DoD installs Mk 8A Decca Navigator in Vietnam (2200 equipments)

1964 BKS using Mk 10 in Ambassador.

1963 Oct. Valetta retired

1963 RAF fits Doppler 62 to DH125, Avro 748, VC-10

1964 March. Decca buys Ambassador aircraft from King of Morocco G-ALZP.Originally with BEA 1951

1964 Sep 23. Ambassador aircraft leaves for US tour.

1964 Mid-Dec. Returns to UK

1964 BUA fit Decca in VC-10's. Cost £30K per aircraft.

1965 Decca fitted to North Sea oil exploration helicopters.

1965 NY Airways obtains approval for use of Decca in helicopters. Two Mk 8/Flight Logs per aircraft

1965 Decca acquires Bell 47G

1966 Mobile Decca chain used for crop spraying in Louisiana. Dectra Mk 2

1966 Danish Air Force fits Mk 8/Flight Logs to helicopters.

1966 RAF fits Andovers with Navigator/Flight Log/Doppler 62/Roller Map

1967 Flying Tigers fits DC8-63F fleet with Omnitrac (VOR/Doppler inputs)

1967 Seaboard World Airlines fits fleet with Decca/Dectra.
BOAC fits VC-10 with Omnitrac/Loran-C
Eastern Airlines fits DC-9 with Omnitrac VOR/DME

1967 May 17/18 NATCS demonstrations at Heathrow of Omnitrac with Decca and, VOR/DME coupling.

1967 66 RAF Hercules to be fitted with Decca Navigator/Loran-C/Doppler.Sept 26 36 Sqdn demonstration.

1967 French Air Force evaluate Doppler type 72 for Jaguar.A & AEE ditto.

1968 May - BEA fits Trident fleet with Omnitrac, Mk 16 Decca.
Nov - BEA 1-11 fleet fitted with Omnitrac/Mk 16

1968 Aug. Eastern commences STOL evaluation of Omnitrac with Mk 16 and vertical guidance.

1969 Decca/Arma agreement to develop Omnitrac 5 system for L-1011

1970 Nov 2nd. Harvey Schwarz retires.

1984 April 11th. W. J. O'Brien dies at age 76.

1988 April 23rd. Harvey Schwarz dies at age 82.

1972 USAF fits T43 (737) with Decca Loran-C ADL-21 (6 sets per aircraft) (AN-ARN-109)

1972 FAA evaluates Decca/Ambac MONA system aboard Tristar

1972 Decca TANS plus Doppler 71 for RN/Army helicopters.

1974 Sept Decca Omega rx at Farnbro show

1974 Oct Saudi, C Pacific and Gulf airlines select MONA for 1011

1974 Decca buys Jetstream G-AWVK

1974 Oct RAF Vulcans fitted with Doppler 72 win USAF bombing competition.

1975 "Over 100" MONA systems sold.

1975 Doppler 71/TANS system installed on Puma helicopter.

1975 ADL-81/TANS evaluated on Jetstream

1975 Omega receiver flown on Jetstream aircraft.

1976 April 29. Decca Doppler 80 evaluated at Boscombe Down for Gazelle.

1976 MONA aboard BA, Cathay Pacific, Saudi, Delta, All-Nippon L-1011's

DECCA NAVIGATOR CHAINS (List not complete)

1946 English

1948 Danish

1951 N. British

1952 German; SW British

1953 French

1956 N Scottish

1957 Canada - 4 chains; Swedish

1958 Jan 24 Contract for erection of NY chain signed by AMB USA

1959 Calcutta chain; Bombay Chain

1960 N Persian Gulf

1961 S Persian Gulf

1962 N and S Bothnian; Bombay

1963 New York chain.

1964 Calcutta; NW Spanish

1967 June Icelandic Dectra station added.
May 27. First Norwegian chain - Finnmark; June 2 Skagerrak chain
First Japanese chain - Hokkaido

1968 May 14 Formal opening of six Norwegian Decca chains.
Aug Contract signed for Californian Decca chain.
Norway - 6 chains; Frisian Is; Demonstration chain Great Lakes.

1969 Kyushu

1970 Baltic; S Africa - 2 chains; Pt Hedland

1971 S Africa - 3 chains; Gulf of Finland

1972 Holland; Dampier; S African Cape chain

1973 31 May Irish Chain opens

1974 Hebridean Chain; Northumbrian Chain

1975 Northumbrian; Dumai; Bangladesh; Hebridean

1976 Tohoku; Salaya; S Spain; Nigeria - 4 chains

PRODUCTS

1958 Decca Data Link development initiated.

1959 Loran-C AN-SPN31 designed for the US Navy. Built in USA by Continental(?)

1962 Nov 27 Introduction of Mk 12 marine rx.

1963 Marine fittings = 8000 Air fittings = 600

1964 Doppler type 62

1966 Doppler Type 70 initiated

1966 Loran-C type ADL-21 demonstrated in Ambassador aircraft.
200 units purchased for RAF.

1967 Loran-C Type DL-21 built for RN.

1967 New range solid-state receivers.
Mk 14 air rx - simple set; no LI
Mk 15 air rx - ZI, auto LI uses cptr 1910
Mk 16 air rx - uses Omnitrac
Mk 17 air rx - uses Omnitrac and has Dectra
Mk 18 marine rx -
Mk 19 air rx - dual purpose. Can emulate either Mk 8A or Mk 15. Use cptr 9360

1968 First Decca Doppler Type 70; originally for TSR-2

1969 Danac computer introduced.

1969 MANGS (Decca/Omnitrac Modular Area Navigation Guidance and Attitude System)

1969 Omnitrac/Doppler 72/SGP 500 inertial hybrid introduced

1970 Navigator Mk 25 - Map-only display for light aircraft.

1970 Loran-C ADL-23 introduced.

1971 TANS computer

1972 Decca Doppler Type 72 for MRCA (forerunner of Tornado)

1972 Decca NDB marketed.

1974 Decca DL-91 Loran-C

1975 Doppler 80 for helicopters.

1977 USCG names DL-91 as current procurement standard for non-military Loran-C receivers.

1978 First Decca Satellite Navigator - DS2

1980 Second Decca Satnav - DS3

1980 Decca Loran-C 1024

1980 Decca sells 31 ILS to RAF (Wilcox under licence)

1964 Decca Data Link demonstrated at SBAC Show

1972 Marine Plotter 350T marketed (transistorised 350)

1976 Decca Doppler VHF Omnirange (DVOR)

MARINE

1946 First Decca yacht "Abedonia" purchased for demonstration work.

1946 Oct DFDS Kronprins Frederick fitted with Decca

1947 Feb 26 First Mk 4 rx fitted to mv "Rogate" (Stephenson Clarke Shipping)

1947 "Abedonia" replaced with Harbour Defence Motor Launch "Navigator"

1947 First Survey chain installed in Greenland.

1949 Survey work for offshore oil started.

1957 Fittings 4100. Practically linear increase since late 1945.

1965 July Hifix coupled to Omnitrac

1968 MY Navigator returns from 6-month tour of USA

1964 July Decca HiFix used for Channel Tunnel survey.

1965 Oct . M.Y.. Navigator replaced by new Navigator (Camper and Nicholson)

1969 Ships fitted said to be "over 14,000"

1969 Nov Mk 21 introduced.

1974 Fittings now 20,000

COMPANY ACQUISITIONS

1965 88 Bushey Rd acquired.

1976 Decca Software Sciences Ltd (Decca 80%, SSL 20%)

1953 Decca Navigator Co (Canada)

1969 March Decca companies in USA bought by ITT. Become ITT Navigator Systems Inc and ITT Decca Marine.

1975 Flight Navigation Ltd. (Decca/Smiths Ind.)

Acknowledgment: This list was provided by Walter Blanchard.

Back to Decca Intro Page

DECCA NAVIGATOR - HISTORY

INTRODUCTION

David S. Jones, a former Decca employee, provides this very fitting introduction to the Decca Navigator system

"I have been struck by one fact that is perhaps unique to Decca amongst the hyperbolic systems featured in this web page. The fact is that Decca was proposed, developed, designed, promulgated, manufactured, sold-by, operated, maintained and supported by one company during its entire fifty year life.

All of the other systems were developed as part of a quasi-government research program and subsequently farmed out to various contractors for manufacture; leaving their deployment and support in the hands of some government department. Typically an armed forces agency or the like was tasked with system operation and staffing. Since these agencies just looked upon their task as budgetary administration, no continuous bond developed between the product and it's keepers. Routine changes in personnel and re-assignment of government agency responsibilities would only serve to break any continuity bond. All of these agency staff would only consider their time spent with these systems as part of a routine assignment, however dedicated the individual. Hardware manufacturers would likewise have a similar transitory relationship with the system.

Not so with Decca, which maintained a closely bonded group of developers and engineers for many years, all of who played a part in the history of the system. Even Bill O'Brien, the systems founder stayed active in the company for almost forty years after he first joined. This common pool of knowledge, stories and pioneering spirit is something which I believe sets Decca apart when compared with others."

ORIGINS

The difficulty of navigating a minesweeper across the English Channel and making a precise landfall at night was considered impossible without some form of precise radio navigation. Established on the south coast of England, Decca began transmitting on the day before the D-Day invasion force landed. Had this radio navigation aid not been available, it is now believed that D-Day would have followed a completely different plan. How did this all came about?

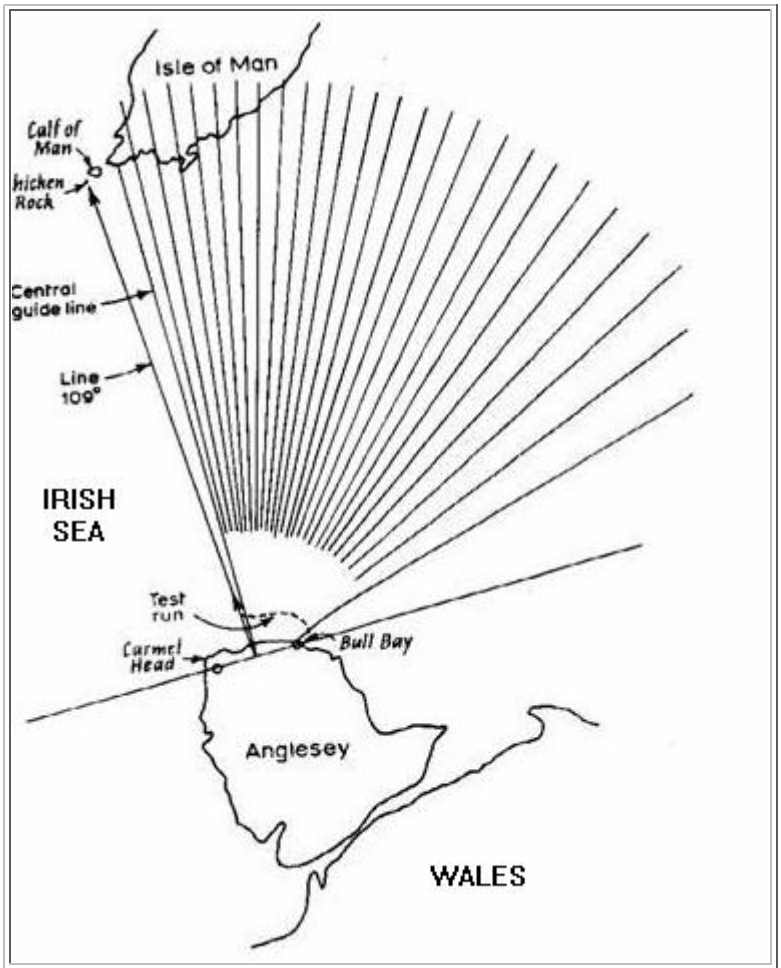
The Decca Navigator system found its origins in the United States but was later developed into an operational system by Decca Radio and Television Ltd. of London. Originally it was conceived by an American, W (Bill). J. O'Brien as a method of measuring the ground speed of aircraft undergoing trials and was simply named 'Aircraft Position Indicator'. Without knowledge of the patents of Harms or Honore and without even being aware of developments in the US by Shanklin, Donnelly, and Holmes, O'Brien worked on the system independently from 1936 to 1939. He was unsuccessful in raising any interest in the US Armed Forces or the civil authorities so the system lapsed until the outbreak of war in 1939. Thereupon he offered the idea to the British Air Ministry through his friend H. F. Schwarz, an American working in London for the Decca Record Company. Neither was aware of the work which was proceeding on pulsed navigation systems in Britain so the idea was rejected by Watson-Watt as being prone to jamming and subject to interference.

O'Brien and Schwarz, with support from Decca, then tested a prototype system in California using a master transmitter at 300 kHz and a slave at 600 kHz. Comparison was made at 1200 kHz and the accuracy of the system was demonstrated in a car. It proved the basic viability of

the system and was a major departure from earlier proposals by using harmonically related radio frequencies for transmission. This solved the problems of identification and phase comparison at the lowest common multiple of the carrier waves without needing any sort of modulation. It was a neat solution and had the additional advantages of occupying a very narrow bandwidth and only using low power for the transmissions. It did not however, eliminate the problem of "ambiguity".

The British Admiralty, which started planning the eventual landings in France, had a requirement for an accurate navigational system so it started taking an interest in Decca in 1941. There was also a need for a stand-by navigational system to guard against any possibility of the existing "Gee" system being jammed hence further impetus was given to the development of Decca. Trials were organized off Anglesey in mid-1942 using the same frequencies and equipment that were used in California. This trial was highly successful and resulted in further research with assistance from the Admiralty Signals Establishment (ASE).

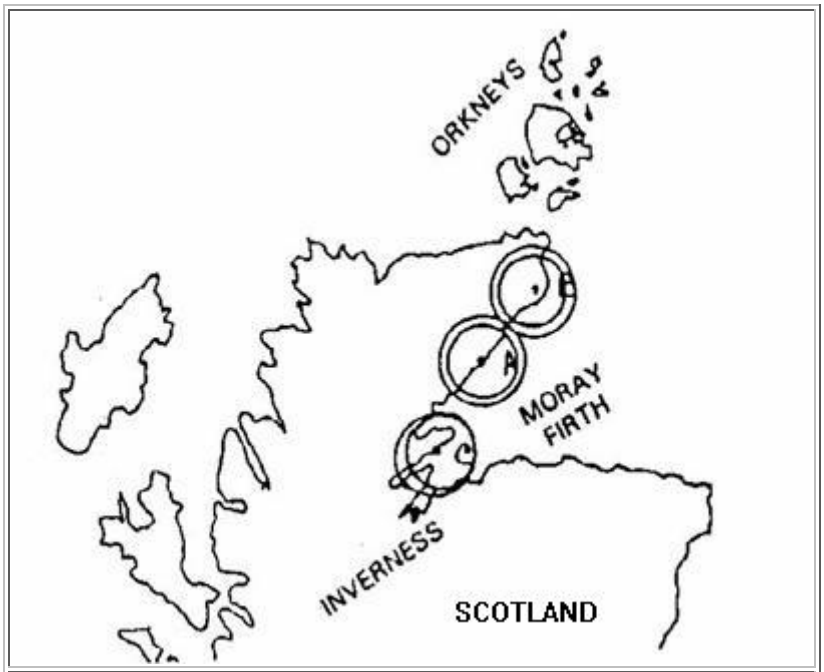
Early in March 1943, Decca was given the order to produce 27 receivers plus the driver and phase control units needed for the transmitters. All equipment was delivered by mid-May when the Royal Navy began its training and preparations in earnest. In January 1944, a test of Decca (or QM as it was then known) on new frequencies was carried out in the Irish Sea and it was also compared with the Royal Air Force Gee system for accuracy.



This is a position-line pattern for a guidance demonstration run to Chicken Rock on September 16, 1942. The inter-station base line was about 12.5 km *(Decca Radio And Television Ltd, drawing 1942 from the collection of Walter Blanchard)*

It is important to note that the Gee system was in widespread use at the time. The naval version of Gee (Outfit QH) was first used by the Royal Navy in the Dieppe raid in August

1942 and was subsequently established as a standard system for surface navigation. For Operation Neptune (D-Day), the initial legs of swept channels were planned to coincide with the same lines as the Gee lattice maps. So important was accuracy that some 860 invasion ships were outfitted with Gee Outfit QH.



Station sites for the third Admiralty trial of the QM system. The base lines were approximately 45 nautical miles which comprised a true prototype for D-day. *(From the collection of Walter Blanchard)*

Although Gee and Decca were similar in broad principles only, Decca was more accurate than Gee and in modern parlance, more 'user-friendly' because the results were presented directly on clock dials called "decometers" instead of a cathode ray tube as was done in Gee. One disadvantage of the early Decca sets was the need for the decometers to be initially set up using an accurately known position. If there was a break in reception for any reason, the decometers had to be recalibrated.

For Operation Neptune, four Decca transmitting stations were set up in great secrecy. Intense security surrounded the construction of the transmitters as knowledge of their location could betray the intended landing beaches. It was subsequently revealed that the master station, known as 'A', was built near Chichester. The western 'B' (Red) station near Swanage in Dorset and 'C' (the Green slave) about a mile inland from Beachy Head. On the Isle of Sheppey, a transmitter was built to look like a 'decoy' in case the Germans discovered any part of the plan. After the war, it became usual to establish a fourth (Purple) transmitter for additional accuracy, but it was not considered necessary for D-Day.

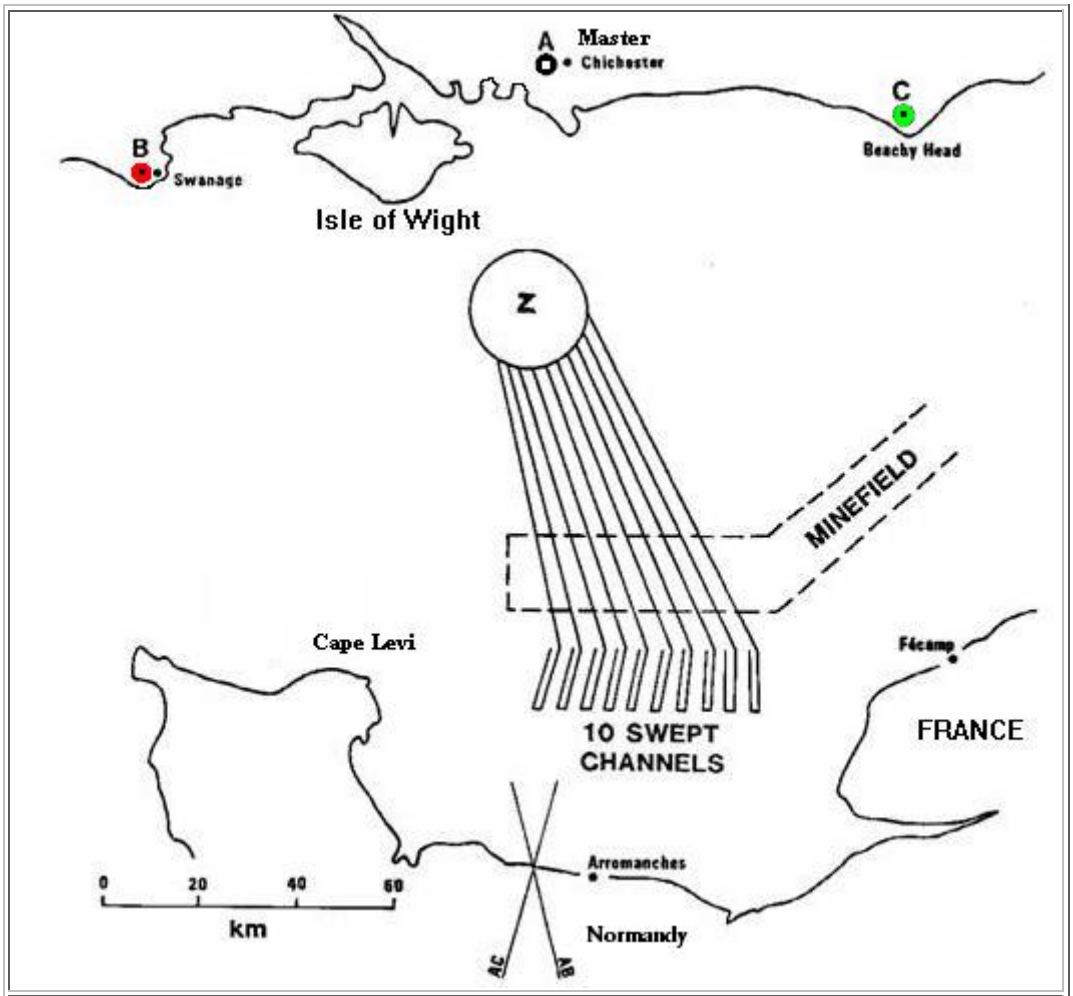
Signals from the Red and Green transmitters formed hyperbolic patterns. These were plotted on maps and were known as lines of lattice. The ladies responsible for calculating the Decca lattice lines worked in pairs in a hut at the ASE. So secret was their work that an armed guard was provided. Nineteen pre-production Decca receivers were made by the company on very short notice and these were fitted in the leaders of twelve minesweeping flotillas, five headquarters landing craft (LCH), and two navigational motor launches.

Transmissions from the chain commenced early on June 5. Bill O'Brien, Decca's developer, kept a prototype
receiver turned on in his London home. When the decometer dials came to life, he knew that the invasion was under way. There were also monitoring receivers set up on shore.

Perhaps because it was so secret, or perhaps because so few Decca sets were fitted compared with Gee, the use of Decca Navigator in Operation Neptune was not mentioned in any of the published accounts. Although the system worked extremely well and provided more accuracy than Gee, it was less reliable due to a problem known as "lane slipping". Also, ships fitted with Gee receivers could only navigate accurately as far as the mid-channel mustering point.

During one of the Admiralty wartime trials, the test nearly ended in disaster. For ease of use, the ship performing the evaluation navigated on a single hyperbolic line which passed through a reef. Intent on only watching the decometers, they steered exactly on the line and nearly ran aground not thinking that Decca was so amazingly accurate!

Thanks largely to Gee and Decca, the 18th Minesweeping Flotilla, for example, was only about four minutes late and 400 yards out of position on reaching the destination point off it's target beach despite strong winds and tides during the passage. This was considered a reasonable margin of error! One of the navigating officers said afterwards " It was uncanny. It seemed as if we had some sort of overhead cable which not only showed us the direction but also our speed."



This is a sketch map showing the QM chain which supported Operation Neptune, otherwise known as D-Day. The orientation of the position lines AB and AC on the French coast indicates the care taken to position the stations so that across-track accuracy was maximized on the channels to be swept. The circular rendezvous area 'Z' became known as Piccadily Circus.The dog-leg appearance of the swept channels came as a result because the initial part was aligned with the GEE lattice system (AB) while the latter part was aligned with the Decca lattice (AC) *(Drawing by Cdr H. St. A Malleson RN, Ret'd. From the collection of Walter Blanchard)*

To the chagrin of the minesweepers, who could have made good use of it, the Decca chain was switched off on D-Day plus one, presumably because the system was so secret at the time. Some thought it was shut down due to transmitter troubles. Decca was never jammed and, as far as it can be ascertained, its existence during the war was never suspected by the Germans. It is now believed that the invasion would have followed a completely different plan with a potentially different outcome if it wasn't for Decca Navigator.

POST WAR

In 1945, the Decca Navigator Co, Ltd was formed and the first commercial chain of stations established in south-east England in 1946. The problems of ambiguity were never far away and a system of lane identification was introduced in 1947 which was still only a partial solution and did not completely resolve matters. It was not until the mid-1950's and the introduction of the ' Multipulse ' technique that reliable lane identification out to the same range as the basic pattern almost completely removed ambiguities.


AGREEMENT

This was first commercial hiring agreement for a Decca MkIV Navigator dated 15 January 1947. The receiver was fitted aboard the Steam Ship *Carrickmines* , ex City of Antwerp. Click to enlarge. *(Photo by David Duncan)*

In the 1960's, a very considerable effort was mounted by Decca to get it adopted by ICAO as the standard airborne navaid in preference to VOR/DME. It was a very serious initiative which even included setting up special chains in the USA at Decca's expense, but to no avail. Besides the considerable investment already made in VOR/DME, the technical problems of ambiguity and precipitation static interference, both worse for aircraft than for ships, counted against it, and there was also the fact that, with a reliable range of about 200 miles, a single Decca chain needing four transmitters covered little more area than a single VOR/DME installation. At that time, Decca was been installed on the British European Airways Viscount 701 fleet as well as on many smaller aircraft and helicopters and it was probably its zenith as an airborne navaid.

In 1975, Mr H. Schwarz, the Managing Director of Decca Navigator, admitted that Loran-C was probably a better aircraft navaid than Decca and that satellite navigation would be better than either.

Pulse-8 became Decca Survey's name for their short-range Loran-C system. It was designed for offshore survey and had a design range of only 300 miles although it got out much further than that. There were eight transmitters around the North Sea alone in the late 1970's and many others abroad.

Although Decca Navigator as an airborne system made little headway, many other devices produced by Decca were prophetic and well ahead of their time. The concept of area navigation (Harco), the airborne area-navigation computer (Onmitrac) and the flight-deck map display (Decca Flight Log) were all originated by Decca and have since become standard. Decca became very popular with pilots of helicopters and smaller business aircraft for getting into small airfields without other navaids. The system continued to expand and by 1989 had 42 fully operational chains around the world, including 42 master stations and 119 slave transmitters.

When the service first became commercially available, users would rent a receiver from the Decca Navigator company. In 1973, the factory near Raynes Park in South West London turned out one marine receiver every hour. By the early 1980s the widespread availability of

low cost microprocessors made inexpensive Decca receivers available for purchase. The loss of rental revenue caused Racal Electronics, which by then had acquired Decca Navigator, to inform the Government that it could no longer afford to operate the system without financial support. From then onwards, the Decca Navigator Service was funded by the British General Lighthouse Authority (GLA) and Racal continued to operate it on the Authority's behalf. In 1992 an agreement was signed between the GLA and Racal-Decca Marine Navigation Ltd that the 18 Decca stations that had not already been modernized would be updated to reduce operating costs. This multi-million pound investment was completed by Racal in June 1994 by which time the entire system had been fully automated. Large buildings filled with tube technology transmitter equipment built in the 1960's were replaced by automated solid state units housed in small transportable containers. A new Supercontrol centre was opened in Edinburgh from which the entire UK Decca system could be monitored. Staff numbers were reduced from 64 to 19 and running costs were reduced by 40 per cent.

Despite the system operating within its reduced budget and successfully maintaining Decca Navigator's 99.95 per cent performance reliability, the writing was on the wall for the service. The advent of GPS navigation satellites slowly made the service superfluous. During 1999, the GLA announced the final shutdown of the service at midnight March 31, 2000 following over 50 years of successful operation. The occasion was marked earlier that week by a farewell conference at Church House in London where users and pioneers of the system met to review the development of the technology and their experience of its benefits.

During its lifetime, the name Decca became a piece of nautical terminology that epitomized security and dependability. At its peak there were chains in all of the principal shipping areas of the world and an estimated 200,000 Decca users in Europe alone. By measuring the differences in signals received from transmitters along many of the world's coastlines, mariners and aviators were able to establish their positions with a degree of accuracy and consistency previously considered impossible. Even Concorde 002 was kept on track during its flight trials using Decca Navigator.

Speaking at the farewell conference, Stephen Clark, director for Racal-Tracs, said: "It is always sad when something good, that so many people had worked so hard to create, comes to an end. Decca Navigator was a huge success in its day but life moves on. Satellite positioning is with us now and happily Racal has not lost its lead. The company has built on its long experience to create the next generation of positioning technology." Continuing, Stephen Clark said: "Racal was the first company to offer a commercial Differential GPS (DGPS) service and the rest of the world followed us.

Despite the free availability of GPS positioning, the withdrawal of the Decca service is still regretted by some sectors of the maritime industry. Most notably, fishermen valued Decca’s ability to guide them back to fishing spots at sea with a degree of precision that is only available now through the more advanced Differential GPS services. Other sectors of the maritime community regret the loss of a positioning service that is totally independent of satellites. The demise of Decca Navigator did not greatly affect the aeronautical community because aircraft installations were less common than those of VOR/DME, the internationally accepted system for position finding.

Racal and Thomson-CSF also become Thales in 2000, thus loosing all ties to the recent association with the Decca Navigator system.

SPREADING THE DECCA NAVIGATOR WORLDWIDE
by Wilfred St. John White

The following tribute to the Decca Navigator system was delivered by retired Decca employee Wilfred St.John White at Church House, UK on Mar 30, 2000, the eve of the final

Decca system closure. Users and pioneers of the system met here to review the development of the technology and their experiences of its benefits. Many thanks to Väinö Lehtoranta, OH2LX, who provided a copy of the transcript. Wilfred St John White sadly died 12 January 2006.

Church House, March 30, 2000 - Everyone here is aware of the growth of the Decca Navigator System from the single chain operation in 1946 and its remarkable spread throughout the world. By the 1980's the coverage had extended so that there were chains in all Continents apart from South America and nearly all the world's major shipping routes were covered.

At its peak, there were over fifty chains in operation all of them working under international agreements which ensured reliable transmissions for all licenced users. To list the chains and give their dates of operation would be tedious. Suffice to say that for many years the average rate of coverage increase was one chain every eight months. This was quite an achievement when one remembers that the problems posed by every chain (or group of chains) were very different. I do not want this paper to be a lesson in history or geography. Instead, I wish it to be a review of our various successes and recall some of the problems encountered in spreading the system. Also, I want to pay tribute to some of the people involved.

THE EARLY DAYS

Bill O'Brien sometimes spoke of the "bean-patch" experiment in which he set up two phase-locked transmitters in a field and received the signals on a two-wheeled handcart. As the cart was moved the receiver indicated the phase-change in the signals and so showed the presence of a hyperbolic pattern. I do not know the year but I believe it could be as early as 1937. Perhaps someone here knows the date better than I.

The story of Bill coming to the UK at the beginning of the war is too well known to repeat here. I will only say that without the genius of Bill and Harvey and Ted, we would never have had a Decca System. The first operational use of Decca was for the D-Day landings. The story goes that twenty receivers were required but only nineteen were available so it was necessary to take an experimental receiver from Bill O'Brien's flat in Dolphin Square to make up the numbers. The story may not be true but it is a good one.

The success of the D-Day chain lead to its relocation to the Scheldte estuary where it was used later in the war. These two operations clearly illustrated the practicality of the Decca system and led to its commercialization and the formation of The Decca Navigator Company. In passing the company was usually called "Decca", "DN" and sometimes ""DNCL" but Ted Lewis always stressed the full name should be used where possible including the capital T for "The".

THE INITIAL CONCEPT

I understand that in 1945 it was necessary to make a deal with the Government so that the system was established as the property of the company and that the company had the full commercial rights for the system's exploitation. I believe that £50,000 had to be paid by the company for it to receive these rights. Perhaps I am wrong here and it was £50,000 that the company was paid for its work during the D-Day Landings. I do not know which but I am sure the sum was £50,000. Even if we allow for inflation, it must have been a bargain whichever way the money went!

With the company under way (it was Decca Records in those days), decisions had to be taken regarding the system's development. It was here that the genius of Ted Lewis showed itself. These were days long before business was being widely done on a "provision of services" basis. Theidea of a company building transmitters and receiving payments from the hire

(rental) of receivers was revolutionary then but looking back it is hard to see how the system could have progressed so well without this basic concept.

Not only was the idea revolutionary, its implementation was going to be difficult. Building transmitting stations just after the war was a formidable task but was only one of the problems. It was necessary to design and build new civilian receivers and an infrastructure for their maintenance had to be established. Charts had be available and there was a sales problem as hardly any one who knew what a radio navigation aid was. Despite it all, the first chain was built and receivers were available in less than a year. It was a tremendous achievement.

THE ENGLISH CHAIN

The English chain was sited to cover the Channel and parts of the North Sea. With its short base lines and high radiated power, it performed well and despite its lack of Lane Identification it provided an excellent service to the early users. It was the English chain which established the reputation of Decca for both accuracy and reliability. Furthermore, it was this chain that provided the "test bed" for the development of Decca and was the centre for much of the promotion of the system.

It was in these early days that the foundations of the receiver rental/maintenance system were laid. An effective organization was set up in the UK and, as time went on, this organization spread world-wide. The effectiveness of this network was a great contributor to the spread of the System overseas. Many of you here will recall the Decca yachts on the Thames which permitted so many enjoyable demonstrations of the system as well as the Decca aircraft flights which showed the fine characteristics of the system for aviation. These demonstrations were very effective in securing new hirings but for me, as a system promotion man, they were a perfect way to illustrate Decca's potential. I think that in the promotion of every overseas chain there were air and/or marine demonstrations of the system using the English chain --- as a sales "tool" the chain was invaluable.

THE DANISH CHAIN

As the costs of providing the transmissions had to be borne entirely by the company, it was vital that we obtained as many marine hirings as possible. It was obvious that the greater the area covered, the more hirings would be obtained. With this in mind the Danish chain was built and operated by Decca with a subsidiary company in Copenhagen. It was our first overseas chain. The overall Decca coverage was roughly doubled. So too were many of our operating expenses. Although the number of hirings did not double, the significance of the overseas development was considerable, laying the ground for expansion in Europe.

EUROPE

In the 1950's the system steadily expanded in Europe with stations being built in France, Germany, Holland, Spain, Sweden, Finland and Norway together with added coverage in UK for Scotland and Ireland. This European expansion was helped tremendously by Bill O'Brien's team making many brilliant improvements (crystalized receivers, Mk V and Multipulse for example) and the popularity of the receiver lease/maintenance arrangements. Decca was getting better and cost only £1.00 a day !

Here I would like to mention Grahame Coles and his team who ran the various sales and service bases in the UK. Also the Commercial Office which, under George Hawker, Roy Mitchell and Dave Baker, co-ordinated the activities of all the overseas Marine agencies --- as well as many other things. A force persuading European countries to adopt Decca was much of the European coast line had been strewn with mines. There was a major requirement to clear these fields so that ports could operate properly. Exports were vital to nearly all

European countries and this gave an added incentive.

Minesweeping and Hydrography go together and nearly always the various Hydrographic offices were great supporters. Not only did they help in getting the system adopted, they had great responsibilities for the chart preparation and distribution. Besides the Hydrographers, every time the system expanded there were many who were not Decca employees but were still dedicated to the system. These often came from the various Governmental Departments and from the Shipping operators who would be the users of the new coverage.

It is very difficult to make a list of the people who were so involved but I would like to mention some who were quite outstanding. In Holland, we had Mr Verstelle: there was Commodore Fogelberg of Sweden, Mr Rohrholt of Norway and finally Pierre Hugon of France. All of these men made significant contributions and it is a great pity that space and time do not permit my mentioning their many counterparts in other European countries. I should also mention the wonderful work done by the Decca agents and licensees. Again my list cannot be complete but I would like to include Captain Pripp in Denmark, Olle Wageus and Tor Palmquist of Sweden, Hvinden Haug of Norway, Jan Vollebregt and Caas Kooy in Holland, Drs Maillant and Pundt in Germany and Messrs Giroud and Laveriere in France. The list is far from complete and I apologize for the omissions. Most of my remarks on Europe have been related to marine matters but aviation was. important too. The Berlin air lift story is well known and there were the early air users like Silver City and BEA.

INDIA

It was from India that the first non-European Decca chains were ordered. They were to provide coverage around Bombay and Calcutta and later on in the South. Our supporter was Mr Lahiri of the Indian Lights Authority. Local conditions meant that the building of these chains was difficult but the various problems were solved and the stations went on to provide useful additional coverage.

NORTH AMERICA

The St Lawrence Seaway was the starting point for our expansion into North America and four chains were built for the Canadian Government. The chains provided excellent coverage and were widely used for fishing operations. It was an early and important development.

In the United States the first Decca chain was built and operated in the New York area. One of the users was New York Air, a helicopter company providing services from the airport to the Pan Am Building in the center of Manhattan.

An interesting comment is that during the New York operation there was a major electrical power failure and the City lost virtually all of its power and many of the emergency services were not available. However, the Decca stations with their advanced emergency power supply systems developed by Dougie Boycott continued without interruption.

THE PERSIAN GULF

Coverage was needed over virtually the whole of the Persian Gulf which meant that several States had to be involved. Usually these States were not agreeing with each other and often there were bitter rivalries and unhappy memories of past events. No one State could possibly be responsible for the whole of the Gulf.

Fortunately, we found a remarkably effective organization operating lighthouses and beacons in the area. It was the Persian Gulf Lighting Service which was operated by the major oil companies and so was a "natural" starting point for us to introduce the system.

We initiated discussions with the PGLS and the major oil companies were deeply involved. Agreements were signed and led to a programme of construction and operation under the most difficult conditions but ended with us providing a reliable service. This continued until the military operations in the North required the relocation of some of the stations and ultimately their closure. The leading man in PGLS was Captain Webb and he was aided by representatives from Shell and BP and included the late Tom Gaskell, scientific adviser to the BP board.

JAPAN

It was in the mid-fifties that I first visited Japan. We had hired a survey chain to Shell for use in Seria and I had to visit Singapore for discussions with their local office. Having got as far as Singapore it seemed a pity not to go "round the corner" to Hong Kong and then "a little further on" to Tokyo. With piston-engined aircraft a lot of flying hours were involved but it was time well spent.

Japan in those days was quite different from the present but it was obvious that for Decca it was a land of opportunity. Japan relies on the sea for its food supply and fishing is a major industry. There are almost no useful minerals so oil and steel have to be imported. The sea is vital to Japan. Furthermore, the Japanese people like new things.

Japan was an early user of the Decca system having bought its own survey chain in 1960. Also, it was an early European chain user, ships picking up receivers from Mediterranean ports when entering the area and leaving them behind when returning to the Far East.

When I arrived, I found a few knowledgeable people anxious to learn more about Decca. They were not many but they were influential. The big names were Shimasue and Kiyono. I am happy to say Mr Kiyono is still very active in Japan and his company, SENA, is still hiring Decca-licenced Japanese-made receivers.

In the mid-50s, the basic problem for Japan was a shortage of money but as the country's financial situation improved so did our chances of success. In 1964 with Japan just beginning its up-turn we signed agreements with the Government and with a number of commercial organizations. These included Kobe Kogyo (now Fujitsu) as our manufacturing licensees. All of the relationships were most cordial and long lasting.
Over the years the Japanese Government built six chains so that the whole of Japan was covered. Despite the advent of Loran-C and GPS, two of the chains are still operating.

NIGERIA

The economy of Nigeria has been closely linked to the oil industry and the discovery of considerable reserves brought about many changes there. For many years there had been exploration programmes using small Decca survey chains but as the development of the industry took place it became necessary to install full size non-restricted-user chains. Five such chains were commissioned.

The dramatic changes in world oil prices were paralleled by Nigeria's internal political problems. There were many difficult years for Nigeria and these lead to difficult times for the chains. There were big responsibilities for the company and for David Baker who was deeply involved but the chains became an established part of Decca world coverage.

SOUTH AFRICA

In the late 1940's the South African Government conducted a series of tests to determine the effects of the local conditions on the propagation of Decca signals. George Hawker spent several months in the area and much was learnt. We kept good contact with all concerned in

South Africa and this was rewarded by the building of five chains in the mid and late '60's. The chains were operated by a Decca subsidiary in South Africa and again represented an important step forward in the world's coverage.

I would like to mention just a few names in connection with this area. General Wilmott, the Supremo of the South African Forces and General Martin, the Head of the Air Force were closely involved whilst Colonel Broadhurst and an engineer called Wadley conducted the initial trials. It was Wadley who developed the communication receiver which established the technical base for much Racal Communications equipment. Another side story from South Africa is that it was then I met a gentleman called Ernie Harrison who became rather involved with Decca later on !

AUSTRALIA

Australia had always taken a deep interest in the Decca system and, as part of our expansion campaign, we gave a number of presentations including a major symposium in Sydney organized by John Lucken. Our final opportunity came in a rather roundabout way. In the 60's, Japan's shipbuilding and motor car industries were expanding rapidly and as Japan has no natural source of iron and steel it was necessary to import large quantities of ore. Australia, although thousand of miles away, was the source selected. Japan had its own Decca Navigator coverage and many of the ore carrying vessels were already equipped with receivers. The ore carriers were large and the channels in Northern Australia were twisting and narrow. Decca was clearly a logical solution to the problem and two chains were installed one in Dampier and the other in Port Hedland. Gerry Unkels of the Department of Shipping and Navigation was a tireless worker on these projects.

HYDROGRAPHY

Hydrography and minesweeping are closely linked. The Royal Navy quickly saw the System's value for mine sweeping and survey. This was particularly true at high level. In this connection I would mention the Admirals Day, Nares, Ritchey and Irving and of course their successors. The influence of these people was enormous because of Britain's leading position in hydrography. The word quickly got around that besides its value for navigation Decca was good for position fixing. With this in mind in 1946 the company appointed Claude Powell as survey manager.
It was a significant step forward and gave a new way for the system to expand. In many countries, hydrography paved the way for the adoption of Decca for navigation.

SURVEY CHAINS

It was clear there was an operational requirement (and hence a commercial opportunity) for small mobile chains. I well remember the day when Ned Fenessey and his commercial manager, Johnnie Johnson, brought back the order from the Danish Government for a survey chain for use in Greenland.

The order was placed in summer of 1946 and in the following Spring the chain was operating in Denmark for initial tests. Later the same year it was shipped to Greenland and the survey programme started. In all, it was quite an achievement.

Demonstrations given in Copenhagen during the tests were attended by many and resulted in the Swedish Government buying their own survey chain the following year. After this, similar chains and chains operating in a two range mode became very popular for hydrography. Oil companies quickly recognized the assistance the system could provide to seismic and similar surveys. In 1949 the first oil survey chain was installed in the Persian Gulf by a Caltex subsidiary. Iain Thomson, who later became the Head of the Survey Company, was the Chain Commander. The year 1952 was the start of our "rent-a-chain" business with Shell operating

in the Persian Gulf. It was the beginning of the rapid deployment of survey chains in many parts of the world and this continued until most of the activity was taken over by Hi-Fix. Military survey chains were used for mine sweeping with the French being particularly active with chains in Metropolitan France, Morocco and Tunisia. The fifties were an important time for survey development.

LARGE RESTRICTED USER CHAINS

Besides the light weight transportable Decca chains for survey purposes the system has been widely used in a restricted user mode with large stations running long periods. These operations are not well known but were important. Broadly speaking, these operations related to the oil industry's long term large area exploration programmes and to military operations. They took place in many different areas but in general the ultimate users and customers were European or North American. Here are some examples.

NORTH SEA OIL

For many years it was known that there were valuable reserves of oil under the North Sea. With the development of deep-sea drilling techniques it became practical to develop the area. Shell led this programme. The accuracies required for survey were too great for the navigational chains. To overcome this problem special Decca stations were built which provided baselines across the North Sea. Normally this would lead to unacceptable skywave interference but, as the exploration took place in daylight hours, no problems were experienced. There were two separate systems, Sea Shell and Sea Search and these provided basic position fixing for the initial surveys and rig locations. Decca has played an invaluable role in the North Sea oil development programme.

THE UNITED STATES

Perhaps because of the early competition between VOR/DME and Decca, it is often thought that the USA was not a big user of Decca. Far from it. In the mid-sixties two high power Mk V Decca chains were built for position fixing for oil companies operating in the Gulf of Mexico. They were particularly successful as they had greater range than the 2 MHz systems used previously.

Further South in the "Tongue of the Ocean" area the US government had built an impressive underwater research testing ground. Decca was the only system capable of providing the ranges and accuracies that were necessary to carry out the tests. It was a big project and lasted a long time. Decca both built and operated the stations.
Another area where Decca was adopted by the US government was" Vietnam during the war. A special Decca chain was built and was widely used by helicopters for the rescue of wounded troops. Again, a large and successful operation.

CANADIAN OPERATIONS

In the mid 1950's, The Decca Navigator Company of London, England, was run by Harvey Schwartz a real dynamo at marketing. The company was a subsidiary of the massive Decca complex controlled by Sir Edward Lewis. Schwartz's big success had been the utilization of the system in the D-Day landings. It was his dream to expand Navigator throughout the civilized world and in particular, to the United States.

Roy Mitchell, an ex-RAF squadron leader and an associate of Robert Watson-Watt, the British scientist credited with the development of radar had been selected to lead Decca into the North American market. He had already convinced the Bendix company to consider a North American licence. In the winter of 1956, Roy moved from London, England to Toronto, Ontario and established a Canadian office for Decca Navigator.

In 1957, the Canadian Coast Guard started to evaluate Decca Navigator for eventual certification as radio navigation aid for Canada. Chains were built in Newfoundland, Nova Scotia and Quebec for this purpose. Business was booming. Around Christmas 1958 when everything was going great, Roy Mitchell announced that Decca was about to withdraw from the North American market and the Bendix Corporation had taken over the licence. That meant the Decca Navigator division had to be moved to Ottawa because it would be managed under the wing of Computing Devices Canada (CDC), a Bendix subsidiary. Roy Mitchell was off to New York City to take over the Decca Radar Corporation there. By January 1959, the move to Ottawa had been completed but the transition was rocky one having encountered problems between senior management and staff. The basic issues focused around management's fundamental lack of understanding about marine sciences.

Within a short time, business was booming and CDC landed contracts with the Department of Transport, the Hydrographic Office and the Department of Mines and Technical Surveys. The company started conducting Decca Navigator tests with the Royal Canadian Navy and the United States Navy. The Canadian Navy adopted Decca and used it until Global Positioning System became the primary navigation system. By 1961, the Canadian Coast Guard had completed the certification of the Canadian chains and they entered service. In the autumn of 1965, the Decca division was prospering, but the main business operations were somewhat less than profitable. Bendix, who owned 60 percent of the company decided to go public. It was a good deal for the stock brokers, but did absolutely nothing for the bottom line. Massive changes were needed but no one was fired. People were just moved around. Expenditures stayed the same and the income grew even smaller. There were also sorts of wonderful ideas and systems floating around in people's minds but without those defence contracts CDC's survival was in jeopardy. The most lucrative marketplace, the U.S. military was to be denied because of the "not invented here syndrome".

CDC eventually became part of the General Dynamics group. Today, the company is a supplier of military electronics to both the Canadian Department of National Defence and to the United States. The last Decca chain in Canada having closed down in 1986, ended Decca Navigator operations for CDC and signalled the end of an era.

THE ROYAL AIR FORCE

The RAF were great users of Decca using the general navigational chains. However, they were also great users of Decca for special purposes. In Europe there was a special chain operated exclusively for the RAF. It was highly successful and ran for a long period. In the Pacific Decca was on Christmas Island where the RAF were responsible for the testing of Britain's first hydrogen bomb. A chain was built and performed well under unusual conditions. Later, there was a similar operation in Australia. The Christmas Island exercise was commanded by Air Vice Marshall Oulton and he pays tribute to the Decca involvement in his book, "A Christmas Cracker". Many people were concerned with the adoption of Decca by the Royal Air Force but I would particularly like to mention Group Captain Clare who is with us today.

PASSING THE PEAK

Most things in life involve birth, development, adolescence, a prime period and then a falling off --- usually to make way for something new. Navigational aids are no exception. Decca's expansion was continuous for over 35 years but in the 1980's changes were taking place. Furthermore, most of the major sea routes were already covered so now there were fewer areas for expansion.

More important, although major improvements in the system had taken place there were still fundamental limitations due to Skywave. Loran-C, although it had its own problems, could

operate with longer base lines and so was adopted in certain areas. Similarly, there was the slowly evolving GPS system. GPS would take time but undoubtedly would be very attractive. However Decca's position was extremely strong. Decca had coverage in the important areas. It worked well and was backed up by a fine organization. Ironically, it was its very success that brought our third problem --- some people wanted to "run their trains on our tracks".

It was a difficult period for us. With new technology it was possible to make receivers cheaply and these could be sold outright without the manufacturer having responsibility for the transmissions. Clearly, the time had come for radical change and we successfully brought in new licensing arrangements. However, eventually we concluded a contract with the Department of Shipping for them to pay for the running of the chains. This arrangement has worked well and the system has continued to develop but now the Agreement is about to end. Regrettably, the life of Decca is drawing to a close. It is clearly a sad time but we must remember the years of success

WHY WAS DECCA SO SUCCESSFUL ?

The answer to this question is quite simple. It was a very good system and it was brilliantly developed and managed.

Decca had well over a half century of full operational life which is much longer than practically any other radio navigational aid. Its success was mainly due to an exceptional number of quite exceptional people. To mention a few names, Bill O'Brien was a remarkable engineer combining inventive genius and an incredible ability to overcome day-to-day development problems. His friendship with Harvey Schwarz led to the system coming to U.K. where with the impending war there was a natural starting point.

Harvey was a giant of a man. He had a genial, pleasant personality and was able to quickly make friends and inspire loyalty and dedication in his colleagues. He had a natural quality for leadership and gained the respect of all he met. He was a man of vision and was quite tireless.

With Bill and Harvey together in London the system was almost bound to succeed under the genius of Sir Edward Lewis. Ted, as he will be remembered by many, provided the environment in which the system could grow, the Decca company. Ted also provided the political "clout" that was often needed and was able to obtain the money that was required all too often --- particularly in the early days. These three men are no longer with us but their memories will live on.

But it was not just three, there were many. When I joined the company early 1946, there was a lot of expertise already. On the technical side there were Donald Bridges, Denis Hendley and John Huggins and soon after John Vickers. Then from 60 Group we had Maurice Easy, Bill Sanderson, George Hawker and "Ham" Hamilton and from the Navy came Dudley Toller-Bond, Grahame Coles and David Baker. 1946 was a great year for Decca recruitment and I am mentioning only a few names.

And it was not just the outstanding skills of the people I have noted. We must add the dedication and hard work of thousands in the laboratories, the factories, the offices and at the myriad locations in the UK and overseas to get the full picture. It is not surprising the system did so well for so long with so much skill and willing effort available.

For myself, I joined in April '46 and left in February '91
--- forty five happy years. Today I have only two regrets
--- there are so many people I have not mentioned and so many who are no longer with us.

Today we must all be proud to have been associated with the Decca Navigator System and with its phenomenal success. In closing, let me give some recommended reading --- Howard

Capes house magazine, "Decca Navigator News", provides an excellent record of the system's life, particularly during the Golden Years. If you can get hold of some copies and are nostalgic, I recommend a big box of tissues !

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July 14/08

MARINE RECEIVERS & INDICATORS

(Survey and special-purpose receivers, e.g. Type 990 (RAF Mk 1 Air) not included in this document).

QM Receiver

Here's where it all started. This was one of the original Decca receivers which saw action on D-Day. Designated Outfit 'QM' , it was fitted aboard Harbour Defence Motor Launch 1383, which was one of the vessels actually used on D-Day for survey on the beaches. Someone has inscribed the vessel's pendant on the front panel. The serial number of the unit (s/n 112) is actually unit number 12 in the first build series *(Photo from the collection of Walter Blanchard)*

Type: **QM**
Input Power Requirements: 220 AC at 100 watts
Display: 1 pair of decometers
Number of Channels: 3 (Master, Red, Green)
Dimensions: --
Weight: --
Quantity Produced: 27
Purpose: Prototype receiver for marine navigation
Comments: Developed as a secret wartime navigational aid for the British Admiralty.

The original decometers were of the "gas meter" type, and as such, the first Decca display ever made. Printed on the dial is the name DR&T, London. which is an abbreviation for Decca Radio & Television. The "gas meter" name was used since they were originally made from domestic gas meters which were designed to count in multiples of ten. *(Photo by David Jones)*

QM1 Receiver

QM1 receiver**.** *(Photo from the collection of Walter Blanchard)*

Type: **QM1**
Input Power Requirements: 220 VAC at 90 watts; mains only operation.
Display: One pair of decometers, red/green only.
Dimensions: 21.25 x 16.25 x 12.25 inches
Weight: 80 pounds
Quantity Produced: 40
Purpose: Marine Navigation

Comments: Further development of QM receiver. Used extensively by the Royal Navy for mine clearance in the Scheldt Estuary prior to the re-opening of the Port of Antwerp in Belgium at the end of WWII.

The gas meter decometers were fitted with mounting flanges and when mounted, had a slight downward cant. A red or green marker on the front denoted the channel. The cable to the receiver plugged into the top of the unit. This display can be found aboard HMS Belfast in London. *(Photo by David Jones)*

Modified QM1. The two knobs on the front panel of the QM1 receiver controlled the zero adjustment for the Decometers - one for each pattern. They were somewhat sensitive, so later production runs had a small, hinged, black cover plate installed to cover them up so they couldn't be accidentally knocked out of adjustment. This gives the initial impression that they were two different receivers but they were not. Harvey Schwarz is at the left, Bill O'Brien in

the middle and on the right is Edward Lewis, (later "Sir") Chairman of the Decca Group. *(Photo from the collection of Walter Blanchard)*

QM2 Receiver

QM2 receiver. *(Photo from the collection of Walter Blanchard)*

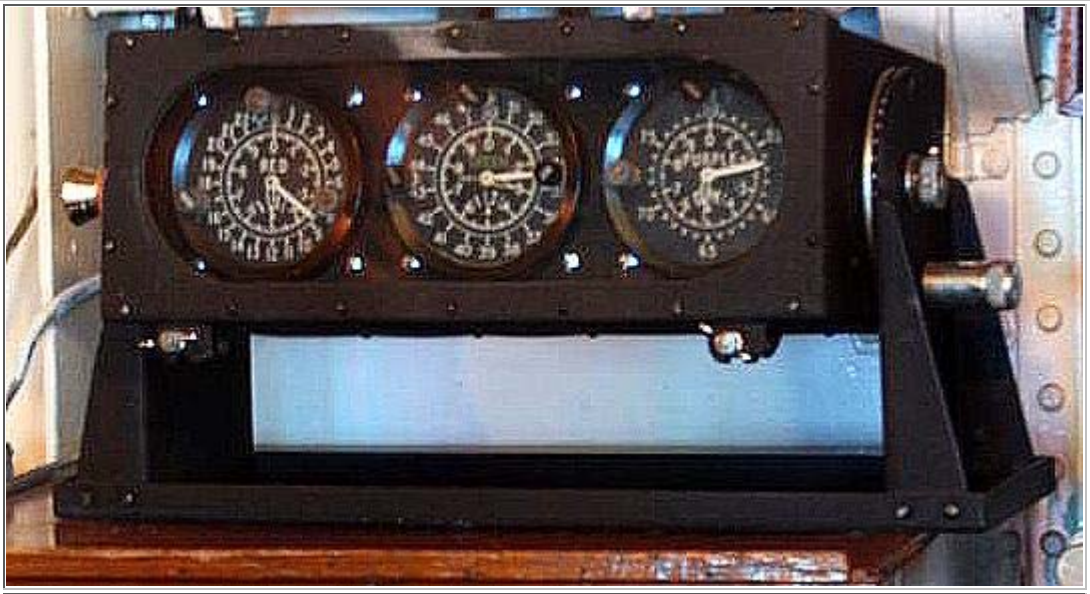
Type: **QM2**
Input Power Requirements: 12 VDC at 8 watts; battery operated.
Display: 1 pair of decometers. Similar in operation to QM1.
Number of Channels: 3 (Master, Red, Green)
Dimensions: 18 x 16.5 x 7.5 inches
Weight: 32 pounds
Quantity Produced: 30
Purpose: Portable survey receiver for general use.
Comments: Portable battery powered receiver developed primarily for use on small ships. Not equipped for operation on 220 VDC mains. Suitable for general use on land or in the air. Used by the Royal Navy in the Scheldt sweeping operations.

In this historic photo, Bill O'Brien (L) and Harvey Schwarz (R) study a QM2 receiver. Note the QM1 receiver sitting on the bench adjacent to the drafting board. *(Photo from the collection of Walter Blanchard)*

QM3 Receiver

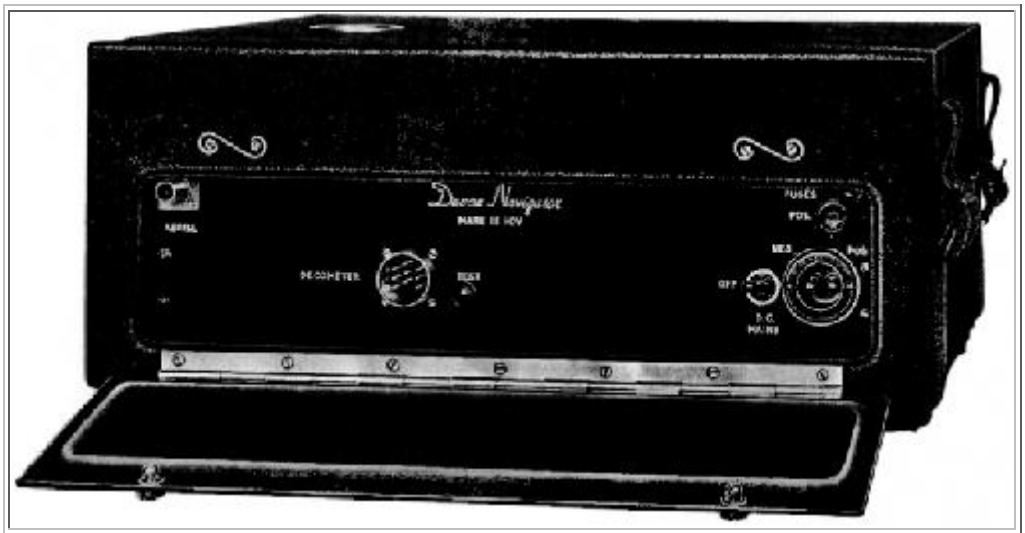
No photo available

Type: **QM3**
Input Power Requirements: 220 VAC at 90 watts
Display: 2 pairs of decometers
Number of Channels: 3 (Master, Red, Green)
Dimensions: 21.25 x 16.25 x 12.25 inches
Weight: 80
Quantity Produced: 40
Purpose: Marine navigation
Comments: Modification program to QM1 receiver . Receiver output stages modified and two pairs of decometers fitted to permit remote presentation of meter readings. Slightly smaller than QM1.



This three meter decometer bowl is awaiting identification but believed to be from around 1948 since it lacks the Lane Identification feature. Decca's Decometers were made by a small British instrument company called Reid and Sigrist. Because it was such a vital item Decca eventually bought the company and it became part of the Decca Group. *(Photo by David Jones)*

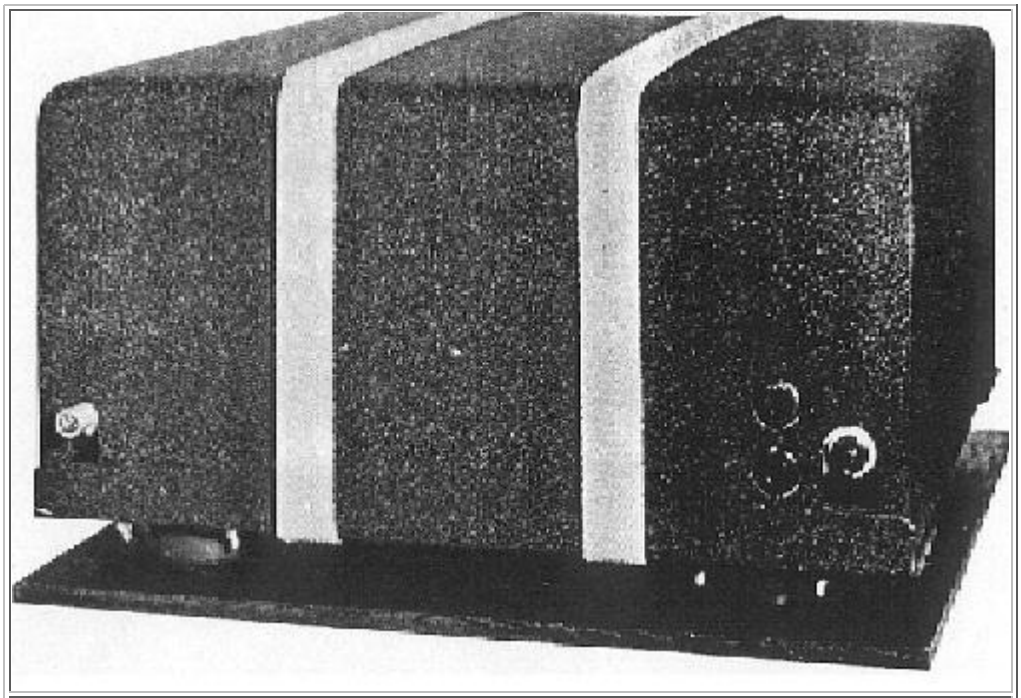
Mark III Receiver



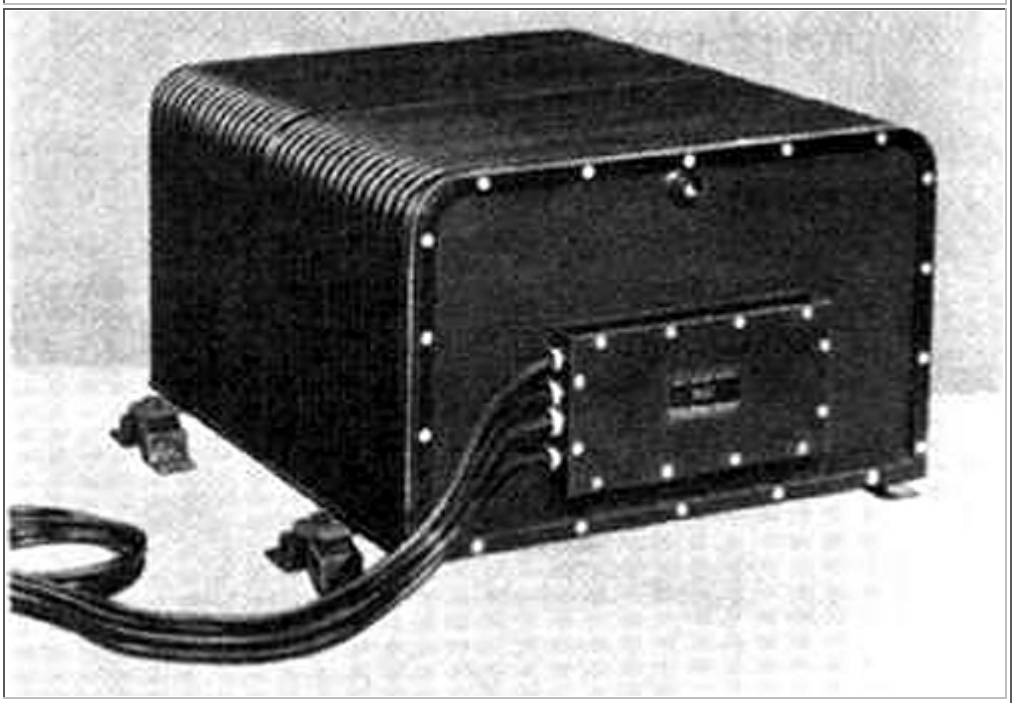
Mark III Receiver. *(Photo from the collection of Walter Blanchard)*

Type: **Mark III**
Input Power Requirements: 12/24 at 65 watts for airborne version; 110 VDC at 70 watts for marine version
Display: 1 pair decometers
Number of Channels: 3 (Master, Red, Green Purple)
Dimensions: 18 x 16.5 x 8 inches
Weight: 27.5 pounds
Quantity Produced: Seven 12 volt versions; seven 24 volt versions; 46 marine versions.
Purpose: Either an airborne or marine receiver depending on power source.
Comments: As an airborne set, it was produced for trials only. As a marine set, they were produced in limited quantity primarily for the Ministry of Transportation trials.

Mark IV Receiver



Mk IV - Front View *(Photo from the collection of Walter Blanchard)*

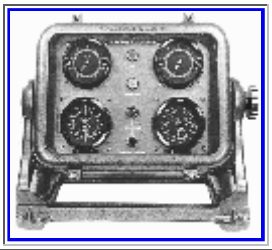


Mk IV - Rear View *(Photo from the collection of Walter Blanchard)*

Type: **Mark IV** (MkIVA airborne version shown above). Available in marine version.
Input Power Requirements: Airborne - 80 VAC at 1000 cps at 80 watts.
12 VDC at 90 watts.
24 VDC at 90 watts.
Marine - 110 VDC at 90 watts
Display: 1 set of decometers
Number of Channels: 4 (Master, Red, Green and Purple)
Dimensions: 15.5 x 15 x 8 inches
Weight: 31.5

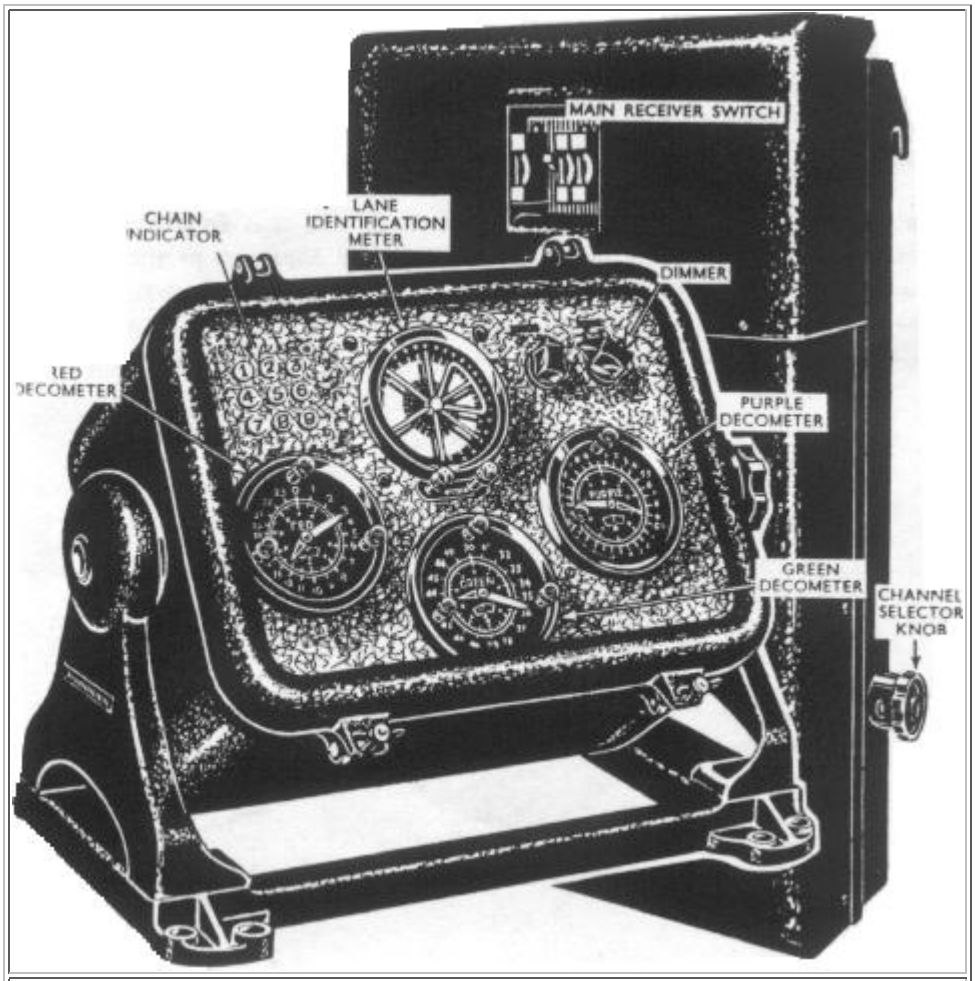
Quantity Produced: --
Purpose: Marine navigation
Comments: Receiver in production as of 1946. Sub-designated QM 's 6,7,8,11,13 depending on chain and frequencies. The very first Mk 4 receiver was fitted to M.V. ROGATE (Stephenson Clarke Shipping) on Feb 26, 1947

Variant: MkIVA was used for airborne navigation.



This is a two range decometer, used on two range Lambda Survey Chains for offshore surveys and was manufactured in the 1960's. The model number indicated is 9039AA Click image to enlarge. *(Photo courtesy V.K.Lehtoranta, OH2LX)*

Mk V Receiver and Display



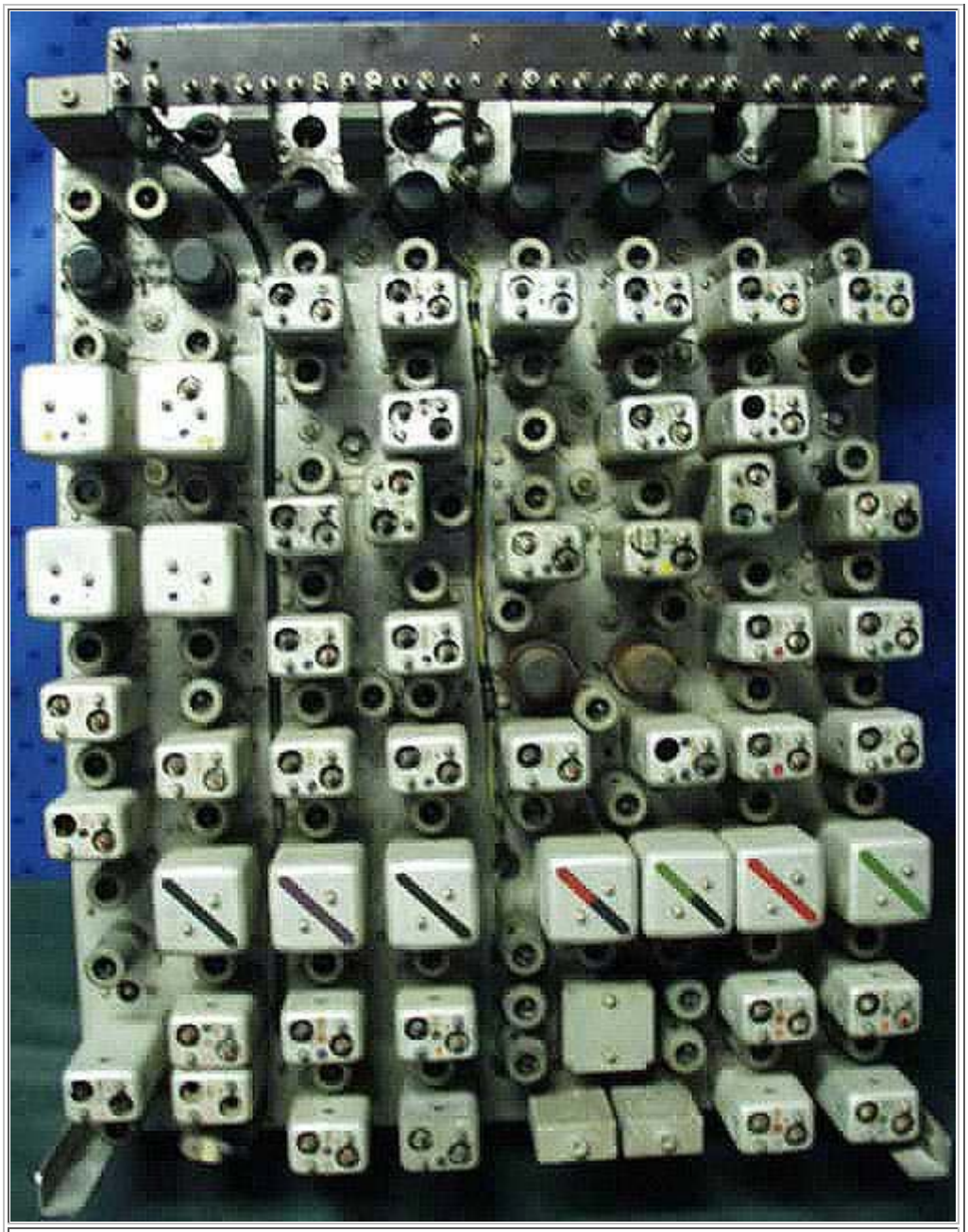
This is the *Decca Mk V (QMS 10)*. On the left is the decometer bowl. At the right is the receiver. Reading clockwise from the upper left corner of the decometer bowl are: Chain Indicator, Lane Identification Meter, Dimmer control, Purple Decometer, Green Decometer and the Red Decometer. On the receiver, it is Main Receiver Switch at top center and

Channel Selector Knob at the right side. *(From BR-45 Admiralty Manual of Navigation).*

Type: **Mk V**
Input Power Requirements: Airborne - 24 VDC at 90 watts.
Marine - 110 VDC at 90 watts
Display: 1 set of decometers
Number of Channels: 4 (Master, Red, Green and Purple)
Dimensions: 12 x 15.5 x 8 inches (airborne version)
15.5 x 16.5 x 7.75 inches (marine version)
Weight: 20 pounds (airborne)
62 pounds (marine)
Quantity Produced: --
Purpose: Airborne and marine navigation
Comments: Under development in 1946. The picture above is copied from the Admiralty Manual of Navigation , 1955. The was Decca's first marine receiver capable of lane identification. Also applicable to QM's 5,9 and 10.

It should be noted that the Royal Navy used a different designation for its Decca receivers. All their receivers were purchased, not rented and although they were the same as the commercial models, they used the number code QM.

Here is an example of a Mk V receiver fitted aboard HMS Alliance, a British submarine commissioned in 1947. *(Photo courtesy Royal Navy Submarine Museum page www.rnsubmus.co.uk)*



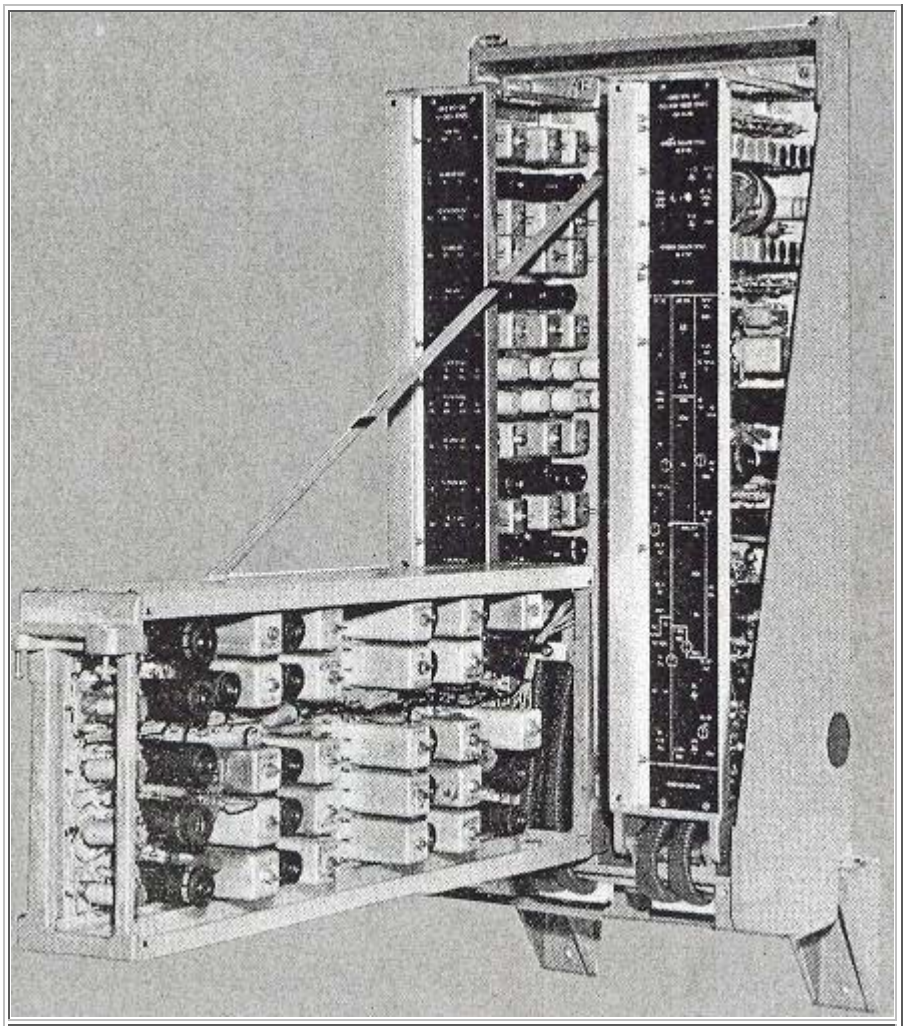
Mark V receiver with chassis cover removed. *(Photo courtesy Patrimoine Radiomaritime web site http://pierre.painset.free.fr)*

MARK XII EQUIPMENT

Decca introduced the Mark XII (valved) marine receiver on 1962 Nov 27, 1962. It supported both Multipulse and Mk. 5 Lane Identification in order to work with all chains. Used a locked oscillator in the master channel.

The receiving antenna for the Mk 12 style of receiver was normally a 3 part fiberglass tube with a single wire inside. Overall length was about 15 to 18 feet and it came with a wall-plate for fixing to bulkhead or building wall. Tube diameter was about 1.5 inches and it tapered slightly. The Mk 12 receiver was a wall mounted unit with screw connections via the base. Decometer and power unit were separate to the receiver. Inside the receiver unit, the electronics were on 4(?) full length swing down modules. These receivers were also used as fixed monitors for the chains. These receivers were also used as fixed monitors for the chains

An example of a Decca Mk12 receiver. At the left is the top view; the bottom view is at the right. The chain monitoring receiver was a *modified* Mark12 unit. *(Photos courtesy Maritime Museum of the Atlantic).*



An internal view of the Mk 12 receiver showing one of the chassis units swung down for servicing. *(Courtesy Decca Navigator News April, 1972)*

Here is an example of a Decca Mk12 decometer bowl which was donated to HMCS HAIDA Naval Historic Ship. One major change from the Mk V to the Mk XII system was the relocation of the chain selector switch from the receiver to the display unit. *(Photo by Jerry Proc)*

The decometer bowl was a cast metal tub with all decometers fitted from the front face. Only a large, circular multi-pin connector was fitted at the back for connection to the receiver. The front face was a hinged cover with a thick glass window. A neoprene seal was set into the cover and thumbscrews secured it and made it water resistant . The bowl mounted into a cradle stand and rotated on pivots with a locking wheel at each end to hold it at the desired angle. It was designed to withstand the rigors of life on a fishing boat and it could take whatever the wheelhouse crew threw at it.

Rear view of Mk XII decometer bowl. *(E-bay photo by Tigerstime)*

Mk V decometer and receiver.

Mk XII decometer and receiver. The box under the orange paper does not belong with the equipment.

This side-by-side comparison illustrates the relative dimensions between the receiver cabinet and the decometer bowl. The equipment in these two photos are on display at the museum in Port Ness, Isle of Lewis, Hebrides Islands, Scotland. *(Both photos by James Morrison).*

A typical bulkhead installation in a vessel. This example resides in the Science Museum London, England. *(Photo by Santiago Insua)*

This detail shows the Decca Navigator antenna feedthrough assembly aboard HMCS Nootka in 1959. The assembly was made by Decca and was part of the rental kit. *(Photo courtesy of Gary Pollock)*

Mk 13 EQUIPMENT

Not allocated in the series.

Mk. 20 RECEIVER

This was a receiver made by Norwegian STK under name ANARLOF .It used a digital readout.

MARK 21 EQUIPMENT

Introduced in November 1969, the Mark 21 was the first receiver where everything was contained in a single box unit. *(Photo from the collection of Walter Blanchard)*

DESCRIPTION

The Mark 21 was all solid state marine receiver designed for use with Decca chains radiating Multipulse (Lane Identification) signals only. It was intended as a replacement for the Mk 12 receiver. Receiver and display was housed is a single unit; was suitable for bulkhead, deckhead or table mounting. Different mains voltages could be accommodated with interchangeable power unit modules. Power consumption using AC was 25 watts and 35 watts for DC. It employed locked oscillators on all channels.

When used with a non-Multipulse (V-type) chain, only the decometers of the Mark 21 receiver would be operative but **not** the Lane Indicator (L.I) readout. The L.I. readout may appear to have been triggered but the numbers displayed were meaningless. The Decometers, however, would operate normally with the fraction pointers automatically taking up their correct positions within the Lanes, but the receiver provided no independent check on the

counting action of the Lane and Zone dials. It was recommended by the British Admiralty that in the absence of L.I. readings, it was necessary to set the Lane and Zone dials by reference to other navigational data.
Since the L.I. readings were not valid, possible confusion could be eliminated by turning the L.I. dimmer anticlockwise to dim the L.I. display. It was essential to keep the receiver operating continuously in order to avoid loss of Lane or Zone count, especially if no external data was available. For all practical purposes, the Mark 21 was a Multipulse only receiver.

When the Mark 21 receiver operated with a Chain designated MP but having only two slave stations, the fraction pointer of the Decometer associated with the 'missing' slave station would rotate continuously. Although this Decometer was not used, it had to be referenced correctly to zero; failure to do that would adversely affect the L.I. readings for the two patterns to be used. To do that, the user followed a simple procedure outlined in the operator's manual.

Mk 21 installation aboard Her Majesty's Yacht Britannia, now an exhibition ship at Ocean Terminal, Leith, Edinburgh, Scotland. *(Photo by Santiago Insua)*

Mk. 22 RECEIVER

Prototype for submarine use. Based on Mk. 15 but with decometers and switchable Lane Identification / Zone Identification meters.

Mk. 23 RECEIVER

A Mk. 19 receiver for land vehicle use. It was built into a Creeth container.

Mk. 24 RECEIVER

A Mk.18 receiver redesigned for small craft. It did not go into production.

The early 1980's were a critical phase in the history of the Navigator system since it marked a point at which conflicting forces were converging upon the company. The technology to improve the product was now coming on stream, (ie new receivers and packaged stations), the expiry of Decca's patents, affordable microprocessors, rival receiver manufacturers, GPS and the fallout that resulted from the takeover of the company by Racal.

All this must have left the designers wondering what path to follow and it seems that they chose to hedge a few bets and make a play for multi-input receivers. In hindsight, this generation of product was probably the finest that Decca Navigator made.

Mark 30 Receiver

The set is similar in appearance to the Mk 21. It has three dials on the front, each marked from 0-1 with divisions of 0.1, subdivided to 0.01, with an additional digital readout in the centre of each. A panel beneath the dials swings down to reveal further controls, including chain selection. The Mark 30 was a semi-microprocessor controlled receiver, which was introduced in 1981 in response to recent developments in electronics.

Mk 30 receivers were first produced by (Decca Navigator in 1981 and then by Racal Avionics Ltd from 1 April 1982. One of the features incorporated into the design was cross chain fixing.

Dimensions: 14.76" x 16.8" x 11.8"

Mark 51 - Looking for info. Contact jerry.proc@sympatico.ca

Mark 52

	Click on image for a description and additional photos. *(Photo by John Redpath)*

Mark 53

	Click on image to enlarge.No text available at this time *(Photo by John Redpath)*

The MK53 was the last of the hyperbolic navigators, certainly to be designed by what was the old Decca Navigator Company. The case was used for many other products including the MK90 GPS receiver and an Inmarsat marine telex system.

There was a significant thing about the case. It was the company's first and only high pressure, die casting. Its tooling was very expensive but it resulted in a case that cost less than £20 painted! It was a lot cheaper that the sand castings used in MK21 and MK30 which required extensive machining and preparation prior to painting.

Decca Navigator Simulator

E-bay photo by Tigerstime

This nameplate, affixed to a Type 2538 decometer bowl for a Mk XII system, suggests there was a training simulator. If anyone has any information on it, please contact jerry.proc@sympatico.ca

MARINE AUTOMATIC PLOTTER

The Decca Marine Automatic Plotter (DMAP for short) provides an accurate and continuous map presentation of a ship's position and at the same time, producing a complete record of the track made good. It enables ships to follow any desired course with an accuracy hitherto unobtainable and eliminates the problems which are encountered when a ship is required to make good a track which does not coincide with a Decca hyperbolic position line.

Used in conjunction with the Decca Navigator receiver MK V or with Decca Survey equipment ,this display unit is primarily intended for operations in which accurate holding of predetermined tracks and the maintenance of complete track records are essential.

In principle, the DMAP is similar to the Decca Aircraft Flight Log ; the decometer information is translated into related movements of a roller-mounted chart and a plotting pen along axes lying at right angles. The hyperbolic Decca position-line patterns are presented upon the chart in a rectilinear "inverse lattice" form; the pen indicates the position of the ship upon that lattice at any instant, tracing a continuous record of the track made good as the ship moves across the Decca pattern.

A range of five switch selected scales, from 0.25 inches to 4 inches per Decca lane, is available for both the pen and the paper, thus giving chart scales between 1:5,000 and 1:80,000 in the central coverage of a Decca Chain. These limits fall to some 1:30,000 and 1:500,000 at the extremes of the coverage area. Further switching gives four possible orientations of the display each displaced 90 degrees from the next, enabling a rough approximation to north - or heading-upward display to be obtained in all parts of the coverage area. The remaining controls, in addition to their use in setting up the display, provide facilities for producing latticed charts on a blank chart sheet. This last operation permits the production of track records in areas for which no prepared charts are held, By entering the control settings and the decometer readings for any one point on the track upon the chart , a complete record is obtained .

The complete DMAP comprises of a display unit and Control Amplifier (embodying the power supply) . The first houses the actual display head in which an area of chart

approximately 10 in. by 10 in. is visible at all times along with the operating controls. Its equipped with a glass, water-resistant cover , a quick release catch permitting easy access to the chart and controls. The amplifier power supply unit takes the form of a shelf or bulkhead mounted case. The equipment is designed for operation from an AC power source and will normally draw its supply from the converter associated with the Decca receiver.

Decca Marine Automatic Plotter (*Decca Navigator Company photo)*

Credits and References:

1) Walter Blanchard <wblanch(at)ntlworld.com]
2) Danac Operating Instructions Manual, June 1979. Decca Navigator, New Malden, Surrey

3) Extracts from *Decca's Genealogy* provided courtesy Walter Blanchard, Royal Navigation Institute.
4) Stuart A Wolf <stuart.wolf(at)nats.co.uk>
5) James Morrison Decca photos. http://www.flickr.com/photos/jamesm/107572653/in/set-72057594120797676/
6) DECTRA marketing brochure published by the Decca Navigator Company.
7) Denis Chouinard <denischouinard(at)enter-net.com>
8) Santiago Insua <hwasp(at)hotmail.com>
9) Matthew Parker <parkermat(at)hotmail.com>
10) David Jones <dsjjones(at)bellsouth.net>
11) Mk 30 info http://www.competition-commission.org.uk/rep_pub/reports/1987/fulltext/215c04.pdf

Back to Decca Intro Page

Oct 21/10

DECCA NAVIGATOR - OVERVIEW

THE CHAIN

A Decca chain normally consisted of a master station controlling the phase of three slaves, which were situated about 120 degrees apart, at a radius of 60 to 100 miles from the master. That provided all-round coverage, and, because ground waves of this frequency band are not seriously attenuated by passing over land, the stations could advantageously be situated well inland.

Each Station in the chain would normally transmit a particular unmodulated phase stable carrier wave. These carriers were all harmonically related to an internal station reference which was about 14.2kHz, referred to as "f".

* The **Master** Station normally transmitting a "**6f**" unmodulated carrier wave signal in the **85** kHz band,
* **Red** Slave Station transmitting a "**8f**" signal in the **112** kHz Band,
* **Green** Slave transmitting a "**9f**" signal in the **127** kHz band,
* **Purple** Slave transmitting a "**5f**" signal in the **71** kHz band.

The Slave stations received and phase locked their station reference oscillators to the Master "6f" Transmission.

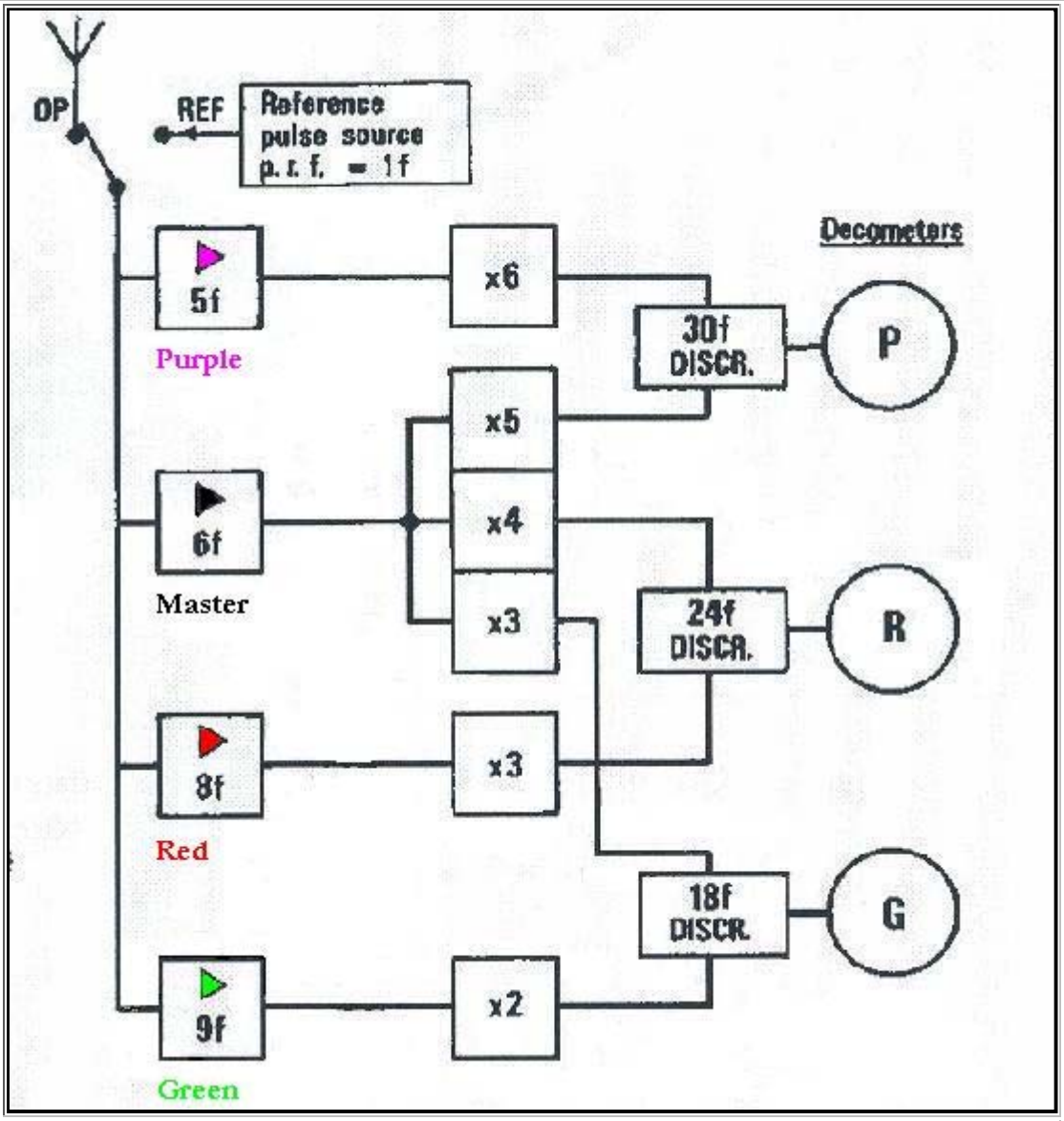
The frequency ranges for the master and slave stations were:

Master: 84 - 86 kHz
Red slave: 112 - 115 kHz
Green slave: 126 - 129 kHz
Purple slave: 70 - 72 kHz

Since the signals were continuous wave (CW), 150 Hz spacing was sufficient to ensure there would be no interference.

These transmissions were received by a special receiver and frequency multiplying circuits therein produced phase comparisons of:

24f for the Master and Red
18f for Master and Green
30f for the Master and Purple

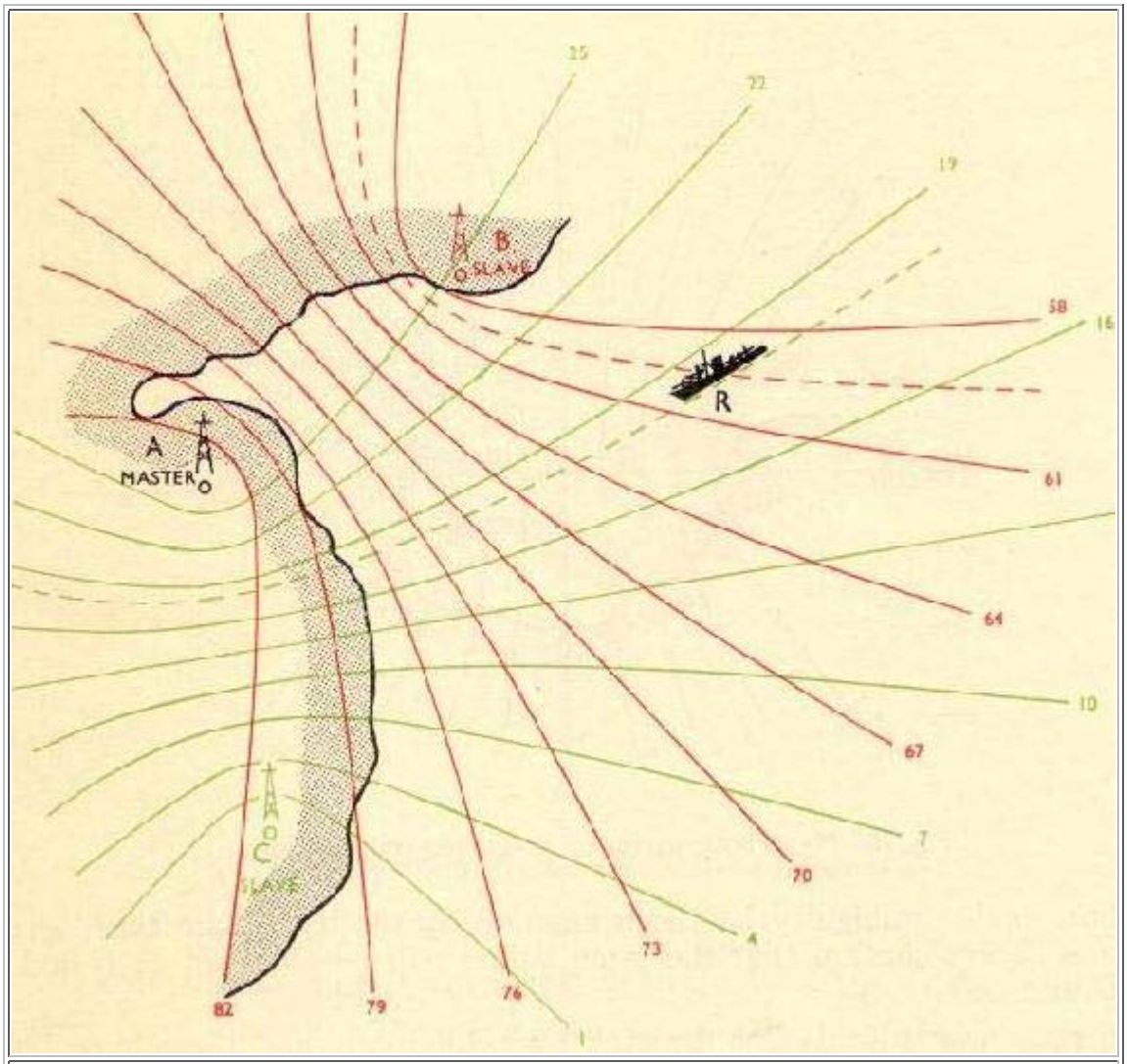


The block diagram of the basic Decca receiver for survey and marine use (not including Multipulse). The master and slaves were processed by superheterodyne stages in the left column. The resultant outputs were applied to frequency multiplying circuits in the middle column. The outputs of the frequency multipliers were applied to the discriminators in the rightmost columns. The difference in phase would be amplified and read on a decometer. It is very easy to see how all the slave signals are compared to the master in this diagram. **f** is some frequency around 14. 2 KHz. *(Graphic courtesy Decca Navigator Co. Modified by Jerry Proc)*

Although for most of the time the stations only transmitted their single carrier, during part of the transmission cycle, each station would transmit what was termed a Multi-pulse also called "Mark 10" transmission. In the Mark 10 context, it meant that Multipluse could only be received on Mk X receiver equipment and higher.

The Multi-pulse was transmitted by each of the stations in turn during the 20 second transmission cycle to provide a coarse reading, or a Zone reading, and was generated by all 5 transmitters at the given station briefly transmitting simultaneously. During transmission of the Multi-pulse by, say the Red Slave, all transmissions from the other stations in the Chain would be suppressed.

The original 'V type transmissions, prior to the introduction of Multipulse also had V-1 and V-2 variants. Both of these were being phased out by the mid-'70's when many of the chains were being updated. More on this as soon as additional information becomes available.



Decca Lattice: An example of a Decca lattice chart showing the lines of hyperbola from the read and green slaves.

The transmissions from the chain are received by a special shipborne receiver, which measures the difference in phase of signals arriving from master and slaves. All stations in a Decca chain must 'phase locked', and this has to be done over an appreciable distance separating the stations, sometimes up to 100 nautical miles, the phase difference being determined by this distance. Each slave station is fitted with equipment which receives the master signal, converts it to the slave frequency, and uses it to control the drive oscillator of the slave transmitter. Thus a constant phase relationship is maintained. To ensure that this relationship is maintained accurately, a monitoring station checks the transmissions.

Click to enlarge. This simple and more practical red-green lattice chart relates the coloured lines to actual decometer readings. *(Map courtesy Decca Navigator Company)*

DECOMETERS

The detected phase differences are displayed on phase meters called 'decometers', and the readings may be plotted onto Decca lattice charts, on which the lines of position are

numbered in the same units as those shown on the decometers.

The decometer indications are continuous, and depending on the position in the coverage, readings of the two appropriate decameters can be taken simultaneously whenever a fix is required. The third decameter can give some additional information, but usually its readings are disregarded in the wide sector around the base-line extension. The lattice patterns are formed by hyperbolic position lines similar to those previously described. They are overprinted on ordinary Mercator charts. The slave stations are known as Red, Green and Purple slaves, according to the printed colour of the lattice lines derived from their transmissions.

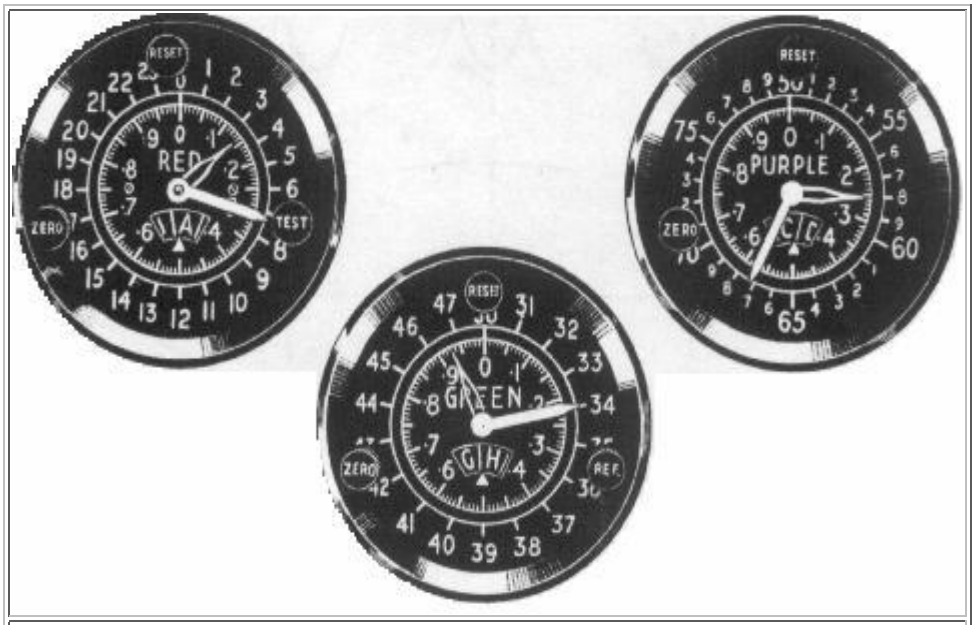


Figure 2: A set of decometers.(C*ourtesy Decca Navigator Company)*

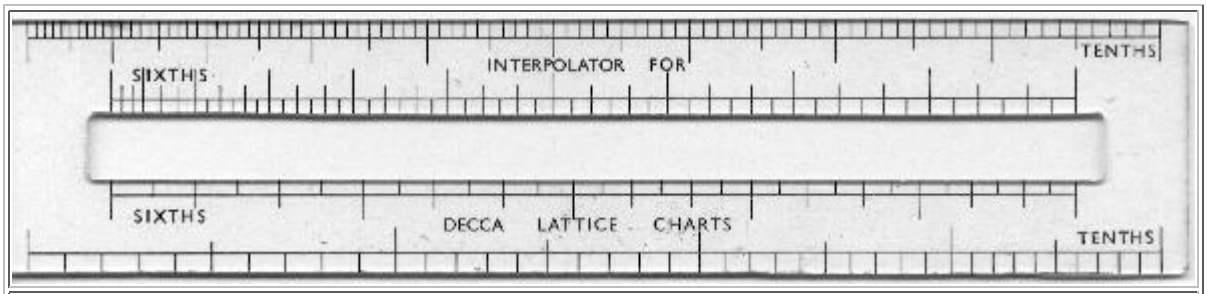
A very high degree of instrumental accuracy is obtained by the use of continuous wave transmissions, the phase of which, on arrival, can be measured to within 4 degrees. Near the base-line, between a pair of stations, this may represent a distance as small as 10 yards, though it must be borne in mind that constant and variable errors due to operational causes exist in the system, which, in practice, does not normally give an accuracy as good as +/- 10 yards. It is, however, considerably more accurate than any system employing pulse transmissions (ie Loran).

LANES

The areas between the lines of zero phase difference in a Decca pattern are known as "lanes". The width of each lane on the base-line is approximately Red: 450 metres, Green: 590 metres and Purple: 350 metres. Lanes are grouped into Zones. Each Zone contains 24 Red lanes, 18 Green lanes, or 30 Purple lanes. For unambiguous presentation, the Zones are lettered, and the Lanes numbered outwards from the Master Station. Each group of ten Zones is lettered from A to J, and the Lanes in each zone are numbered:- Red: 0 to 23, Green: 30 to 47 and' Purple: 50 to 79. Readings at the Master Station are Red 0.00, Green A 30.00 and Purple A 50.00. The correct Zone Letter must be determined from normal navigational methods and by reference to the appropriate Decca latticed chart. As the zones are about 6 miles in width on the base lines, and this width increases away from the base-lines, the accepted position of the ship is generally not critical for this purpose.

It is essential that the signals from the two stations should be received separately in order to preserve their individual phase properties. Since the C.W. transmissions are simultaneous, this can only be achieved by transmitting on different frequencies: but these frequencies

must have an exact common multiple. The transmissions are received by what are virtually four separate receivers within the Decca Navigator receiving equipment. The frequencies of these signals are then multiplied up to their lowest common multiple, the so-called "comparison frequency" on which the phase comparison is made. As the pattern is traversed by the Decca receiving equipment so the reading will be observed to alter steadily from 0 degrees to 360 degrees between the limits of each lane; the decometer, from which this reading is obtained, is therefore graduated in fractions of a lane instead of in degrees.



INTERPOLATOR: Shown above is the Interpolator for Decca Lattice Charts. When overlaid on a lattice chart, it would help the navigator resolve the distance between lattice lines. *(This artifact was donated to HMCS HAIDA Historic Naval Ship by Duncan Mathieson)*

The decometer is simply a phase meter whose dial is graduated in hundredths of a lane width; one revolution of the fractional pointer represents the extent of one lane. It will, therefore, indicate very accurately a receiver's position between two lattice lines, but it is unable to identify the particular lane in which it is situated. Since lane width varies from less than a mile near the base line to 3 miles or so at 300 miles range, this would cause a high degree of ambiguity, which a ship, entering the coverage area after an ocean passage, might not be able to resolve. Once the initial position has been established, however, the decometer, which is capable of continuous rotation, can integrate its movements in the lattice pattern by a set of counters geared to the fractional pointer.

LANE IDENTIFICATION METER

The ambiguity of the Decca Navigator system has been resolved in the Mark V (or QM5) receiver by the addition of a fourth dial called a "Lane Identification Meter". Its use enables the operator to set each decometer to the correct lane within a zone. He must still know which zone his ship is situated in, however, in order to set the correct letter on the decometer. Since a zone consists of about twenty or more lanes, this only requires that the dead reckoning position should be known within wide limits so that, except in unusual cases, no ambiguity should arise.

Should lane-slip have occurred, the fact will be apparent from the lane identification meter as soon as the ship enters the lane identification coverage area and the decometers can be reset accordingly. Essentially, lane identification consists of transmissions from master and slave at much lower frequency than the normal. This lower frequency, which is used as a comparison frequency in the receiver, is actually obtained as a beat frequency of the two transmissions originating from the same station. Thus a very much coarser pattern is obtained in which the 360 degree phase change corresponds to a whole zone. Since this lower frequency is a multiple of the pattern comparison frequency, a zone comprises a whole number of lanes. This is shown in figure 3. The lane identification meter, which measures phase difference in the same way as the decometer, will indicate the position within a zone.

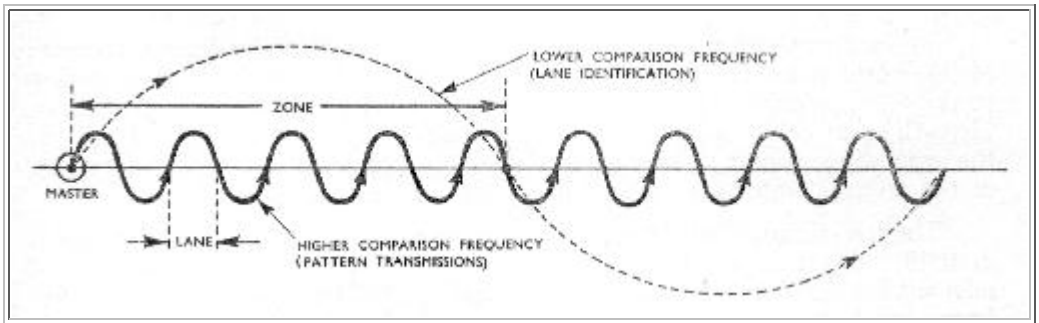


Figure 3: Lane identification transmission.

If this meter is graduated in lanes, instead of fractions of a zone, it will then indicate directly the correct lane in which the receiver lies. In practice, the lane identification meter has three concentric scales (one for each pair of stations), coloured red, green and purple. Lane identification signals are transmitted from each pair in a fixed sequence at short intervals; and, as each one is received, a relay is closed, illuminating the appropriate coloured scale while the pointer indicates the correct lane on that scale. The indication for each colour remains on the meter for about 5 seconds, which is ample time in which to obtain a reading. This was due to the discovery that, in certain conditions of skywave interference, the accuracy of the meter responding to the coarse pattern was inadequate for the required purpose. The indicator consists, therefore, of two separate components: the sector pointer and the "vernier" pointer assembly. The former indicates the position to the nearest sixth of a zone, while the latter, working on an intermediate frequency, indicates the actual lane itself within that zone.

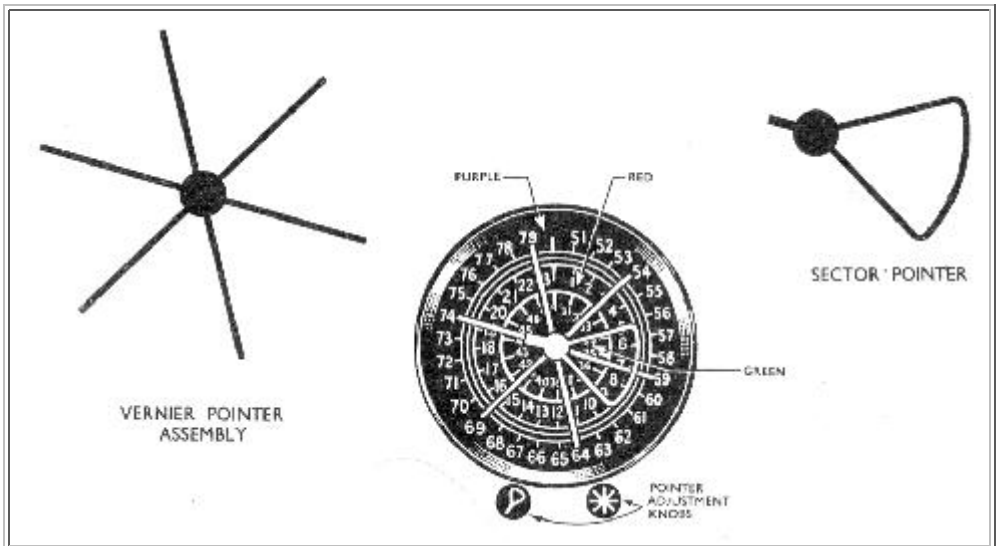


Figure 4: The Lane Identification meter and the vernier and sector pointers.

The vernier indicator is basically a meter with a pointer revolving once as the receiver travels across the space between two adjacent boundaries of a lane (a sixth of the width of a zone) of the particular pattern which affects it; but, for compactness of display, the action is geared down six times mechanically, and the single pointer is replaced by an assembly of six pointers, which are read against the same scale as the sector pointer.

It should be noted that the word "vernier" is used in this connection not in its true sense, but merely to indicate a finer indication. A reading is effected by noting, on the illuminated scale, the lane number indicated by the particular vernier pointer which is enclosed by the arms of the sector pointer. Thus, in Figure 4, if the red scale were illuminated on the meter, the correct lane reading would be between 7 and S. It should be noted that, beyond 100 miles

from the base line, the center of the sector pointer will not always coincide with the vernier pointer, owing to skywave interference; but as the vernier pointer indicates the exact lane, this will cause no inaccuracy. Near the limits of coverage at night, however, the arms of the sector pointer may coincide exactly with two vernier pointers, or the sector pointer may even enclose the wrong one. The use of lane identification was approved by the British Ministry of Transport in 1949, subject to strict compliance with the instructions contained in the relevant Data Sheets, which were promulgated by the Decca Navigator Company from time to time.

CHAIN OPERATION

DESCRIPTION OF 'V' TYPE TRANSMISSIONS

Each station in a Decca chain transmits on a different frequency. If the master and slave stations all operated on the same frequency, the receiver would be unable to distinguish between the incoming signals. In order to compare the phases, however, all the transmission frequencies are related harmonically, and each signal is separately converted in the receiver to a frequency which is the lowest common multiple of the master and slave frequencies. The relative phases can then be compared at this "comparison frequency", which will be different for each pair. For example, if the Master, A, transmits on 60 kc/s and slave B transmits on 80 kc/s, the comparison frequency would be 240 kc/s, which is the lowest common multiple (LCM) of 60 and 80. As far as the receiver is concerned, apart from signal separation, the waves appear to have travelled from the transmitters at the comparison frequency, and it is upon this frequency that the number of lanes in a lattice depends.

Remembering that one lane is half-a-wavelength wide along the base-line, and taking 240 kc/s as the comparison frequency of the AB pair, we obtain the following: 240 kc/s is equivalent to a wavelength of 1,370 yards i.e., each lane will be 685 yards wide along the base-line. If the distance between A and B is 85.5 miles, then the number of lanes will be:

85.5 x 2,000/ 685 = 250

The phase differences between the slave signals and that of the master are displayed on the decometers during the whole time that the receiver. is switched on. Lane identification is provided, at intervals of one minute on each pattern, during a short break in the normal transmissions. For this purpose the transmission frequencies are grouped in a different manner in order to produce the required coarser patterns. For the lane identification of a pair, in addition to the master and a slave, two transmitters -- one at each section are put in operation at fixed times every minute. These additional transmitters work on frequencies 'borrowed' from two of the remaining slaves. While this 'frequency borrowing' is taking place, transmissions from the stations normally operating on these frequencies are suppressed for about half a second. The sequence of transmissions and suppressions is maintained to a rigid time schedule by automatic phase locking circuits, and the sequence of events appears on the lane identification meter in the following manner:

TIME	LANE IDENTIFICATION	FREQUENCIES AT MASTER	AT SLAVE
0 sec to 0.5 sec.	**RED**	Master	Red
15 sec to 15.5 sec.	**GREEN**	and	and
30sec. to 30.5 sec	**PURPLE**	Purple	Green

The last transmission is followed by a 30 second interval before the sequence starts again, so that the lane in each pair is identified once every minute. Since the time intervals are unequal, (ie 15 sec., 15 sec., and then 30 sec.) it is easy to recognize which lane identification (L.I) is on, and then check whether the L.I. light sequence is correct. In order to avoid false Red,

Green, and Purple readings during the "frequency borrowed" transmissions, the decameter circuits are cut off for this period; but, owing to storing elements in the circuit, the readings are maintained on the previous levels. This 'persistence' of the decometer readings is sufficiently long for them to be unaffected by the very short lane identification transmissions. The only effect on the decometers is a slight 'kick' of the pointers, which does not affect the accuracy of the reading.

For more information on the MULTIPULSE transmitting format, please refer to the Decca Transmitters document.

VARIABLE ERRORS

The presence of a sky wave component in the received signal may cause variable errors at the receiver. In the case of Decca, there is no means of distinguishing between the two waves. This leads to an inaccuracy in the decometer readings which will vary with the range from the transmitters and with the time of day. At ranges greater than 75 miles, the accuracy at night is noticeably lower than it is by day, since sky wave effect is normally only experienced during the night. Beyond a range of between 150 and 220 miles there is a serious danger of "lane-slip".

Disregarding systematic errors and transmission failures, the accuracy of a fix from the Decca system can be considered to depend upon:

(a) Instrumental errors
(b) Propagation errors caused by either Sky Wave or Coastal effects.
(c) Lane width.
(d) Angle of cut of the hyperbolae.

Thus Decca errors are subject to many variables and cannot be summarized precisely. The following figures give a guide to the accuracy that should generally be expected:

a) By DAY 0-100 miles or by NIGHT 0-75 miles: +/- 10 feet near base line; 1 mile at limits

b) By NIGHT 75-240 miles: Up to a maximum of about 5 miles, depending on sighting of slave stations.

Notification of any transmission failures, which might result in lane slipping, were promulgated to mariners by signals broadcast from certain coastal radio stations. Details of this service was contained in the Admiralty List of Radio Signals (Vol. V). Decca Charts.

Decca charts, produced by the Hydrographer, consisted of Admiralty navigational charts overprinted with Decca lattices. They were given the series letter 'L' with the word 'Decca' in brackets after the number - e.g., L 1408 (Decca) - to distinguish them from other lattice charts.

Contributors and Credits:

1) Matthew Parker <parkermat(at)hotmail.com>

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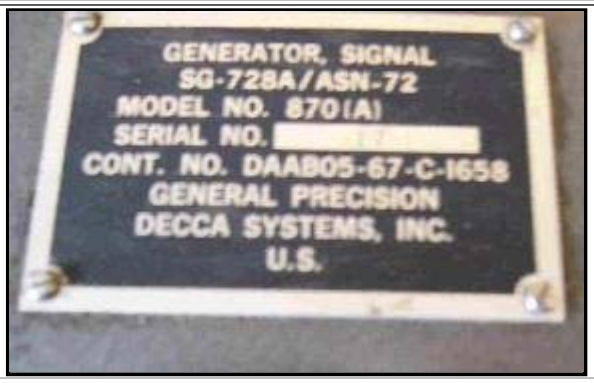
Jan 26/08

DECCA NAVIGATOR - TEST EQUIPMENT

Decca Model 306 Signal Generator. These were used at the master stations to service the "Remote Monitor Receiver". The remote monitor was a modified MkV receiver, located about two to three miles from the station and connected to it by landline in such a way that the Decca signals could be displayed on the decometers in front of the watch keeper. A signal generator would also be held by the local marine service company who repaired shipboard Decca receivers. *(Photo submitted by Santiago Insua <deccanavigator(at)mundo-r.com>)*

Decca Model 870 Signal Generator. Built by GPDSI in the USA, it was similar to the 306 except it had a motor which controlled the Red/Green/Purple identification sequence. The red paint on the front panel meant it was consigned to the scrap heap but luckily it was salvaged just in time. *(Photo by John Molloy-Vickers <vickymv(at)stn.net>)*



Model 870 nameplate. *(Photo by John Molloy-Vickers <vickymv(at)stn.net>)*

Model 8960B Signal Generator S/N 56. It was used in the mid-1960's and onwards as a bench test unit for the Mk15 to Mk19 range of Decca aircraft receivers. It also marked the identification sequence with a
"hole" in the master transmission. This was a Decca system "feature" which was added to thwart a new crop of Decca compatible receivers after they came to market . The thinking was that this type of signaling would be incompatible with the crop of cloned receivers thus protecting Decca's market share. The hole was added on an experimental basis to the English chain only by Rex Young. It worked, and the clones could not be easily modified to get around the problem.

The 'B' version was the second and final type. Although it is enclosed is a neat travel case, it was not really intended to be a field test unit. Apparently it was designed to work with an 8961 monitor box. The device in the photo was last calibrated in 1994 and is still in use in Spain by Santiago Insua to demonstrate the principles of the Decca system. *(Photo by steve(at)engineroom.free-online.co.uk)*

Model 8960B lid with accessory cables. *(Photo by steve(at)engineroom.free-online.co.uk)*

The 8961B is a special-to-type test set for the Mk 19 Decca Navigator only. It was designed for line testing of the Mk 19 receivers fitted to some Royal Navy choppers. It does not radiate RF any signals. *(Photo courtesy Walter Blanchard)*

Can anyone confirm if this RF signal generator was used on Decca's production line and if so, for what family of products? What is the approximate vintage? The nameplate is marked: The Decca Navigator Co. Ltd., Signal Generator, 20-40 Mc/s Type 162 Serial NO. 0031, Made in England. Click to enlarge photo. *Photo submitted by Tobias. E-mail mongosapien(at)t-online.de*

Mk 12 (left) and Mk 21 (right) equipment is being tested at Decca's Marine Service facility at Croydon, England in the early 1970's. There was a staff of 400 employed at this location. It included workshops, spares inventory, installation, service control, engineering support and training. *(Courtesy Decca Navigator News April, 1972)*

Credits or References:

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Apr 20/08

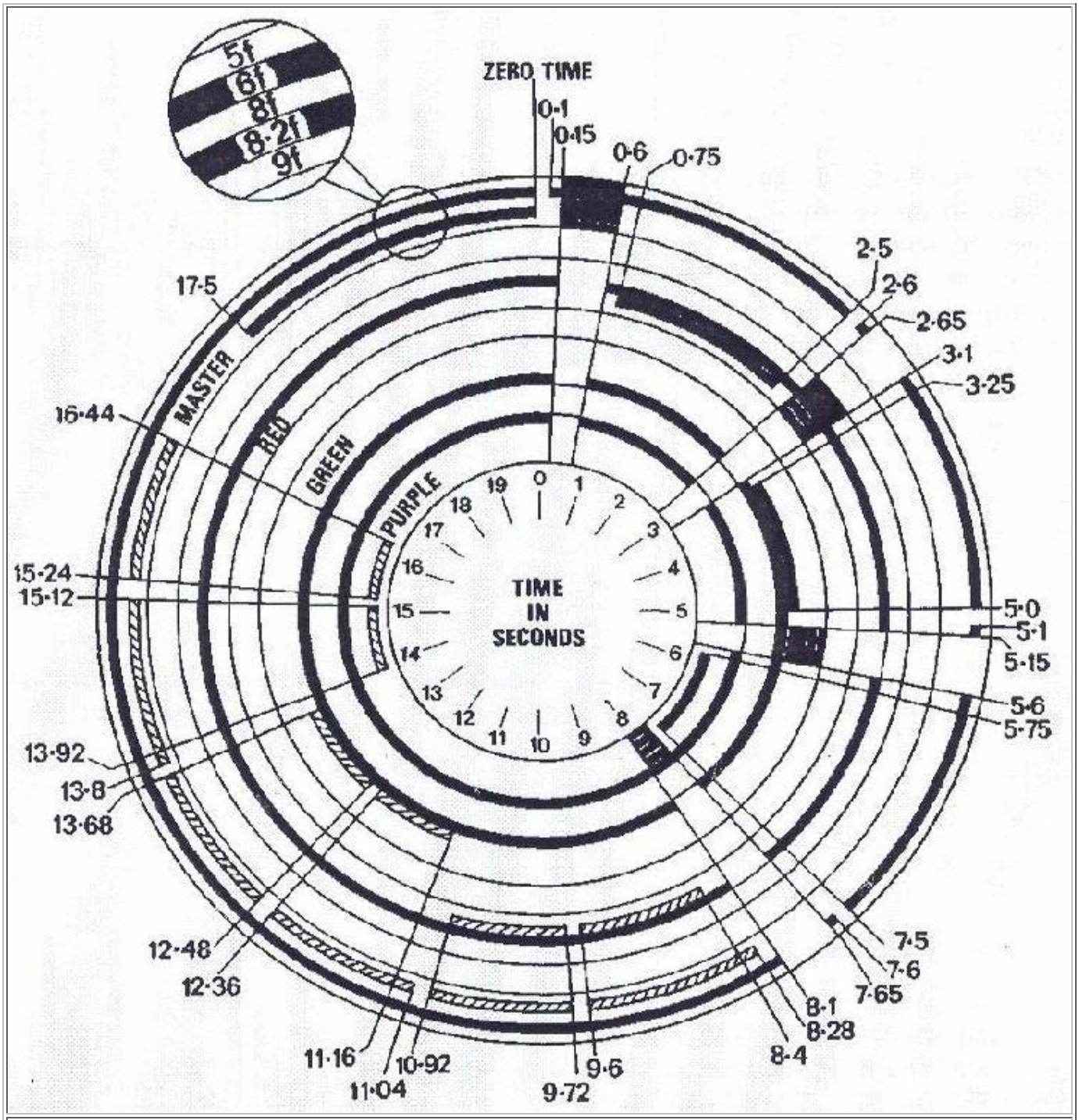
DECCA NAVIGATOR - TRANSMITTERS

MULTIPULSE vs 'V' Signals

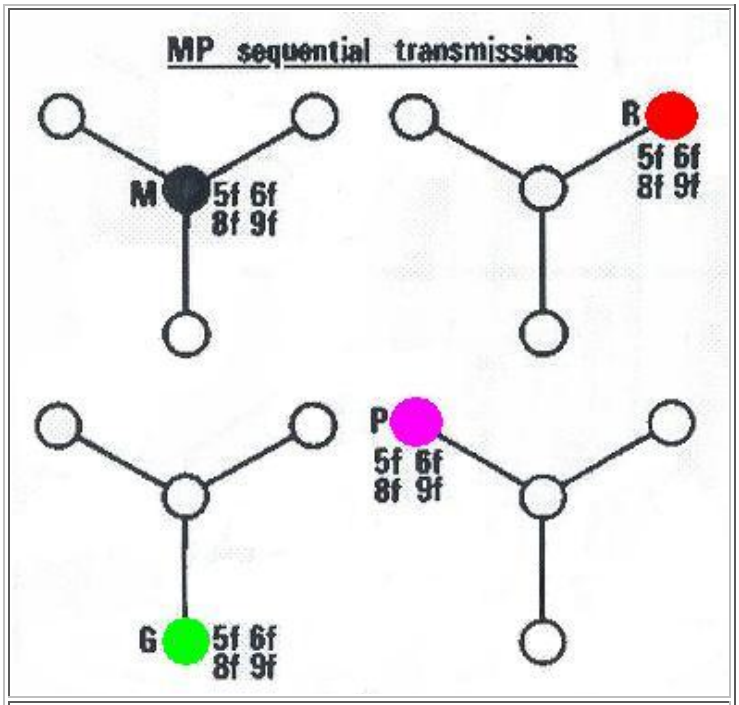
The original Decca emissions were given a designation of '**V**' mode transmission . V mode had two subsets, namely V1 and V2 , however no technical description is available at this time. In the fall of 1962, Decca introduced **MP** (Multi Pulse) signals. At first the MP chains were the exception rather than the rule, however by 1973 MP was referred to as a "normal" chain.

The MP system added the 8.2f transmission which was decoded and used as a coarse zone indicator (0.2f). This zone indication overcame the problem found by fast moving aircraft which could easily fly through lanes and thus needed a coarser indication of basic position. A slow moving vessel started out knowing their basic position. The 8.2f transmission was known by the name Orange. This was in addition to red, green, purple and black being the basic Decca chain transmissions. Since the 8.2f was not used for navigation purposes, it was used for sending chain data between stations and alarm signaling. In MP mode, alll the stations in each chain took turns radiating all five frequencies (5f, 6f, 8f, 8.2f and 9f) on a 20 second time interval.

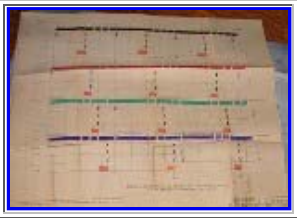
The V was named after the standard marine receiver model of the period, this having the basic three decometer's and whole chain selection. Ground equipment and transmitters were the same for both formats, the only difference being the antenna coil assembly. Another benefit of the Multi Pulse upgrade was the ability to use sub-chain frequencies, (5A, 5B, 5C, etc), rather than the whole number chains that had been the norm. This allowed for chains to be positioned closer together with less chance of interference. The Mark-10 was probably the first Multi Pulse receiver and was also most likely and airborne one. The basic marine Multi Pulse receiver was the Mark-12 which lasted almost to the end of the system and was the basis for the system monitoring receiver.



This figure illustrates the 20 second transmission sequence for MP Decca Navigation chain. Hatched periods denote 8.2f transmissions for chain control and surveillance. *(Graphic courtesy of The Decca Navigator Co)*



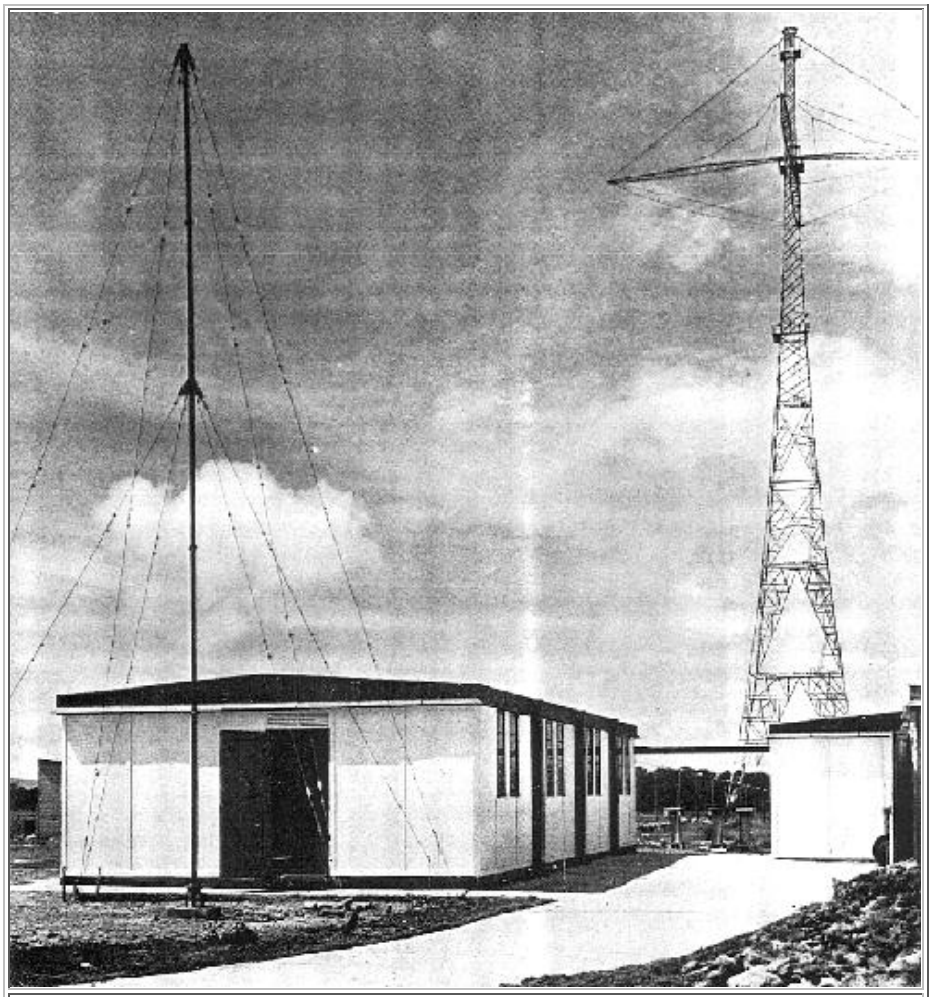
This diagram illustrates the transmitting order of a Decca MP chain. The sequence is M, R G, P. Although not shown here for clarity, each station also transmits 8.2 f. Please refer to the sequence diagram for 8.2f transmissions. *(Graphic courtesy Decca Navigator Co. Modified by Jerry Proc)*



This is the "linear" version of the transmit sequence chart. Click to enlarge. *(Photo courtesy Santiago Insua, Spain).*

MAST RADIATOR AND GROUND RADIALS

Initally, a Decca transmitting mast was self-supporting, made of galvanized steel and employed lattice construction. It's overall height was 325 feet and the base formed a square some 60 feet wide. Mounted near the top, were four, high level booms supporting the specially designed umbrella type aerial array. At the junction of the 75 foot long booms was a work platform. The mast itself formed part of the aerial system and was mounted on four insulators with concrete supports and foundations. Mast head lighting was also incorporated into the design. The height of the towers and the number of towers varied. At Alma Nova Scotia,. there were three towers but they were only 180 feet high.



DECCA SLAVE SITE: This photo illustrates a typical slave site. At the left is the transmitter building. To its right is the ablution (washroom) building. The antenna in the foreground received the phase control signal sent by the master station thus providing input for the Phase Control Unit. Due to the distance and the contrast in the photo, the catenary of support cables is not visible on the main antenna tower in the background. *(Photo source unknown)*

EARTH SYSTEM

A good earth system was necessary to ensure the high efficiency of the Decca Navigator transmitting station, hence an extensive pattern of radial earth wires was therefore employed

This system consisted of 90 radials. Each radial consisted of 7 gauge, 18 strand copper wire, 325 feet long. These were equally spaced radiating from the center formed by the Aerial Coil House. In some installations, these radials were laid above ground for the whole of their length and supported on light wooden posts extending about 18 inches above the ground. To reduce the area covered by the earth system and to free land for agricultural purposes, the radials were laid above the ground to the extent of the area covered by the mast and from that point the wires were buried about 18 inches below the surface.

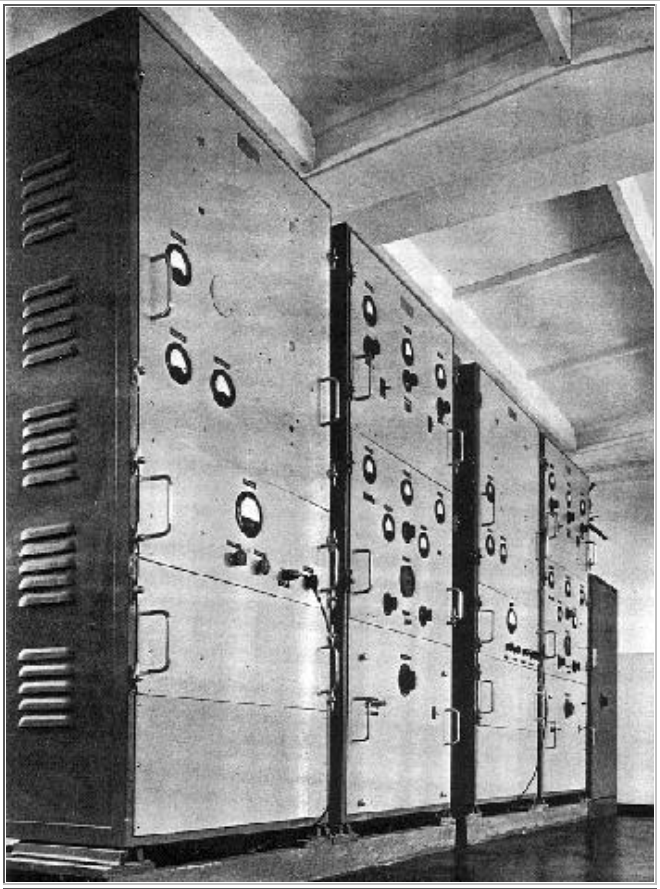
MAST INSULATORS

Arthur O. Austin was the founder of the A.O. Austin Insulator Company of Barberton, Ohio. He was a prolific inventor in the early to mid 1900's and at one time is believed to have held 225 different patents for various insulator products. These achievements allowed him to lead the field in North America for the design and manufacture of Radio Frequency Insulators and Tower Lighting Transformers. Many radio engineers will recognize the renowned "Austin Ring Transformer", which was respectfully named after its inventor, A.O.
Austin. Through a succession of ownership changes, starting in the late 1960's, Austin Insulators became the Insulator Division of Decca, Racal-Decca, and then Litton Marine. In 2000, through an

employee/management buyout, the Austin Insulators company emerged.. The new firm is now based in Mississauga Ontario.

TRANSMITTERS -THERMIONIC TYPE

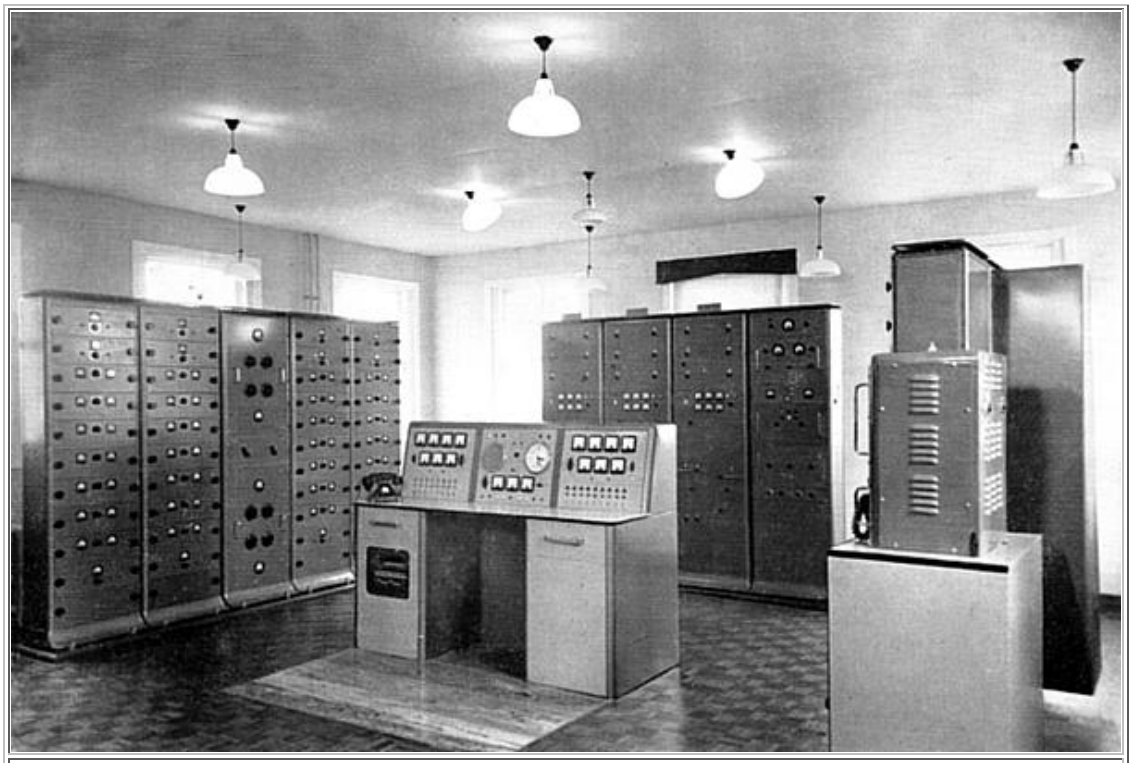
Each station was fitted with three continuous wave transmitters. One unit was always considered to be operational. Another unit was designated for "immediate standby" with filaments on and all ready to take over should the operational transmitter fail. The third was available for maintenance. With this arrangement, the standby transmitter could be flashed up in less than 1.5 seconds thus ensuring continuity of transmission.



TRANSMITTERS: Pictured here are two of the three original 2 kilowatt continuous wave transmitters. *(Photo source unknown)*

In the mid 1940's, a completely new Decca Navigator transmitter had been designed which dispensed with the triplicate installation and at the same time gave absolute insurance against failure of transmission. This was known as the Decca Navigator Unit Type Transmitter. One complete transmitter consisted of eight power amplifier units and two drive units working in parallel to provide a transmitter output of 640 watts. Each unit was completely self-contained with its own power supply. Spare power amplifier and drive units were provided on-site so that any one unit could be withdrawn from the transmitter and replaced by a spare without interrupting the main transmission. This "unit principle" made it unnecessary to have complete standby transmitters and improved the efficiency of maintenance.

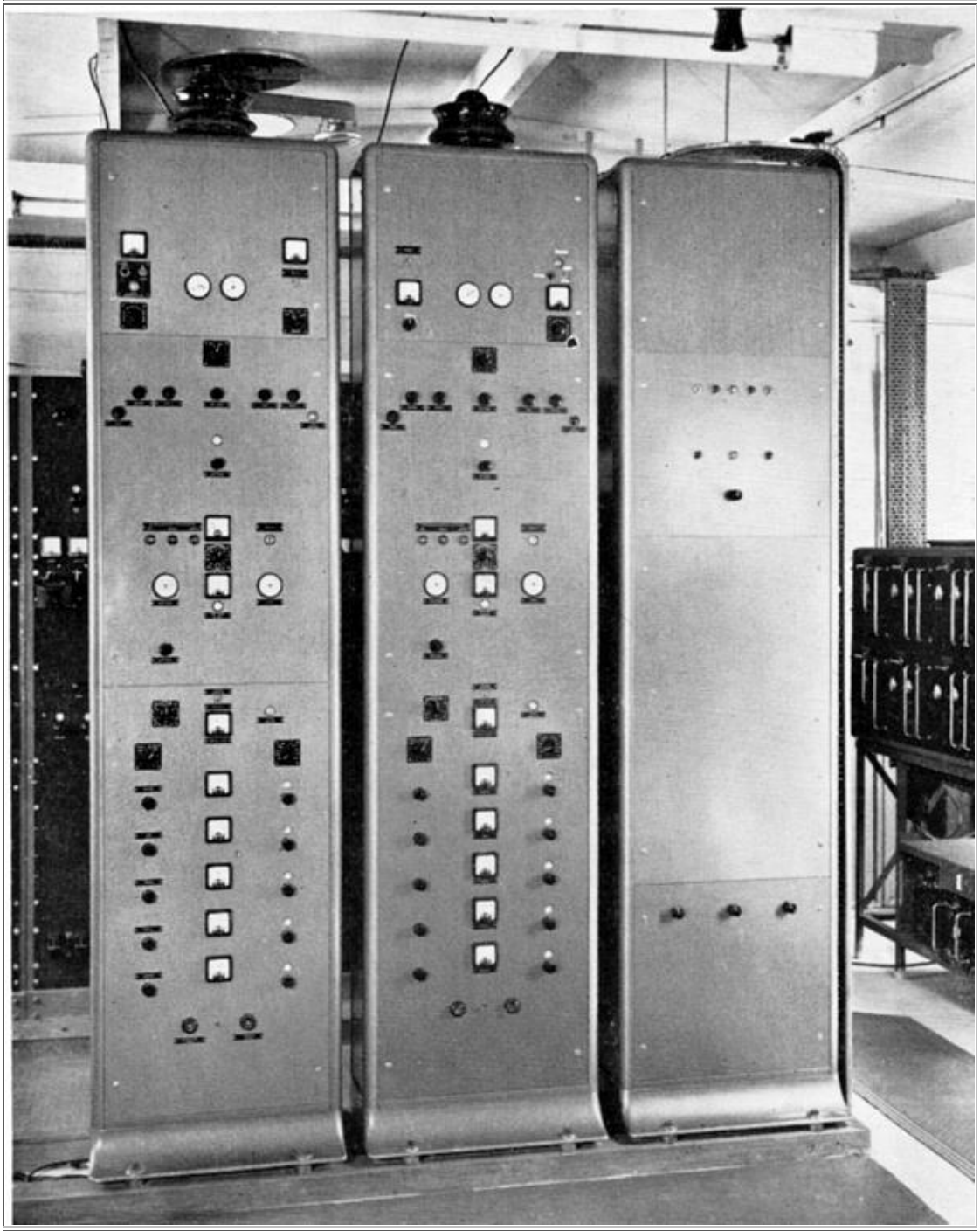
To provide a transmitter power output of 2.5 Kilowatts, a bank of four Unit Type transmitters, each giving 640 watts output, were arranged in parallel. Under typical conditions, the transmitter building was placed some 600 feet from the Aerial Coupling Coil which was housed directly under the aerial mast. On the English Chain, an open wire feeder system was used which consisted of two parallel Litz wires placed 3 inches apart, transposed at intervals and supported on insulators mounted on 10 foot wooden gantries spaced 30 feet apart. Alternatively, it was practical to also use suitable coaxial cable laid along the ground in shallow conduit.



A typical Decca station using 820 series equipment. The monitoring desk is in the centre. *(Photo courtesy Decca Navigator Company)*

Each of the four transmitter racks in a station contains (top to bottom) two drive units in parallel. six power amplifier units, one spare power amplifier and one spare drive unit. Only three out of four racks are shown. Two of these racks provide the normal pattern transmission and two provide Lane Identification (LI). At this Purple slave, two pairs of LI transmitters

are used. The central; rack contains the transmitter tank circuits and changeover switching. *(Photo courtesy Decca Navigator Company)*



Control racks of a Decca station. Though similar in appearance on all stations, they perform a different function at the Master station from that of the Slave stations. At each station the racks are provisioned in triplicate. One serves as the "duty unit" one runs on standby, ready for instant operation while the third is available for maintenance.

A Master Drive Rack contains:

(i) A crystal oscillator of great stability which controls the station frequency.

(ii) Circuits which produce a coded change of this frequency by 60 Hz for 1/25th of a second,

three times per minute to provide the Lane Indemnification triggering signal.

(iii) Circuits which drive all the transmitters.

A Slave Drive Rack contains:

(i) A crystal oscillator forming the source of the slave signal.

(ii) Phase comparison and locking circuits which hold the slave signal at a constant pre-determined phase relationship with the received master signal.

(iii) Filter and relay circuits triggered by the Master which bring up the Lane Identification

transmitters.
(iv) Circuits which drive all the transmitters. (*Photo courtesy Decca Navigator Company)*

SLAVE STATION PHASE CONTROL UNIT

Transmissions from the slave station are phase looked to the master transmission by the action of the Phase Control Unit (PCU). This unit is installed only on the slave stations. Its action is to receive the crystal controlled master transmission, provide a drive for the slave transmitter, and to phase lock the two transmissions by continuous comparison and automatic correction of the slave transmission as necessary.

In the English Chain., the following frequencies were used. Note how the slave frequencies are derived by multiplication and division of the Master frequency.

Master ..... 85.0 Kc/s
Green Slave.....127.5 Kc/s = 85 x 3/2
Red Slave ..... 113.33 Kc/s = 85 x 4/3
Purple Slave ..... 70.83 Kc/s = 85 x 5/6

Each slave station also required a different comparison frequency to be compared with the Master frequency in the phase discriminator. These are as follows:

Green .... 255 Kc/s = 85 x 3 or 127.5 x 2
Red ..... 340 Kc/s = 85 x 4 or 113.33 x 3
Purple ..... 425 Kc/s = 85 x 5 or 70.83 x 6

Associated with the Phase Control Unit on the slave stations was a 30 foot tubular steel mast and aerial for reception of the master signals. (See slave station photo above)

POWER SUPPLIES

The ground station equipment operated from a commercial 230 volt, 50 cycles per second, 3-phase power source which was rated at 11 kilowatts. That included heating and lighting requirements as well. Standby power could be derived from two 5.6 KVA diesel driven generators and one 22.5 KVA petrol-electric unit. One diesel generator was constantly running in readiness for immediate changeover. Diesel fuel was stored in a 600 gallon above-ground tank. Once the new Decca Navigator Unit type transmitter came into service it was possible to feed part of the equipment from the mains supply and part from a diesel driven generator with switching arranged so that one of these two sources of power would take over the full load in the event of failure of the other supply.

820 STATION EQUIPMENT

David Jones, a former Decca employee, describes the 820 station equipment. "The 820 generation of station equipment was probably the most widely deployed of all the Decca transmitters, but was tricky to maintain and when scrapped, had very little value to anybody. This type of station equipment was deployed on chains in the UK, Europe, Canada, Vietnam, Bahamas, North Spain, Persian Gulf, India and Bangladesh just to name a few. The photo set below shows a tank unit, a transmitter unit, a phase control cabinet and a RAMME/RASME rack, all looking as clean as the day they were taken out of service.

All photos in this block by James Morrison. These pristine examples of Decca transmitting equipment are found at the Port Ness Museum, at the top of the Isle of Lewis in the Hebrides Islands, Scotland. It is amazing how this equipment survived since it should have all been upgraded to the last generation of solid state, unattended units during the late 80's or early '90's. Perhaps these racks were donated to the local museum to show the island's strong links with Decca and the local fishing industry. Click to Enlarge

	**820 Equipment.** From Left to Right: * Transmitter tank unit. Matched the output of an individual frequency transmitter to the feed line that went to the antenna coil system. * Transmitter unit. Single frequency 1200 watt transmitter. * Phase Control Cabinet. One of three identical units that provided the phase locked, time synchronized output to the transmitter units. The basic unit was similar at both master and slave stations, the only difference being that the master station unit had a master oscillator as the transmitter frequency standard whereas the slave station units had a 6F receiver which was used to lock their own oscillators. Both versions used a frequency locked clock unit to provide the timing and switching signals needed. The lower part of the rack had the five individual frequency output stages and their respective phase adjustment goniometers. * RAMME/RASME. The main control and supervision unit that allowed the station to run with minimum supervision.
	Shows part of the **RAMME/RASME** front face with the indicator lamps for each PCC (Phase Control Cabinet). The switches are used to select a duty PCC and also perform routine maintenance by taking a PCC out of service. Typically, only one amber light would be on; that of the in-service PCC.
	The lower section of the **PCC** and the adjacent RAMME/RASME. This lower section of the Phase Control Cabinet housed the five individual output stages. The front panels of al these racks could be easily removed with a few screws to reveal the tubes and tuning coils inside. There was no need to remove any of the front adjustment knobs, the panel just lifted off over them.
	**Antenna ammeters** from the coil house. They were placed on the floor of the coil house, just as they are shown, with the phase loop transformer behind them. Normally mounted on a board, they would be situated to the side of the coil trestle, very near the center. The end of the C-coil winding would be passed through the phase loop transformer and then be grounded via the thermal ammeter, seen here on the right. The C-Coil was the main coil connected to the antenna. Hence the two ammeters provided a good indication of antenna current, one read via a DC rectifier, the other by opening the attached knife switch on the thermal ammeter.

TANK UNIT

The tank unit, far left is designed to match the transmitter to the antenna feeder cable. Each tank cabinet houses two tank units, one for each transmitter. Originally, only one cabinet would have a single tank module fitted until the deployment of an 8.2f transmitter made up a full set. The transmitter rack housed six individual amplifiers and two driver units. Each amplifier had six, type 807 PA valves (tubes), fed from a 750 volt DC anode rail. When first tuning up a station, we would remove five of the amplifier modules and by keeping the driver unit just unscrewed past its micro-switch, could switch the amplifier on and off as needed. Later, if no sparks were seen at the coil house, we would add more amplifiers to bring the power up on each band.

PHASE CONTROL

The Phase Control Cabinet was a marvel of relays and RF. At the top of the cabinet was a clock, driven by the rack oscillator which was in turn locked to a 6f receiver channel. The clock was the key to the sequence and it had a rotating arm with a magnet that passed a band of reed relays arranged around its circumference. As the reeds closed, so they activated a main set of relays, all mounted on a hinged panel, behind the clock unit at the top of the rack.

Further down was the 6f receiver unit and its station goniometer. Next came the oscillator unit and then the lower section of the rack was the four (or five) frequency channels, each with their own output goniometers. To tune up an 820 station, we would first stop the clock at the exact station indent when all the transmitters were being driven and the coil house "clanger" relays were energized. Stopping the clock at the exact indent took a bit of practice but with a careful ear, it could be done. After first removing the transmitter drivers, it was now possible to switch each frequency to the antenna coils, using the "clanger" relays in the coil house.

The "clangers" were the name given to the big dual pole relays in the coil house that switched the antenna de-tuning windings in during the quiet period (to prevent re-radiation), and then energized during the identification phase. Their 80 volt return circuit was used to key the transmitter, so by having the rack stopped on the identification and the transmitter on, you could be alone in the coil house and send RF up the stick by plugging each clanger in and out. The relay itself was about six inches square and had a handle on the front that made it ideal for the task. In many strange and foreign lands, this method of tuning was invaluable since a technician would often be working on his own and had little confidence in the local staff or their ability to understand your requests. Since the technician was the one at the "sharp end", there had to be some foolproof way of controlling the RF and this proved ideal.

RAMME/RASME

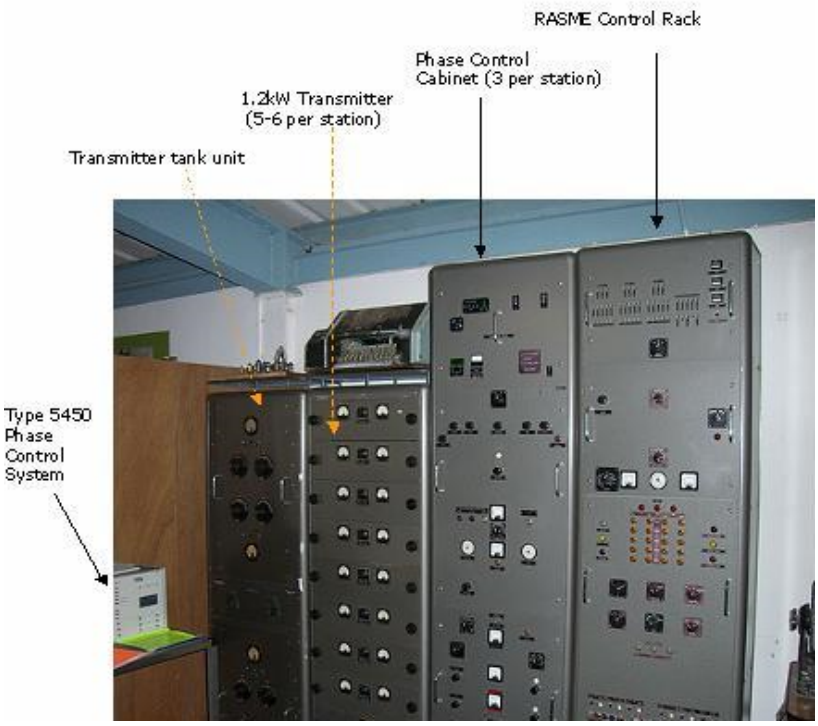
The RAMME/RASME (Remote Automatic Master monitoring Equipment or Slave Monitoring Equipment was a single rack that used a three way vote to decide the operational status. All the rack alarm functions were fed to this unit and by monitoring them it decided if the duty rack should be changed based on a vote. The amber lamps on the front show the status of each PCC rack and from top to bottom they went from "In service, Dubious, Suspect, No-vote and Out of service". Basically, it monitored minor and major alarms to decide on the action to take. Using the RAMME/RASME, any of the three PCC racks could be taken manually out of service for repair. At the top of the rack is a collection of amber alarm lamps that latched on to record system status and had to be manually re-set to clear.

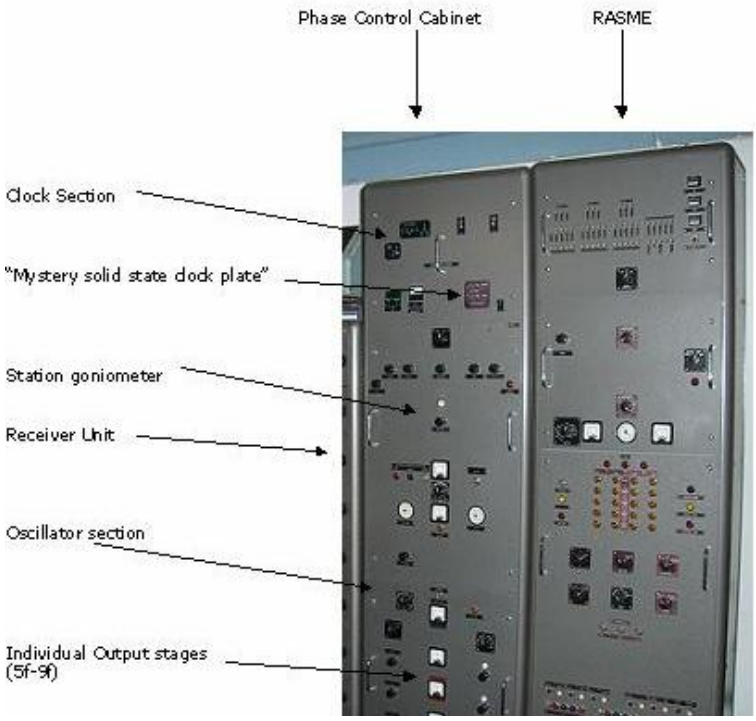
OSCILLATOR (not shown)

As a system upgrade, Decca incorporated a rubidium standard oscillator control unit, which was designed to counter the effect of skywave by having a highly stable frequency standard at each station. Each station used three Hewlett Packard rubidium standards, each mounted inside a controlled temperature cabinet and the whole thing was monitored and switched by the blue colored unit. It is doubtful how much improvement was made by this but it did remove one component of the system error by keeping the station on a locked and stable phase source".

820 EQUIPMENT PHOTOS

Decca 820 Racks – Ness Museum 2006

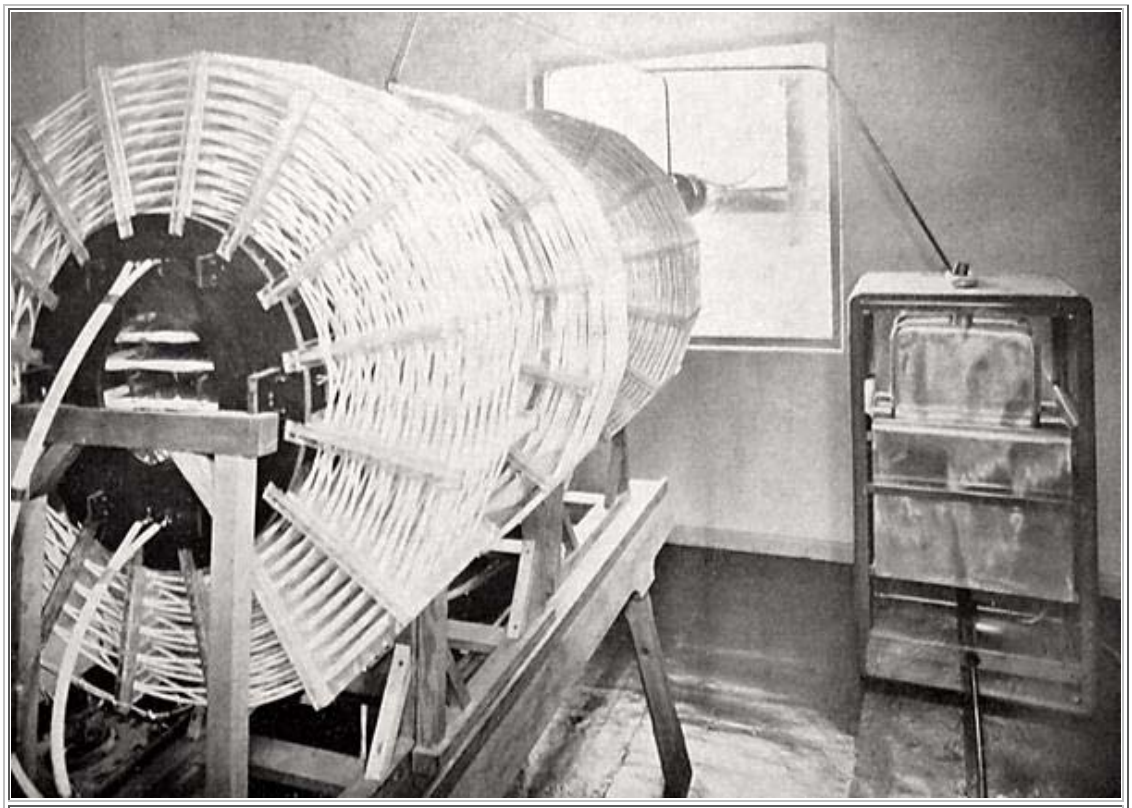




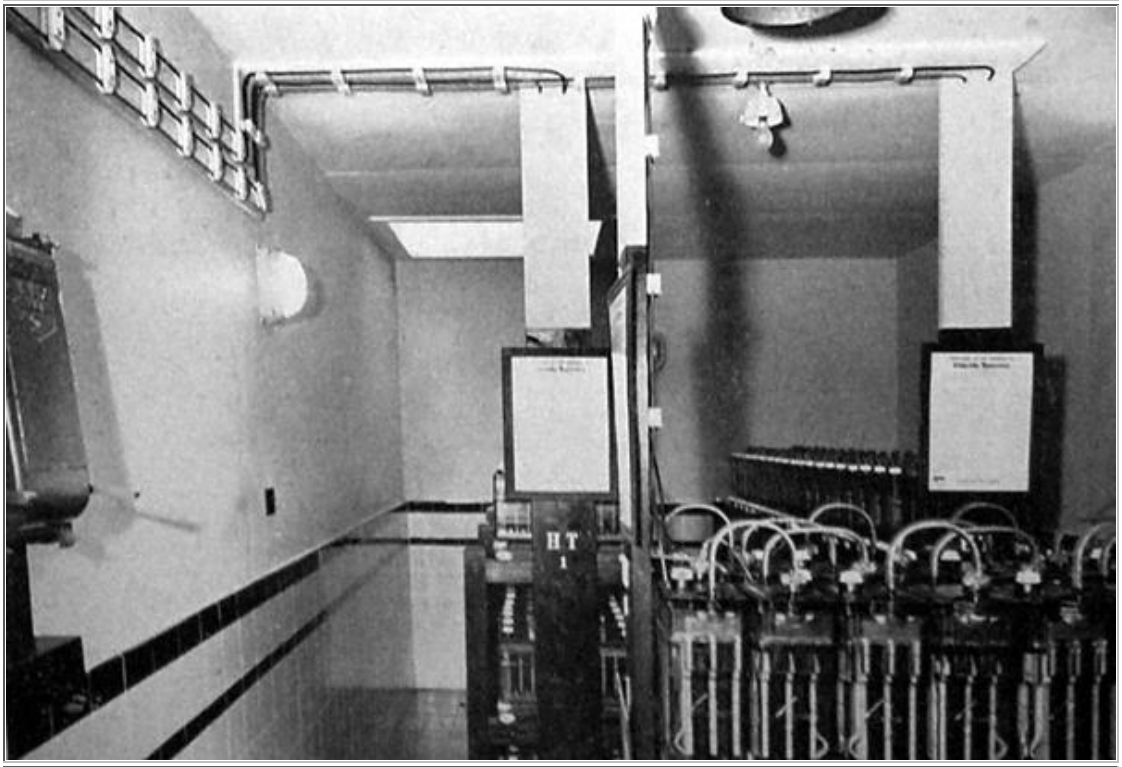
Coil House Ammeters and Phase loop transformer - measure Antenna current and provide a sample phase signal back to the main equipment racks.

Knife switch. When open, the thermal ammeter is in circuit and the current passing through the end of the C coil to ground can be read. The white spiral wrap behind it is the end section of the antenna coil, (C coil) litz wire where it was bonded to the knife switch after passing through the center of the phase loop transformer. From the other side of this switch, the coil was bonded to ground plane. This whole assembly was mounted on a teak board (as this one still is) and was fixed to the floor of the coil house beside the main coil trestle.

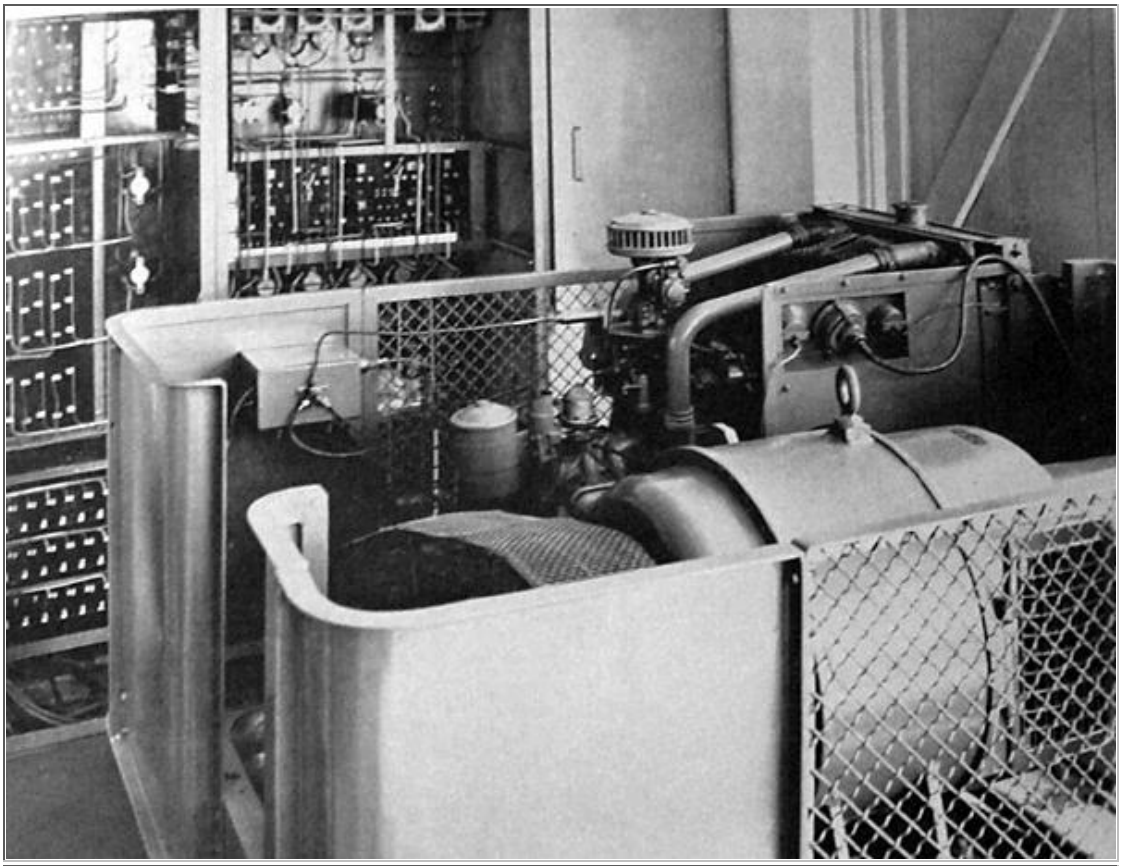
All captioning provided by David Jones. *(All photos in this block by James Morrison)*



Coilhouse: This is the aerial loading coil and the air spaced tuning condenser used in a Mk V purple slave. *(Photo courtesy Decca Navigator Company)*



The emergency batteries could provide sufficient power to operate a station on full load for about 40 minutes. This could be extended to 4 hours by switching off all unessential equipment and reducing the power output of the transmitter. Normally the load would be transferred to the standby generator so the battery bridges the time gap until the generator becomes available. *(Photo courtesy Decca Navigator Company)*



A typical gasoline-driven standby generator which was used in the event of a mains failure. Standby generators were standard equipment on all Decca stations and were rated to supply the full load requirements of the station continuously. In many cases these sets were equipped with an auto starting feature which would bring them into service within 10 seconds of the mains failure. *(Photo courtesy Decca Navigator Company)*

MONITOR STATIONS

The operation of the slave station Phase Control Unit maintained the stability and accuracy of the system by means of automatic phase locking to the master transmitter thus eliminating the need of continuous monitoring as was necessary in other navigational systems. On the English Chain, however, Monitor Stations were set up for research and measuring purposes and to provide constant cross-checking of the operation of the chain in its early stages.

As a general rule of thumb, experience had shown that placing a human at the station often led to more problems since they had a tendency to dabble with the equipment when in reaity, it was best left alone. Most staff were excellent and their dedication was exemplary. A few just got bored and started fiddling.

MODERN TRANSMITTER EQUIPMENT - SOLID STATE

One of the major technical innovations in Decca transmitters was to make them fully automatic and be controlled by remote control. By eliminating manned sites, considerable costs savings could be achieved. Please refer to the block diagram of the last generation Decca transmitter. This diagram was developed by Väinö Lehtoranta, OH2LX. This drawing is based on the following originals:

- Technical Manual 13.1 (Dated Dec.67)
- Technical Manual 13.4 (Chapter 1 - dated Jan.73)

For this specific station site, the tower was a radiator along with two horizontal wires supported by masts on either side, the purpose of which was to increase the capacitance hat. The main mast was 50 meters in height and the spacing to the outer masts was 100 meters. Many sites only used a radiating mast.

The brown arrows from transmitters 6f-9f each had their own connection to the coil system as shown on 5f. It was likely drawn this way for clarity. Feed circuits from each individual matching unit went to all five coils on the trestle.

Marked as a product of Decca Navigator, London, this solid state monitoring receiver was used in master station of chain 7B Samsø Island. Denmark. This equipment has now been been donated to the Museum of Trade and Marine in Castle Kronborg, Elsinore Denmark. *(Photo via Hans Elfelt Bonnesen)*

This is a chain control and monitoring unit from the last generation of chain equipment as evidenced by the LCD decometers in the top and the individual station status lamps in the section below. The last generation equipment was designed to run in full automatic mode with the ability to be accessed from a central location that could issue commands and receive data from the transmitter site.

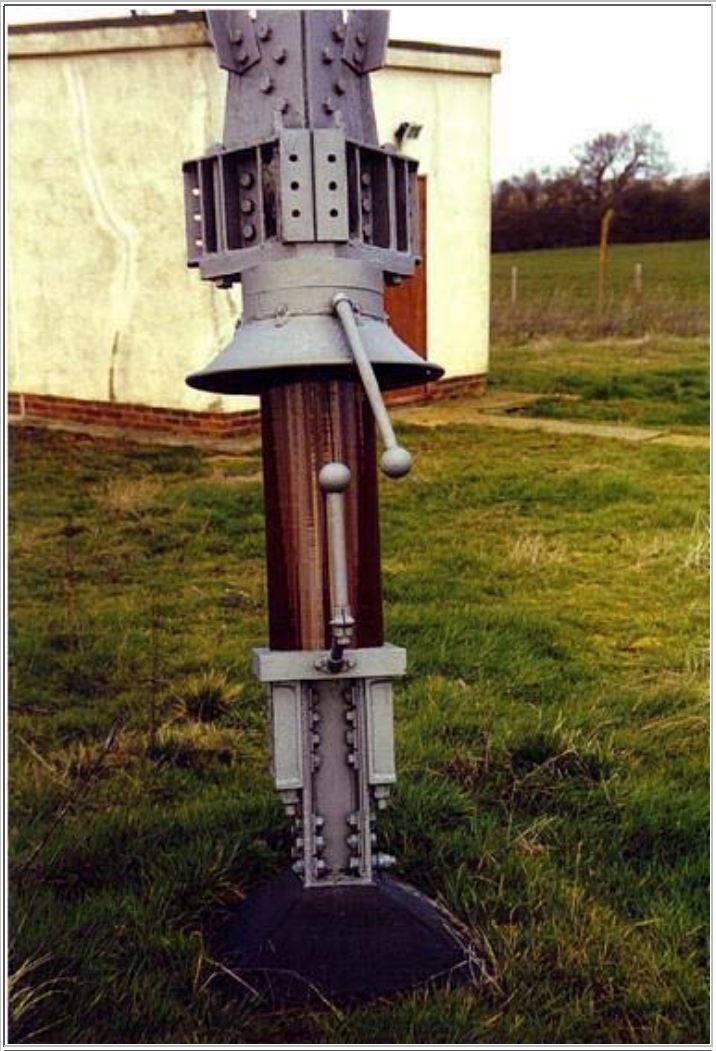
In the lower right hand corner is a an LED decometer panel which is part of a solid state Decca Monitor Receiver. It was of the same type used at the UK Chain monitoring center in Edinburgh. Here, an example sits on the bench in Arthur Watt's lab at New Malden. Some of these receivers were also installed in a back-up control center at the Racal/Decca labs. *(Photo from the collection of Mike Bennett)*

ANTENNAS and TOWERS

Antennas and towers used in Decca chains can be broken down into these types:

PYLON TYPE MAST

This is an example of a pylon tower from the Puckeridge station of the English chain. It is believed that pylon type masts were only used in the English Chain. Click to enlarge. *(Photo via Walter Blanchard)*

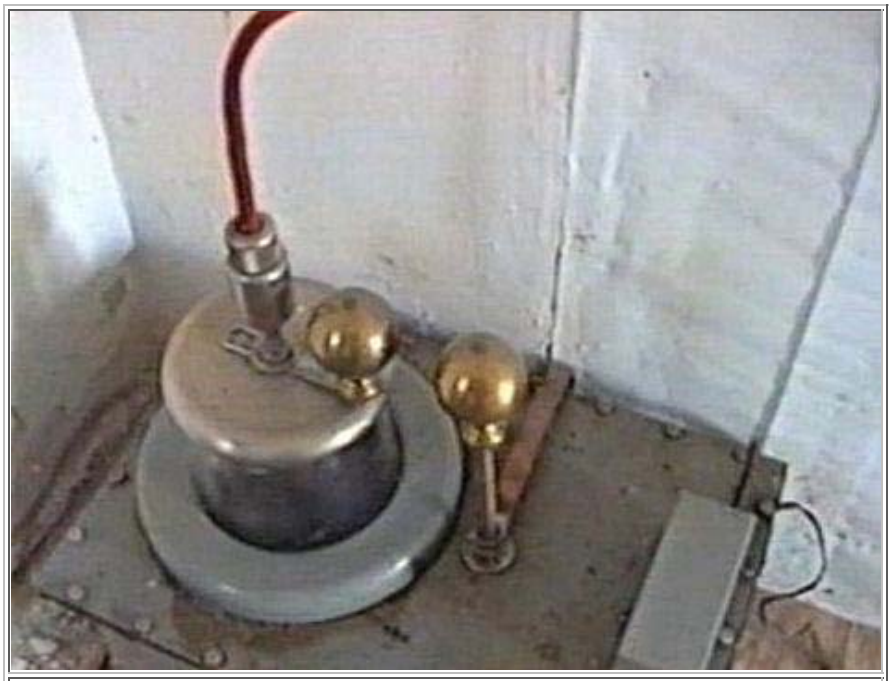


One leg of a pylon type mast showing the insulator and the lightening spark gap arrestor. Decca towers used insulators made exclusively by Austin Insulators. *(From the collection of Walter Blanchard)*

SINGLE TRIANGULAR LATTICE MAST

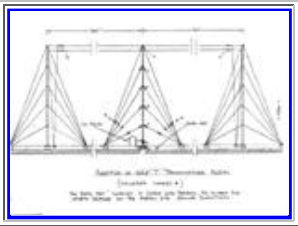
More typical was the single triangular lattice mast, 300 ft tall, resting on a single insulator and set on a raised concrete block. This example is from the 4C chain.
The mast would be supported by two or three sets of guys, each one made up of insulated sections of steel cables. The mast base insulator would have a spark gap fitted and often a second spark gap just inside the coil-house window, directly below the feed-through. In general, the maintenance and performance characteristics of the single 300 ft lattice made it the de-facto standard. *(Photo from video by Santiago Insua)*

Here is variation of the center supported tower at the Master station of the Spanish chain 4C at San Xoan de Rio. *(Photo from video by Santiago Insua)*



Coil house spark gap lighting arrestor. *(Photo from video by Santiago Insua)*

SINGLE WIRE 'Tee' ANTENNA



Other mast systems deployed were single wire 'Tee' antennas around 150 feet tall. Click to enlarge. *(Image courtesy Decca Navigator Company from the collection of Walter Blanchard)*

TUBULAR MAST

This tubular mast was used at the 4C Purple station at Vitgudiono Spain. *(Photo from video by Santiago Insua)*

One example of a guy wire insulator. *(Photo from video by Santiago Insua)*

TUNING THE STATION

David Jones has complied a document that details the steps and procedures for tuning a Decca station and getting it on the air. These are based on his recollections from performing this task at several sites during during his time with the company. It may shed some light on the mystery that used to surround

this secret process. For an outside observer, the process seemed to be tedious and boring since there was very little to see, just a continuous sequence of measurements and minor adjustments. The procedure is documented here.

Additional References and Credits:

1) Austin Insulators http://www.austin-insulators.com/profile/index.html
2) James Morrison http://www.flickr.com/photos/jamesm/107572653/in/set-72057594120797676/
3) Santiago Insua <hwasp(at)hotmail.com>
4) D. Jones <dsjjones(at)bellsouth.net>
5) Walter Blanchard <wblanch(at)ntlworld.com>
6) Hans Elfelt Bonnesen <hans.elfelt(at)me.com>

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DECCA SURVEY CHAINS

This document is intended to list Decca Survey chains and other products which were part of the Decca Navigator suite.

1.1 SURVEY CHAINS - SYSTEM OVERVIEW

Survey chains were either engineered and installed by Ian Thompson of Decca's Survey Department or Tom Moore of the Chain Implementation Department (CID). In the early days there was always considerable competition between CID and the Overseas Projects Department (OPD) as to who was going to do what in building new Chains.

Under Ian Thompson, the SURVEY division eventually grew totally independent and became a separate entity and distinct from Decca Navigator. Other temporary or evaluation chains were installed by the (OPD) whose head was Cecil Hamilton. There were all sorts of chains run by Decca Survey for oil exploration and numerous other activities but they were special usage and the charts would only have been issued to the specific customer and Survey's own people.

Later, Decca Survey also ran Loran C chains , Lambda chains, Pulse 8 (similar to Loran C and there were several of these chains around the North Sea), Long Range Shoran , Hi-Fix 6, Hi-Fix, Sea-Fix, Trisponder and Aqua-Fix. These were located all around the world. Some lasted for years and others for only a few months.

Survey Chains used three ground stations which radiated frequencies of 88.516 kHz (Master), 118.0213 kHz (Red) and 132.774 kHz (Green). At the surveying receiver, these frequencies were multiplied by factors of 2, 3, and 4 without changing the phase values. In this way, two so-called comparison frequencies of 354.064 and 265.548 kHz were formed to correspond to to the Red and the Green hyperbolic patterns respectively.

In other words: If f = 14.1129 to 14.1500 kHz.

Master = 6f
Red = 8f
Green = 9f

18f =265.548 kHz
24f= 354.064 kHz

Survey equipment was known as two range Decca because it only had two slaves.
Possible equipment name of 793 series.

Walter Blanchard offers some additonal information on Survey Chains. Lambda was an early (1950's) Survey system carried mainly on board Naval Survey vesels operating in remote areas who needed to set up a Decca-like positioning aid quickly. The vessel carried a Master station transmitting a master signal that was re-transmitted by two slave stations the ship had set up on-shore. The vessel could then move about continuously measuring its range to the two slaves and thus obtaining position. Obviously it could only be used by that one vessel. It had a range of about 200 km and an accuracy of 10m. This was the "two-range" mode. By a re-arrangement of frequencies and triggering it could also operate in a hyperbolic mode which had the advantage of being usable by several vessels if the Master vessel anchored and wanted to send out smaller survey launches".

1.2 LOCATIONS OF SOME SURVEY OR DEMO CHAINS

Canada - In 1968, a Great Lakes survey chain was proposed and possibly installed but no other info is available at this time.

Canadians also applied Decca Survery in many ways but perhaps the most challenging was trying to establish the position of the Polar Shelf in the Arctic. Link to photos and story.

Dutch New Guinea - Use of the Decca navigator survey system in New Guinea for hydrography and as a geodetic framework[2] Link to map and story.

Greenland - An order for a Greenland survey chain was placed in 1946 and it was shipped in 1947.

Europe and Africa - Morocco, Tunisia, France - mine sweeping chains in the 1950's.

Italy

LOCATION	DESIGNATION	FREQ	COORDINATES
?	Master	?	?
?	Red	?	?
Sabaudia, Italy	Green	?	41.3000N, 13.0167E
?	Purple	?	?

Nigeria - Initially, Nigeria used Survey chains. Under the auspices of David Parker, Decca Navigator was proposed for Nigeria to replace Survey. Four Navigator chains were proposed. Only two were built but they were closed down before seeing commercial service.

Persian Gulf - The main organizer for Decca Survey was the Persian Gulf Lighting Service (PGLS) and Capt Webb. The first oil survey chain for Caltex was established in 1949. A rent-a-chain business started with Shell in 1952.

Spain - 1957. Between Menorca and The Costa Brava a pipeline survey chain was installed for Gaz de France by Cte Jacques Cousteau with his vessel Calypso.

The "Broken Arrow" incident in Palomares Spain saw the use of Decca Hi Fix to obtain grid square fixes in the search for a hydrogen bomb on the sea floor off Spain after a mid-air collision between a B52- bomber and a KC-135 tanker. The are numerous stories about this incident on the web but the 40th anniversary story which appeared in the September 2006 issue of FACEPLATE page 15, is a good one.

Sweden - The first Swedish 'portable' Decca chain was erected in 1947 in the Southern Baltic area with stations at Skedshult (Master), Fåsbo (Red), Tystberga (Green). Transmit power was 600 watts per station. The chain was then moved to Gävlebukten in fall 1951[1]. It also operated in Southern Bothnia 1956-1959, and in Northern Bothnia 1959-1962 when it was dismantled.

The Gävlebukten chain was used by a Finnish survey team led by Simo H. Laurila during 1951-1953. Team was using a steamship 'Nautilus' rented from the UK to conduct the survey. Later, Vaino Lehtoranta, OH2LX helped Laurila to finish his doctoral thesis in 1953-54, soon after he left to Ohio State University, then to Hawaii University. He wrote a

well known book, "Electronic Surveying and Mapping", Ohio University Press, Columbus, 1960.

1.3 RESTRICTED-USER CHAINS

* North Sea oil: Sea Shell, Sea Search etc.
* Gulf of Mexico: Mk V chain for use for oil companies.
* Vietnam - a special Decca chain was built for the US government.
* Europe: a special chain operated exclusively for the RAF. (See 1.4.2)
* Christmas Island: Britain's first hydrogen bomb tests. Used mainly by the RAF.

1.4 OTHER

1.4.1 The Decca Data Link

* Used by the Decca Ambassador aircraft flying along the Berlin corridor using the plot from the Data Link equipment installed at Tempelhof airport

1.4.2 R.A.F.'s Secret German Chain

John Molloy-Vickers recalls the secret German chain built for the RAF:.

"There was another UK Ministry of Defense chain installed in Germany in the early 1960's. Initially they were secret but they were given RAF station names on boards outside the front gate, thus overriding any prevailing secrecy. It was also difficult not to notice a 300 foot and a 150 foot mast in a field. Two of the stations were located near Zeven Germany and Glandorf/Bad Iburg.

I recall we shipped the equipment as quietly as possible but it was delivered to site in RAF trucks. The idea was interesting as they were to be fired up in the event of a major conflict with the Russians. There were double towers at each site with two signals and the intent was that one would cloak the other so nobody could jam the main signal. It was hoped it would last long enough to get the Vulcan nuclear bombers (equipped with special receivers) on their right course".

One ex-Vulcan navigator said that in the event of a nuclear war, he had planned a one-way trip to Moscow, arming the bomb en-route and heading back to somewhere in Africa on the understanding that Europe would then be in ashes.

Dennis Ruffles relates his experiences while serving with the RAF. " I was posted as a ground wireless mechanic in Germany in late 1961. Here I worked on the Tactical DECCA chain as it was being set for operation around 1962 and stayed with the chain in Germany for 3 years. The chain was considered "tactical" because the equipment was shipped in air transportable containers, although the containers were effectively "grounded" once a site was installed. This chain used the lower frequencies and not the higher frequencies as quoted in par. 1.1 above for Survey Chains.

The Master site was located at Glandorf with the slaves at Jever in the north (about 60 km ENE of the civilian site at Zeven) and at Dannenrod in the south. Each site had two towers; the main tower being 300 feet tall with a 150 foot standby tower. Each tower had its own modular transmitter. If I remember correctly, the main transmitter had a maximum power of 3.6 Kw but we ran them at only a fraction of this power.

When we started operation, the sites were active and transmitting continuously until the chain was shut down in the early 1970s. We did not use any "cloaking" transmissions to prevent

jamming. Protection from jamming was achieved in the following ways:

1) We made every effort to transmit a very pure and stable sine wave to reduce the bandwidth to the minimum. To this end, we even ran our power amplifiers in Class B mode to avoid noise on the signal. This was expected to make it extremely difficult to jam.

2. By using a very narrow bandwidth, a jamming signal sweeping the frequency band would only interfere for short periods. Since the receivers would "flywheel" in such cases, it was difficult to disrupt the system.

3. Transmission from all sites was continuous with no lane identification signals.

4. The system was arranged so that we could change the frequencies of the chain in a matter of seconds in the event of an operational frequency being jammed. I think we had 3 or 5 frequency sets to chose from.

From an administrative standpoint, we came under No.140 Signals Unit based in Iburg. This unit had been running the North German GEE Chain since it's inception. We were a slightly "odd ball" part of this unit as they were all radar personnel and we were wireless bods. For me, this was a plum posting, being billeted in a small hotel in a village in the American zone for 3 years".

THE DEBUT OF THE MICROPROCESSOR IN RADIONAVIGATION

Sid Jones, who worked for Decca, explains some of the developments which occurred in the area of microprocessor applications in radionavigation receivers.

"As part of my post-graduate studies at Bangor University in North Wales. I built a microprocessor controlled Decca Navigator receiver. My supervisor was Doctor (now Professor) David Last, who had a good relationship with the Decca Survey Company. After I graduated in Electronic Engineering in 1974, I was offered the chance to study the applications of microprocessors in radionavigation systems.

We used an Intel 4040 microprocessor chip (all of 4 bits and 3 MHz!) and produced a one-off receiver that used crystals to select various chains. That explains the selector knob and the placard atop the case indicating various chains and the values the synthesizer needed to order to generate the range of frequencies for each chain.

The software detected the patterns of breaks in the signals to trigger and meshed the pattern data to get zone and lane identification. Because the zones had a built in ambiguity we used a 'flip' switch on the front to toggle the zone setting. The display cycles round the red green and blue patterns and streamed data output via a 20 ma serial interface.

This was tested successfully at sea and on land and was demonstrated to a well known company in South London in 1976 who thought it was novel, but had no further interest in it. As Decca Survey had sponsored my postgraduate studies, I joined them in 1977 and was part of the team that developed a microprocessor based HiFix/6 receiver which was a fraction of the size, power and weight of the original. But, of course, that is an entirely different story! "

1975: A prototype of a microprocessor controlled Decca Navigator receiver designed by Sid Jones. *(Photo by Sid Jones)*

FOOTNOTES:

1. Iggö (M), Hornslandet (R), Gräsö (G).
2. Verstelle, J, Th. . Report, GA, IUGG, Toronto, 1957.

Credits and References:

1) Vaino K. Lehtoranta, OH2LX. E-mail: <vaiski(at)dlc.fi> provided the initial information on Decca Survey.
2) Brian Kenny provided information about Italy and Dutch New Guinea. E-mail: Brian.Kenny1(at)btopenworld.com
3) Dennis Ruffles <dvrv1(at)tiscali.co.uk>
4) Sid Jones <jonesthechip(at)logicmagic.co.uk>
5) Walter Blanchard <wblanch(at)ntlworld.com>

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