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Aerials- Masts and General Nerdy Stuff.

RAF Communications Towers and Masts 1940s to 1970s.

Most of the towers and masts used by the RAF were erected by the Works Services department of the Ministry of Works (1943 to 1962) or Ministry of Public Buildings and Works (1962 to 1970) or by civilian contractors on their behalf. These include the standard 88 ft. and 118 ft. guyed metal poles and the standard 70 ft., 90ft. and 120 ft. self-supporting wooden lattice towers. The Works Services (MPBW) was responsible for the erection, maintenance and dismantling of these types of aerial support.

In addition to these Works Services towers and masts the following types of mast were the most commonly used ones and were erected, maintained and dismantled by aerial erectors. The mast Type 23 was a 78 ft. guyed metal mast consisting of three cigar-shaped sections. The mast Type 32 was a 105 ft. guyed wooden lattice mast. The mast Type 34 was a 52 ft. guyed metal mast similar to the mast Type 23 except it consisting of two cigar-shaped sections and the mast Type 35A which was a 97 ft. guyed metal mast consisting of three cigar-shaped sections. There were also a number of much smaller guyed and free standing masts used by mobile radio and radar units to support aerial arrays.

In the 1960s several projects were undertaken using 100 ft. lattice steel towers such as the construction of a aerial farm at the Joint Services Headquarters at RAF Episkopi in Cyprus. The steel towers were erected by the Royal Engineers and the aerial arrays and feeder systems were installed by a joint fitting party consisting of Royal Signals aerial erectors from Blandford and aerial erectors from the RAF's Radio Engineering Unit.

Several aerial farms using lattice steel towers were also constructed overseas by civilian contractors, such as the aerial farm, seen below, which was built in the sea at RAF Muharraq in Bahrain.



Mast Type 23 and Mast Type 34.

The mast Type 23 had three 26 ft. cigar-shaped members coupled together end to end by special joints giving a height of 78 ft. The mast Type 34 had two 26 ft. cigar-shaped members coupled together in the same manner giving a height of 52 ft. Each cigar is comprised of tapering tubular sections which are joined together by fitting one into the other, the resulting joint being rigid, due to the tapering fit.

Both types of mast were mounted on a steel base plate. Both types of mast were held upright by flexible steel wire rope guys, 4 upper, 4 middle and 4 lower guys for a mast type 23 and 4 upper and 4 lower guys for a type 34 mast. The guy ropes were anchored to "T" shaped pickets driven into the ground 27 ft. 6ins. from the base plate. In loose or sandy soils the pickets were often concreted into the ground. The guy ropes were adjusted by means of a pair of Astral nuts.

The crown coupling of the mast was fitted with a swivel hooked plate to which a backstay and a halyard pulley block could be fitted. Another variation of the crown coupling had a special welded plate in place of the swivel hook to which a spreader for a Type 412 VHF aerial system could be bolted.

The derrick for raising the mast consisted of one cigar-shaped member identical with those used in the mast and was fitted to the base plate by a trunnion bridge.

The total ground space required to erect a mast Type 23 was 120 ft X 60 ft. and 90 ft. x 60 ft. for a mast Type 34. A team of six aerial erectors was required to erect a mast.



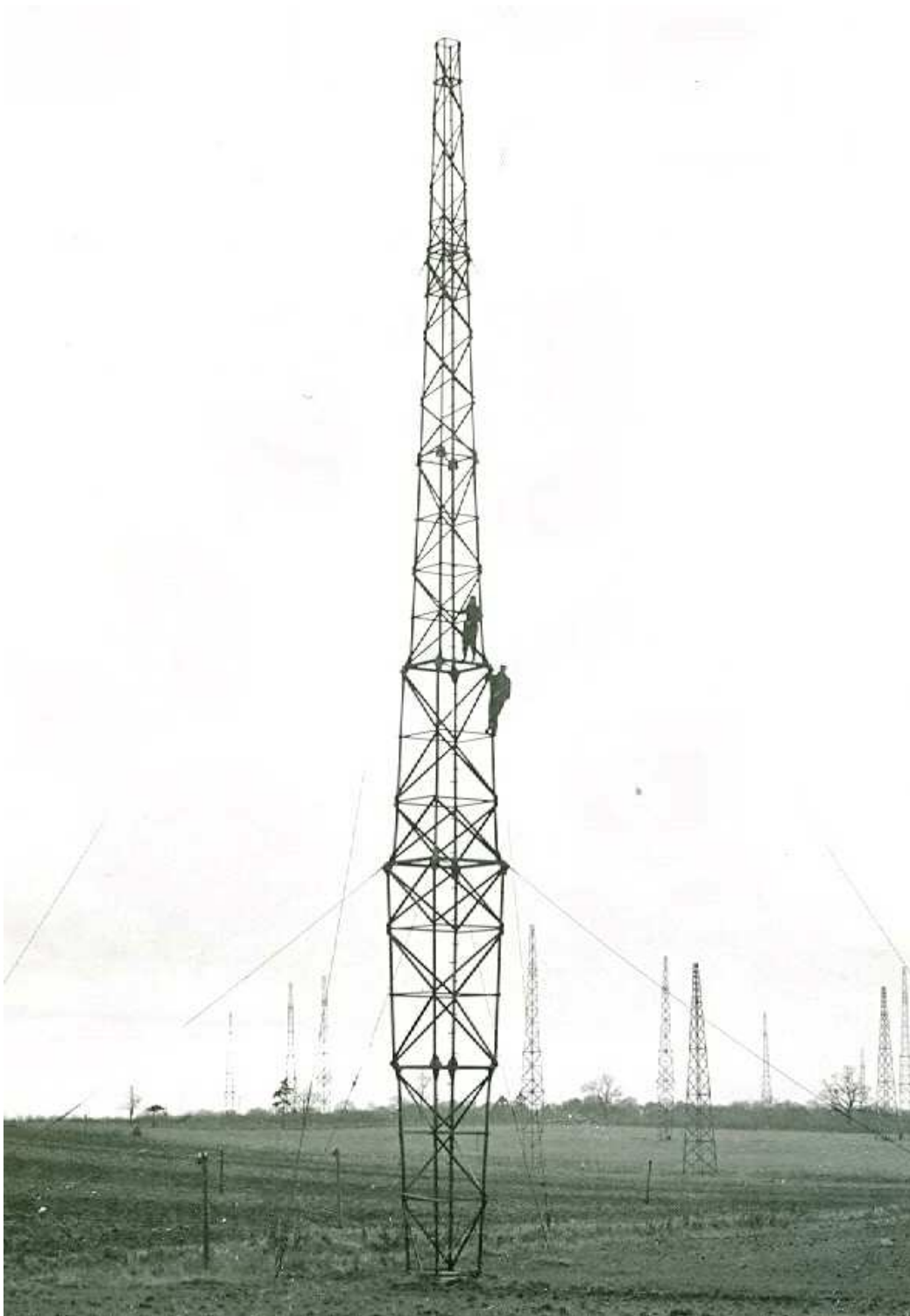
There are four mast Type 34s to be seen in the old photograph above taken in 1963 at RAF Riyan near Mukalla in the Hadhramaut (now a part of South Yemen). The mast on the far left and the one on the far right are supporting a triatic which has several 1/4 wave vertical aerials suspended from it. There two more mast Type 34s in the centre of the picture which are both supporting spreaders. The left hand mast has one UHF Type 41 aerial at the right hand end of the spreader and two Type 41s at the other end, one of which is mounted upside down. The other mast has a Type 24 VHF aerial at each end. There are also two shorter wooden poles near to the control tower, one is supporting a wind speed gauge and the other a wind sock.

Mast Type 32.

The mast type 32 was a wooden lattice, sectional 105ft guyed mast originally manufactured during the 2nd World War for use by mobile radio and radar units in the United Kingdom and overseas.

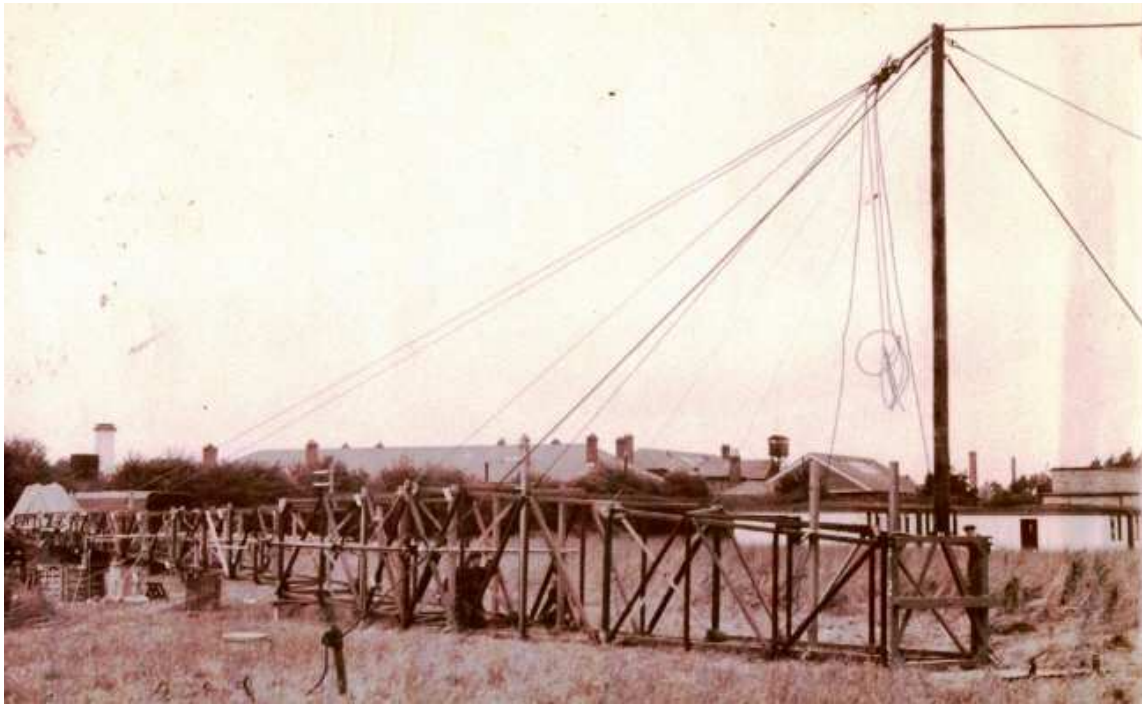
The mast comprised of six short sections which could be fitted one inside another for transportation on special four-wheeled trailers. Each trailer had a winch fitted at one end and it was used to raise and lower the mast once it was removed from the trailer and assembled. The mast trailers were usually towed by the radio or radar vehicles when moving from one site to another site. Being made mostly of wood they were light in weight and were relatively easy to repair.

After the war many were used on permanent sites and over time were replaced by steel masts.



Several type 32 masts can be seen above in the aerial farm photograph (thought to be Chicksands) taken in the 1950s. The two riggers are working on the nearest mast and the six sections of the mast are clearly visible.

In 1957 one (nicknamed "Snow White" for some obscure reason) was still in use at RAF Gangodawila in Ceylon and was destroyed when the camp closed down (see the places page). Several were still in use at RAF Chicksands, an out-station of the RAF Signals Centre at Stanbridge, about the same time. There was also one at the Aerial Erector School, RAF Chigwell in 1956 and it was lowered and dismantled and transported on its trailer to RAF Norton when the Aerial Erector School moved there in October 1956. It remained there, still loaded on its trailer, parked on the aerial farm until the school moved to RAF Digby in September 1959. The trailer was serviced and fitted with new tyres for the move to Digby and was again parked on the aerial farm. It is thought that the mast sections were later found to be rotten and beyond economical repair. As it was no longer required as a training aid and the masts were being phased out of service, the whole thing was scrapped.



A Mast Type 32 fitted with a set of GEE Aerials about to be raised at the Radio Engineering Unit, RAF Henlow.

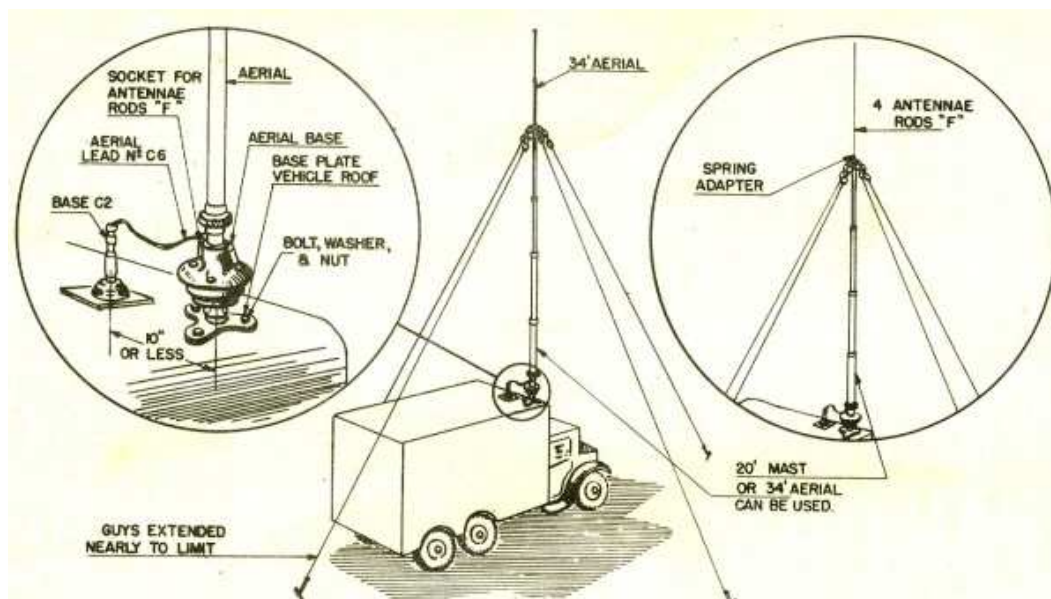
The mast type 32 seen above was one of several which were refurbished at the Radio Engineering Unit at RAF Henlow and were used for a series of experiments using the GEE navigation systems carried out by the boffins from 90 Group HQ in the early 1950s.

No example of a Mast Type 32 is now known to exist.

Aerial / Mast Vertical 20ft and 34ft Steel.

This aerial/mast was designed and manufactured in Canada for the Canadian Department of National Defence in 1943 for use in the field. Large numbers of the kits were used by the British Army and the Royal Air Force by mobile radio and radar units.

The Aerial Kit consisted of two telescopic masts which could be used as vertical aerials or as masts to support a horizontal aerial. The kit came in a large canvas carrying bag with all the necessary parts, one 34ft mast, one 20ft mast, aerial base, vehicle roof mounting base plate, vehicle mounting brackets (with hardware), ground spikes, guys, aerial rods and hammers. The 34ft mast had 6 telescopic steel tubular sections and the 20ft mast 4 telescopic sections, the extended sections were locked into place with a locking collar. When erecting the mast the sections were extended and locked one by one starting with the smallest section.



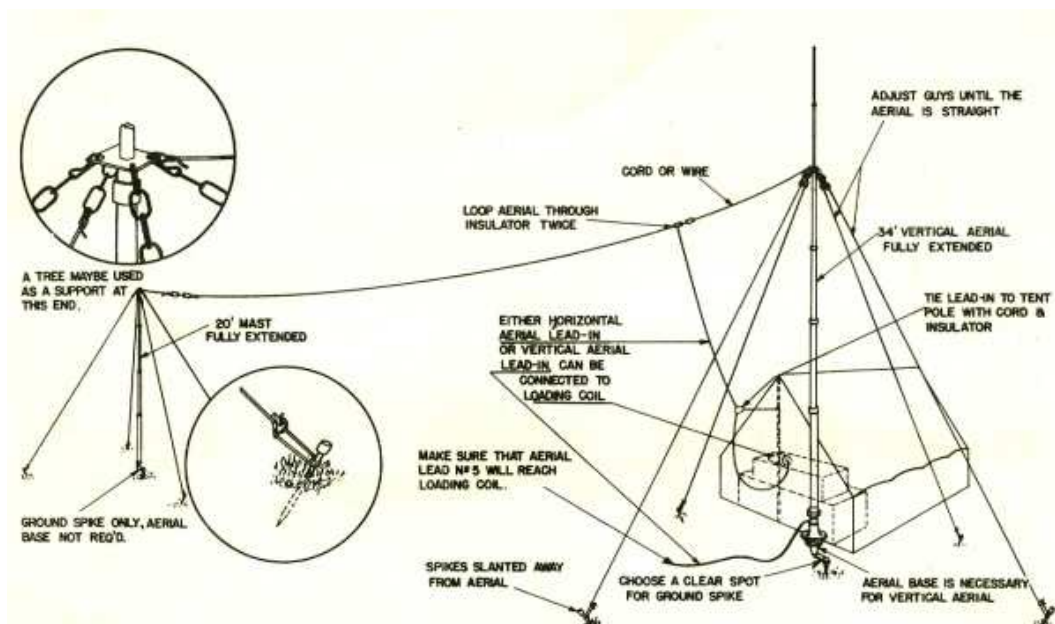
Vertical Aerial mounted on vehicle roof.

Vertical Aerial on a Vehicle. The normal use of the 34ft vertical aerial was on a vehicle roof using the vehicle roof base plate. The aerial had to be guyed.

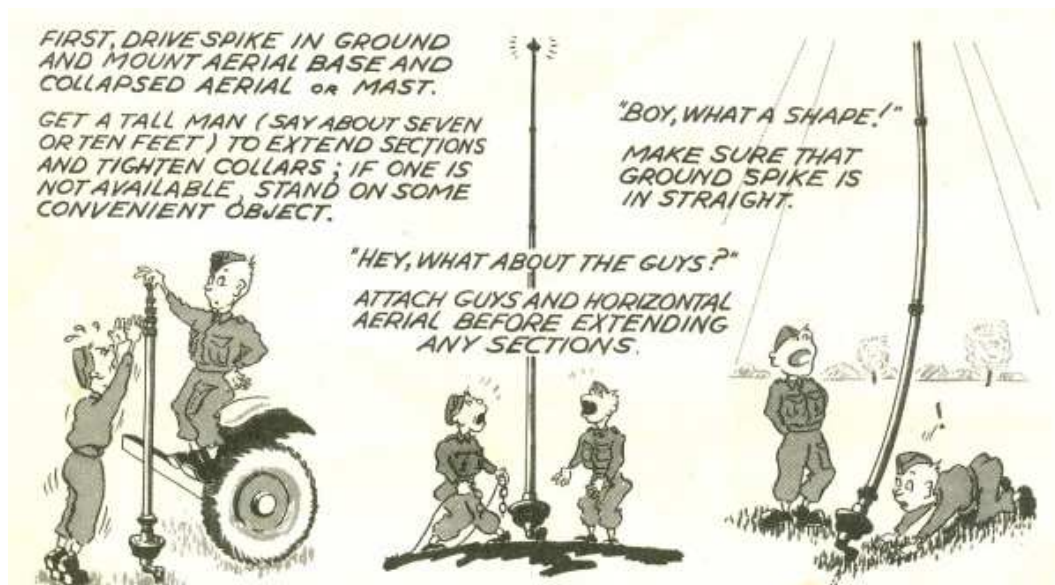


Erecting a vertical aerial on roof of a vehicle.

The Vertical Aerials could be used for a ground station by mounting the mast on a ground spike. The 20ft vertical mast could also be used as a vertical aerial by inserting 4 aerial rods (type F) in the spring adaptor at the top, thereby forming a 36ft aerial. It could be erected on the vehicle roof or on the ground. The 20ft aerial could also be used as a vertical aerial but the advantage over a normal vehicle whip aerial was small.

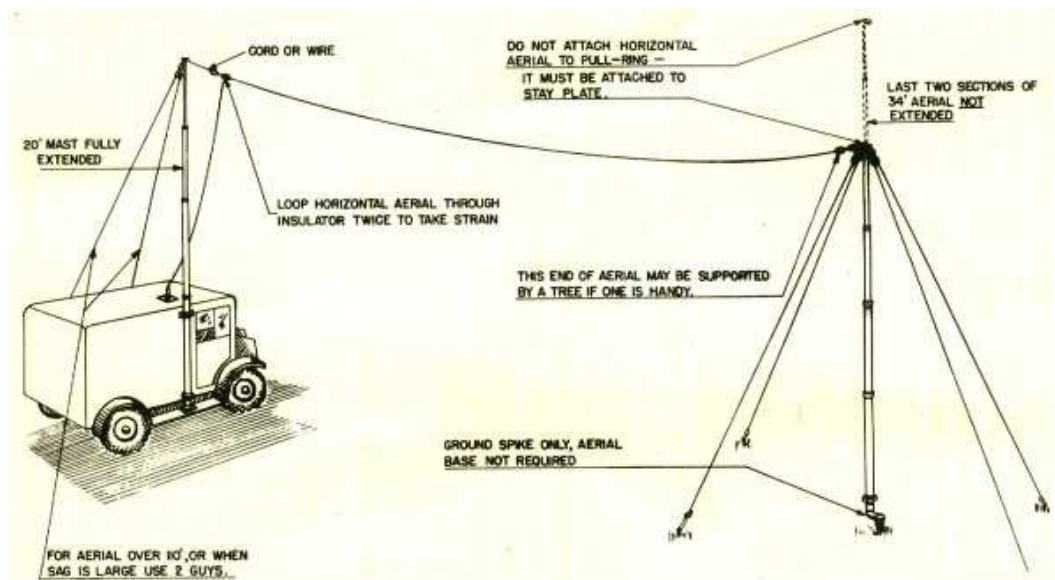


Horizontal and Vertical Aerial installation for Ground Station.



Erecting aerial or mast on the ground.

Horizontal Aerial. Both the 34ft and 20ft vertical aerals could be used for supporting a horizontal aerial. The horizontal aerial was insulated from the vertical aerial mast.



Horizontal Aerial installation for a Vehicle Station.

The use of these excellent small lightweight Aerial/Masts in the Royal Air Force continued right through the 1950s and well into the 1960s.

Lorry Mounted "Wulfel" 110ft Aerial Mast.

This type of mobile radio relay aerial mast was inherited from the German Armed Forces and was in use by the 2nd Tactical Air Force in the Europe in the 1950s. These mobile masts were a part of the German "Pintch" radio relay system and the whole system was adopted by the RAF. Ground Wireless fitters and mechanics were re-trained to maintain and operate this system at RAF Sundern in Germany. These fitters and mechanics were also given training on the operation of the masts and assisted the aerial erectors when raising the masts. The system usually operated over a point to point distance of approximately 40 miles between units. The 3 sectioned 110ft mast was fitted onto a Mercedes lorry chassis and was raised hydraulically. The mast and vehicle weighed about 30 tons. The mast was lowered and folded in two on the back of the lorry when being moved from one location to another location.

Once the lorry was parked in the required position the six stabilizing jacks were lowered on to the ground. Three guy anchorage boxes were then placed into position, filled with sand bags and the guy winches mounted on top of the boxes. The triangular base plate was lowered down from the rear of the lorry ready for the base of the mast to be located onto it. The the two aerial arrays with their stablizer plates and three guy ropes attached to the mast

head. The mast was then hydraulically raised and the release of the guy ropes was controlled using the three winches.

Once the mast was fully erected the aerials were connected to a radio vehicle by co-axial cables. The aerials could be rotated and tilted up and down to get the best possible signal by electric motors. A mobile generator provided the electrical power for the unit.



In the photograph above the mast can be seen folded up on the lorry ready to move off. The triangular base plate is hanging from the rear end of the lorry and the hydraulic ram used to raise the mast into the vertical position is in the centre of the lorry. A row of spades used to fill the sand bags or level up the ground, jerry cans to carry extra fuel and the drums of co-axial cable can also be seen.

Aerial Rigger John Holmes is leaning on the lorry beside one of the stabilizing jack base plates of the lorry at the Radio Relay Unit, RAF Wahn near Cologne.



In the photograph above, taken during a field training exercise somewhere in West Germany, the mast is fully assembled ready to be raised to the vertical position and be located onto the base plate. Once the mast is in place on the base plate it is then hydraulically raised to its full height of 110ft. The two co-axial cable drums are also in position on the rear of the lorry ready to release the cables as the mast rises.

Ex Aerial Erector John Holmes kindly gave his permission to use these photographs taken in 1957. Much useful information about the "Pintch" system was provided by Ex-Ground Wireless mechanic Fred Flight.

Klockner 30/40ft Mast.



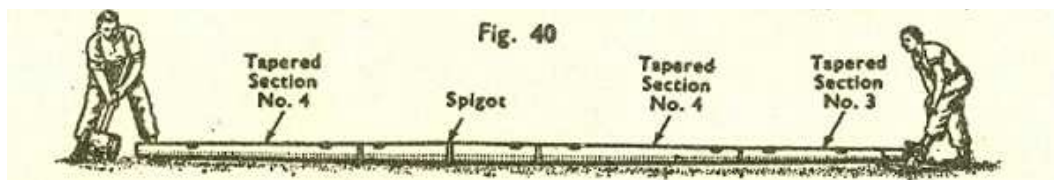
A small 30ft-40ft telescopic mast inherited from the German Army, raised by a series of wires and pulleys. In the photograph above aerial erector Pete Burgess is fitting the upper guy ropes into place on the top of the mast prior to a successful erection. The photograph was taken during Exercise Schnell Zug in the Eiffel forest about 3 hours drive from the Rheindahlen HQ in the summer of 1969.

Mast Type 35A.

In the mid-50s the mast was one of several types of mast adopted by the RAF for use when building some of the temporary HF transmitter and receiver facilities overseas which were required during the relocation of RAF bases caused by the rundown of the British Empire.

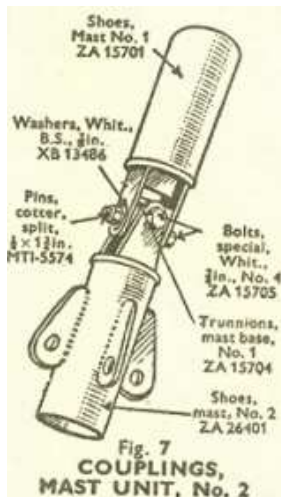
The mast was originally designed and manufactured for use by the Royal Signals in the 1940s and could be assembled to give three different heights, 92ft, 97ft and 102ft. The 97ft variation of the mast was the model used by the RAF and was renamed "Mast Type 35A".

The mast was comprised of three main cigar-shaped members, coupled to each other by means of a universal joint and was held upright by guyed wires. Each cigar was comprised of four tapering tubular sections plus a central tubular section (Spigot) which was tapered at both ends. The sections were fitted one into the other to form the cigar, the resulting joints were held rigid due to the tapered fit. Different sized spigots were used to achieve the various mast heights.

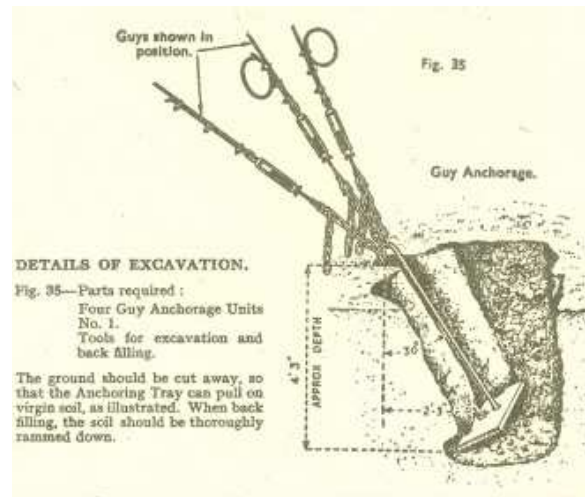


A partly assembled cigar-shaped mast section.

The erection derrick for hoisting the mast consisted of one cigar-shaped member identical with those used for the mast. The feature which was new to the RAF riggers used to erecting guyed masts was the universal joint employed at the point where the cigar sections were coupled together. This flexible joint necessitated the use of check ropes when raising or lowering the mast, to prevent it from buckling or falling towards the derrick, otherwise the procedure was in accordance with the normal practice used in the erection of Masts Type 23 and Type 34.

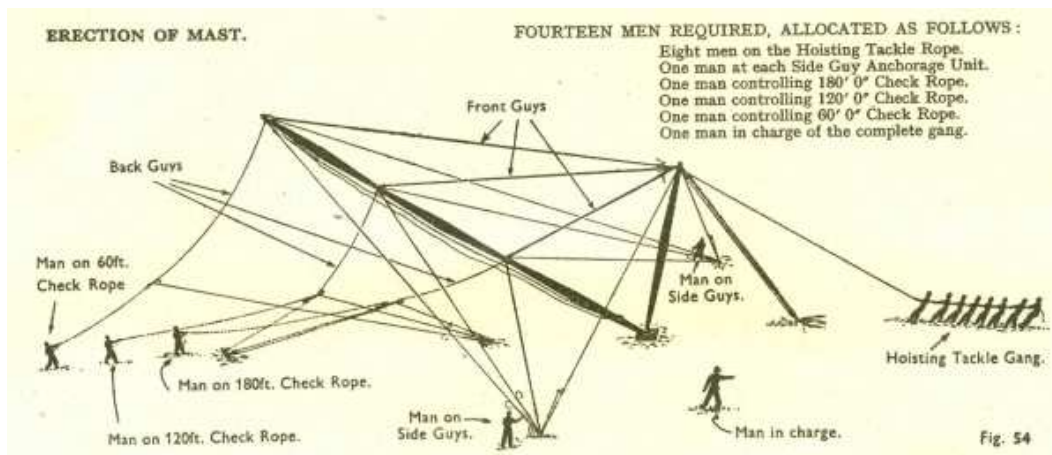


Universal joint details.



Guy anchorage details.

For more permanent installations and on sites where the soil was light or sandy, the excavated guy anchorage holes were often filled with concrete.

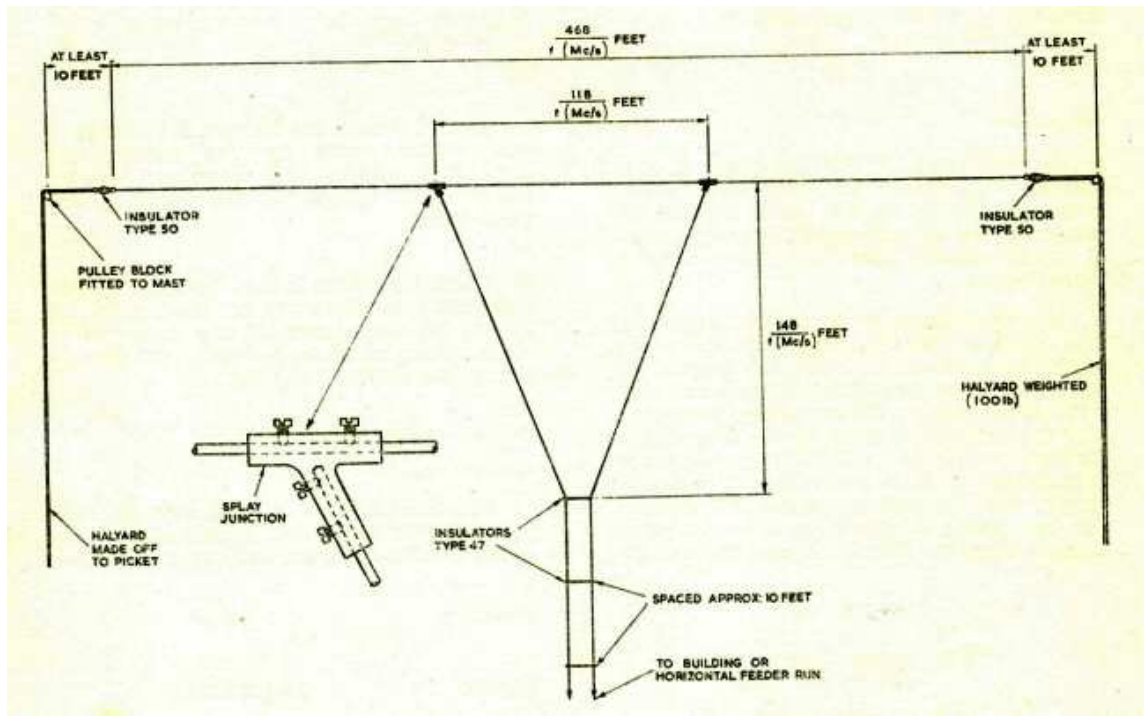


A diagram of a Mast Type 35A being erected showing the positioning of the erection crew and the back guy check ropes.

As can be seen from the diagram above technically there should be 14 personnel in the erection team but these masts were often erected with far less personnel. It was very rare for there to be more than eight or nine riggers in a fitting party and frequently other members of a fitting party were co-opted to assist in erection phase of aerial farm construction.

RAF MF and HF Aerials 1940s to 1970s.

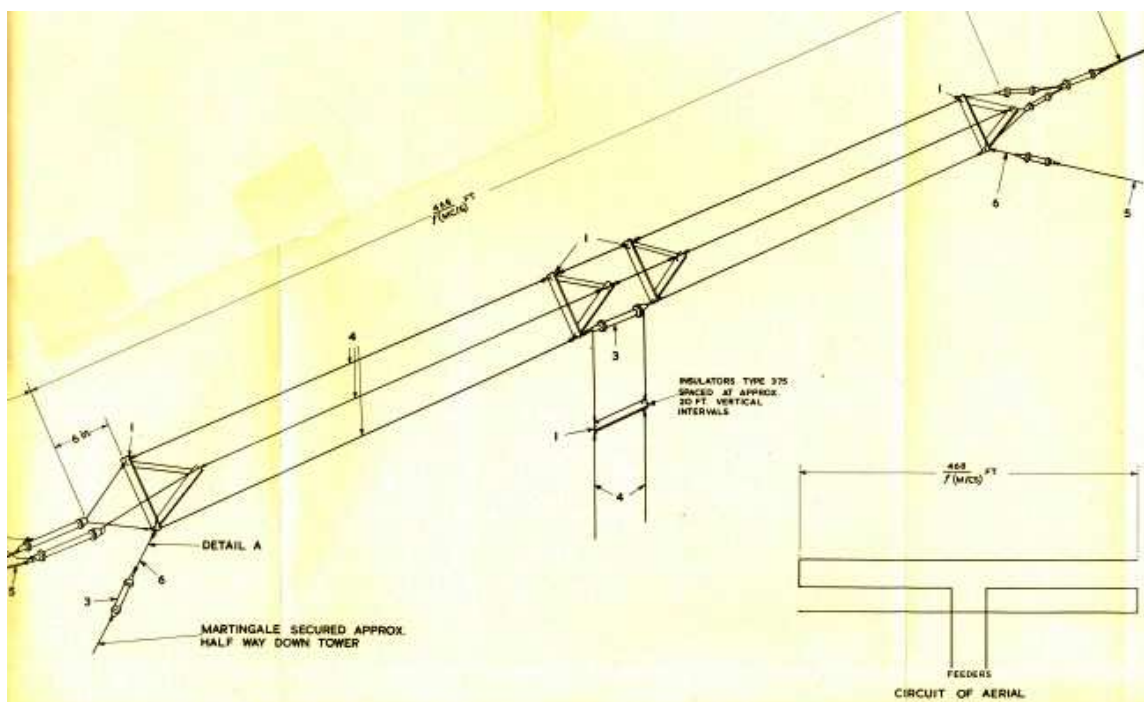
The Delta matched Horizontal Single Wire Half-wave Dipole.



A horizontal single wire aerial had an impedance of 70 ohms but it was not practical to build 70 ohm open wire feeder systems. The problem was overcome by "fanning" the upper part of the down feed as seen above thus enabling the aerial to be connected to the RAF standard 600 ohm open wire feeder systems. The horizontal element was constructed using 300lb per mile copper wire and down feed and feeder line using 100lb per mile copper wire. The junctions of the element with the down feed could be soldered if there were no Splay Junctions available.

The Three-wire Folded Half-wave Dipole.

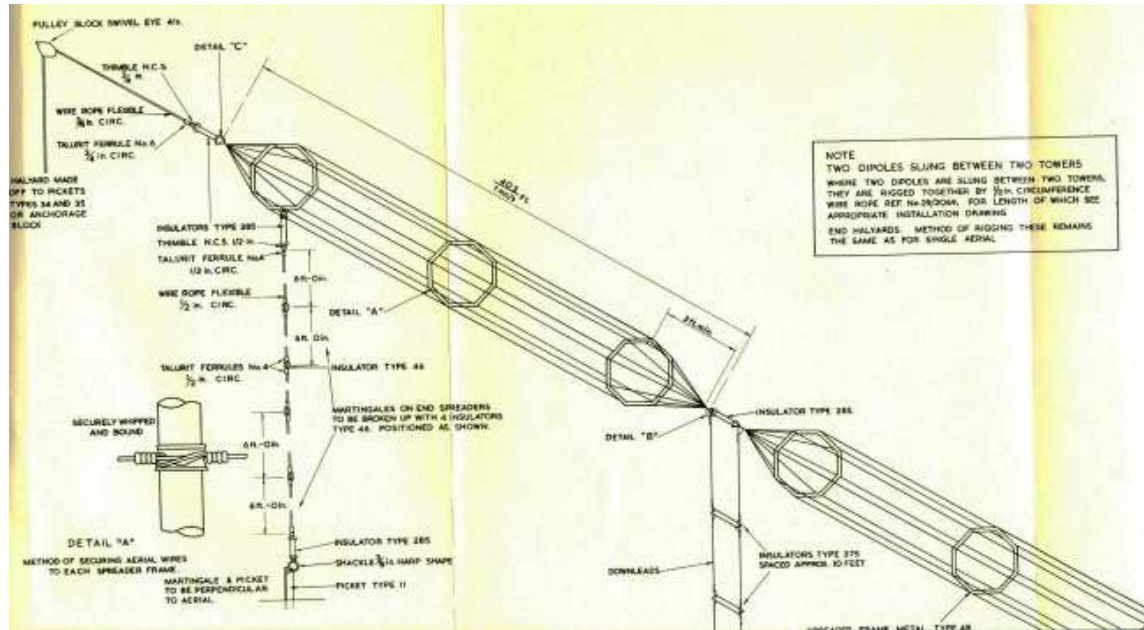
The three-wire folded dipole was used by the RAF as both a receiving and transmitting aerial. The band width is greater than that of a single-wire dipole due to the greater cross-sectional area of the aerial which resulted from the folding. The folded dipole had a greater capacitance and less inductance per unit length than the basic dipole. This type of folded dipole can be regarded as a normal dipole with an extra half wavelength of wire added on to each end, these extra lengths being folded back parallel with the centre portion to form three closely spaced parallel dipoles. The current standing waves in the three portions are in phase and the radiated waves reinforce each other. The feed impedance of the aerial is about 600 ohms and thus could be connected to the standard open wire feeder systems. The aerial elements were constructed using 100lb per mile copper wire.



Construction and rigging details of a Three-wire Folded Dipole.

The Eight-wire Cage Full-wave Dipole Aerial.

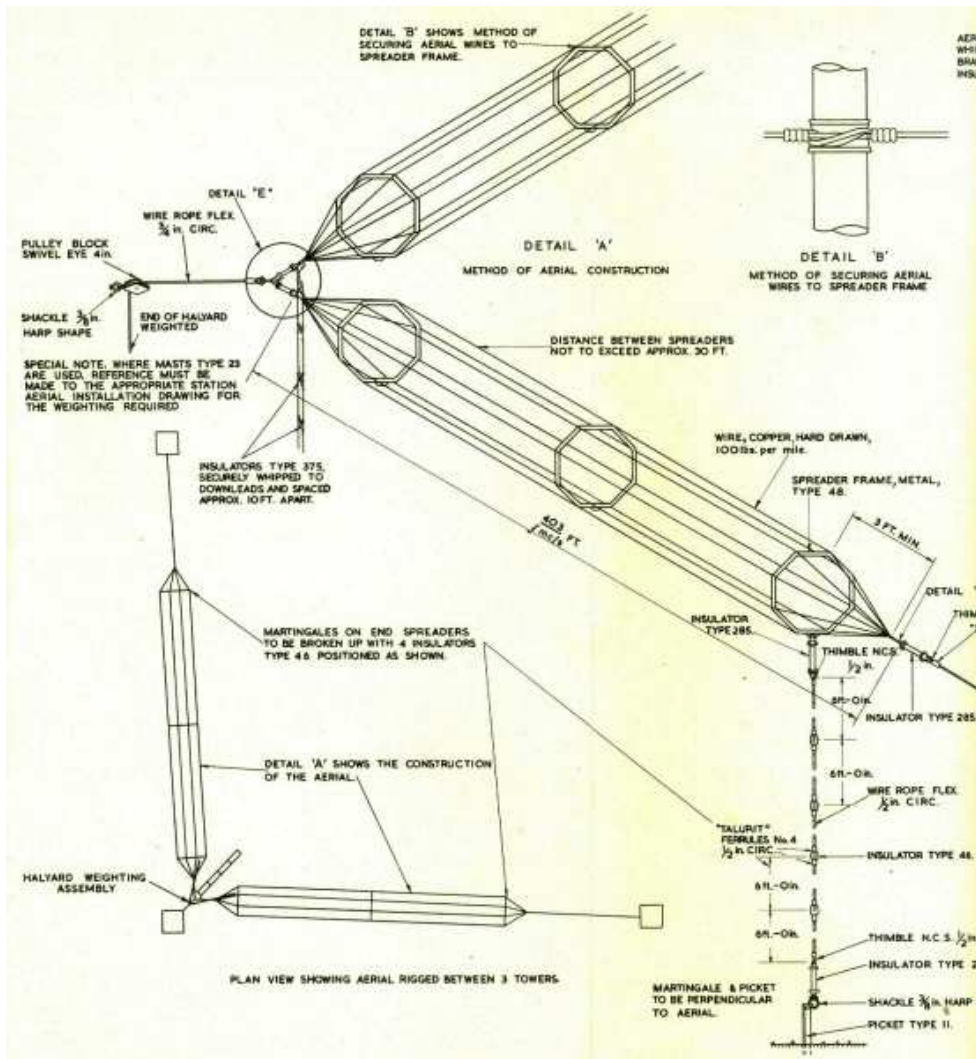
The eight-wire cage full-wave dipole aerial was widely used by the RAF for both transmitting and receiving. The cage form of the aerial gave it a greater bandwidth than a single wire aerial and also gave it a greater power handling capability. Its feed impedance of about 600 ohms enabled it to be connected to the standard RAF open wire feeder systems. The aerial elements were constructed using 100lb per mile copper wire.



Construction and rigging details of a Eight-wire Cage Dipole Aerial.

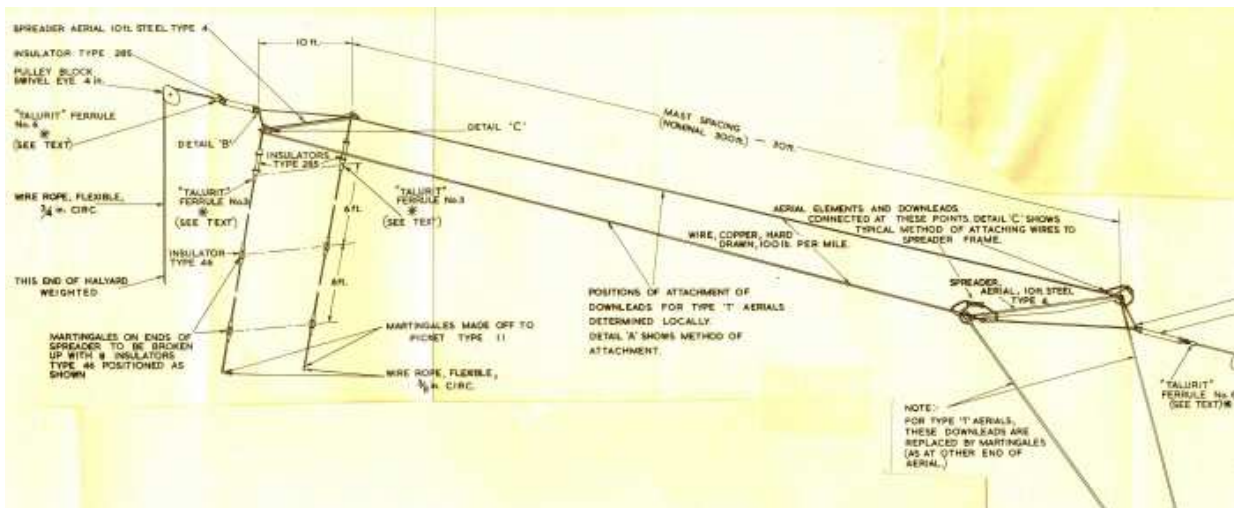
The Eight-wire Cage Quadrant Aerial.

The eight-wire cage quadrant aerial was simply a standard eight-wire cage dipole which was bent at the centre until the two halves are at right angles. This action changes the aerial from a directional aerial into an omni-directional aerial. Its feed impedance remained the same at 600 ohms. The two quadrant cages were constructed at slightly less than a half-wave long using 100lb per mile copper wire.



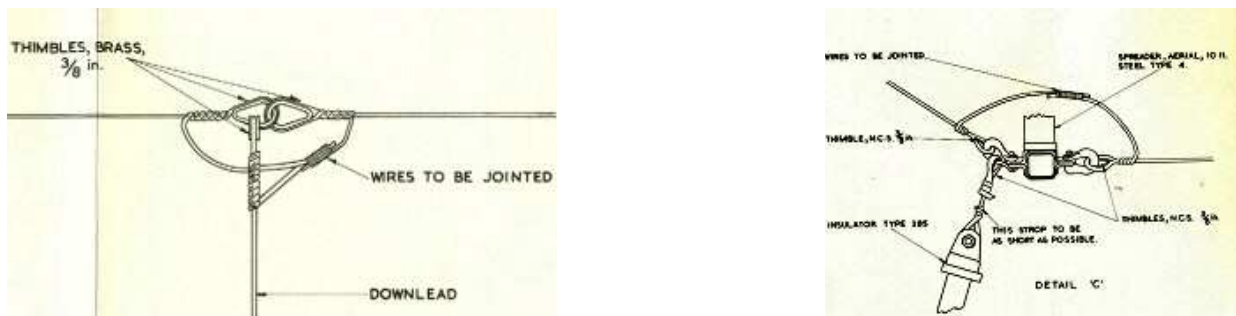
Construction and rigging details of a Eight-wire Cage Quadrant Aerial.

"L" or "T" Type, Two-wire MF Aerial.

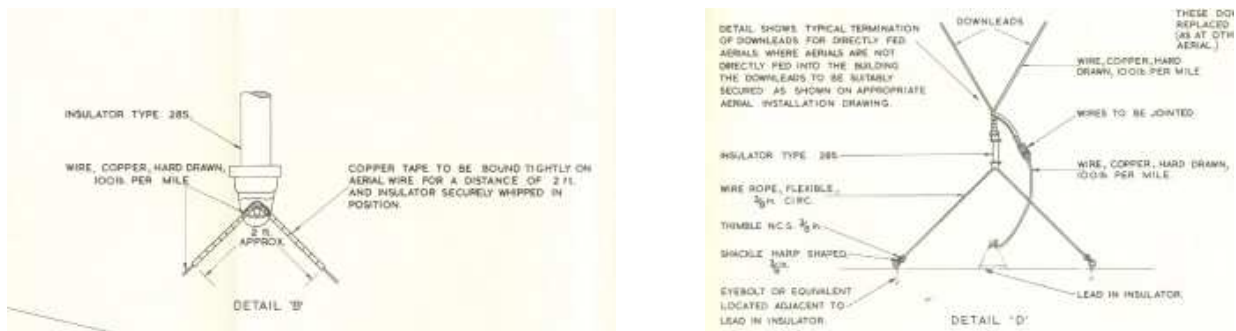


An inverted "L" aerial was a special type of vertical aerial in which the upper part of the wire is bent over horizontally. This enabled a reasonable length of wire to be used without the need for very high masts. The direction of the electric field in the radiated wave was no longer completely vertical but it had a strong vertical component since the current standing wave was greater in amplitude on the vertical portion.

A "T" aerial was another special type of vertical aerial. This aerial consisted of a horizontal wire supported by two masts, with a vertical wire suspended from its mid-point. It may be regarded as an inverted "L" type aerial in which the horizontal portion is duplicated.



An enlarged picture of Detail A, the centre connection of a "T" aerial, shown on the main diagram is above to the left and and Detail C, the spreader details are shown on the right.



An enlarged picture of Detail B shown on the main diagram is on the left above and that of Detail D (down feed termination) is shown to the right.

Vertical HF Aerials.

Single wire vertical aerials were in common use throughout the RAF as they were simple to construct and did not occupy a large amount of ground space. They were used for both transmitting and for receiving. The most frequently used aerial length was the 1/4 wave length aerial as it could be fed directly using a co-axial cable. The aerials could range from 1/8 wave to 5/8 wave length but these aerials needed an open wire feeder system and matching stubs. Some aerials were completely vertical and others had the top turned in a horizontal direction.

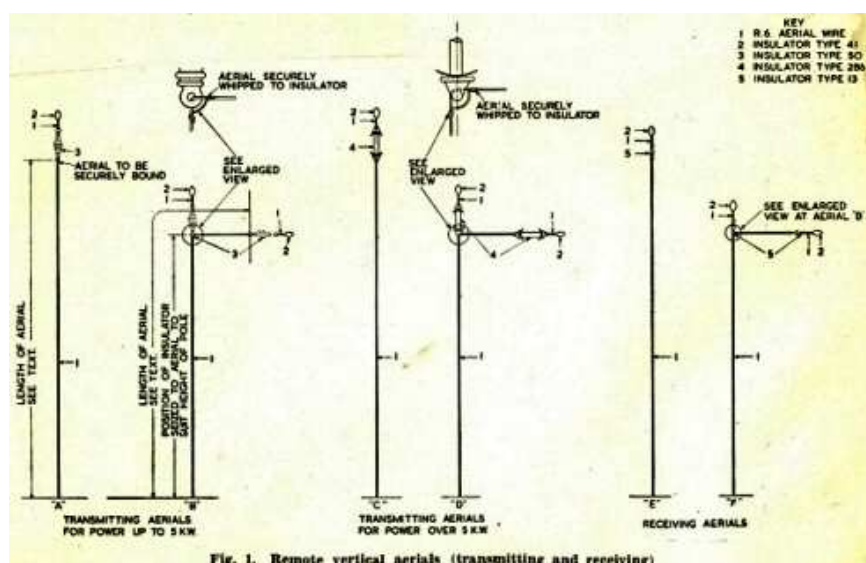
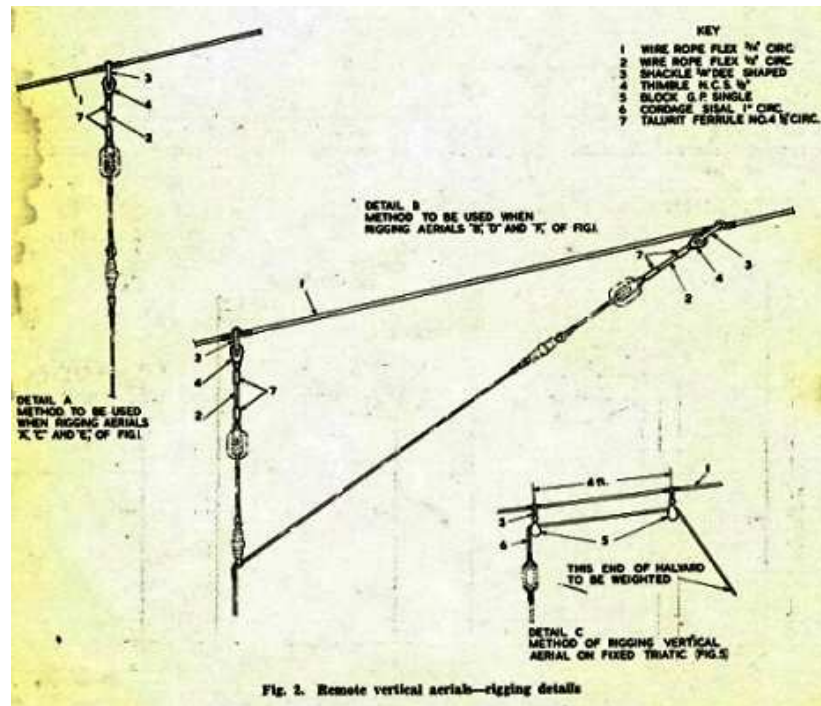


Fig. 1. Remote vertical aerials (transmitting and receiving)

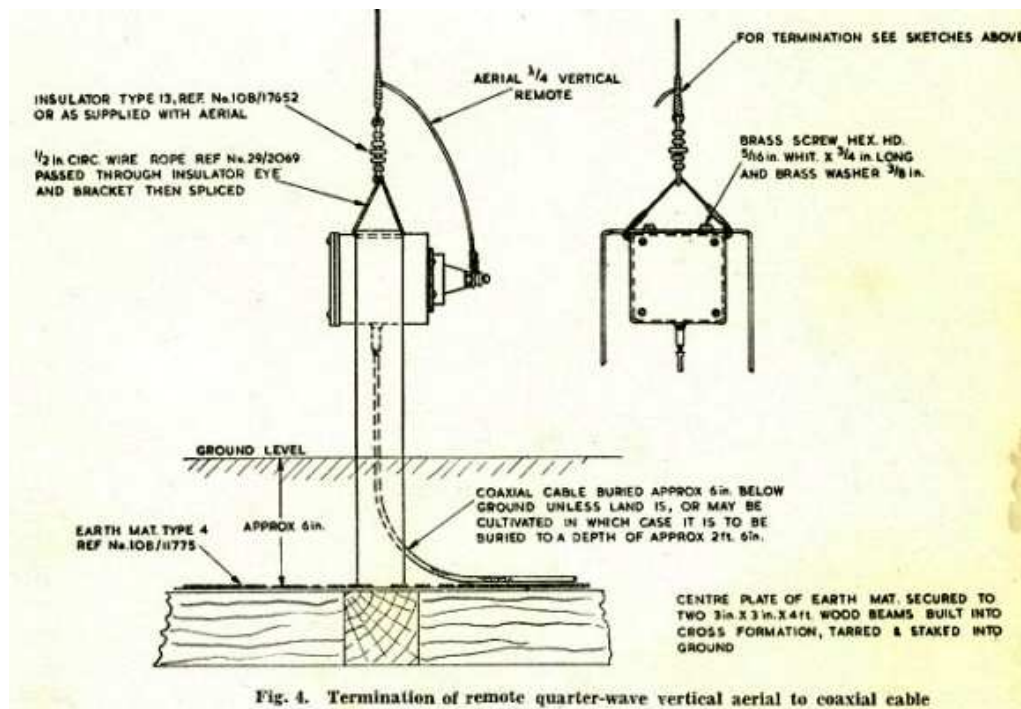
Above is a diagram showing the various construction details of Vertical 1/4 wave aerials.

The aerial elements were constructed using R6 aerial wire but often 100lb per mile copper wire was used instead. R6 aerial wire was a three stranded, enameled copper wire. When transmitting at over 5kw, type 286 insulators were used instead of the pyrex glass type 50 insulators.

Several aerials could be erected using two masts, poles or even trees by rigging them along a common static flexible steel wire rope triatic.



The rigging details for attaching various 1/4wave vertical aerials are shown above.



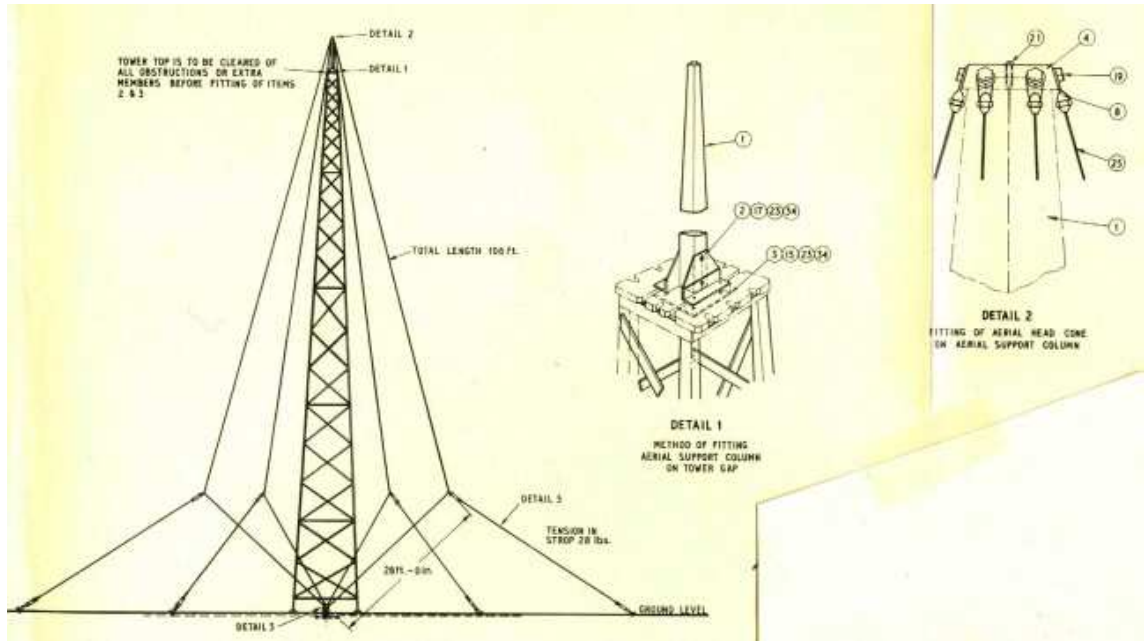
Termination of a 1/4wave vertical aerial to a co-axial cable.

The junction box shown above is a Type 12 Junction Box which was used for connecting the aerial to a 43ohm co-axial cable. A Type 2 or Type 7 Matching Unit was used if connecting to a 75ohm co-axial cable. If it was not possible to bury the co-axial cables they were carried overhead suspended from a triatic at least 7ft 6ins above ground level. Eighteen 30ft long 14swg copper wires which were soldered to the centre plate radiated outwards from the Type 4 Earth Mat were usually buried about six to nine inches below the ground surface.

Vertical Bi-Conical Aerial.

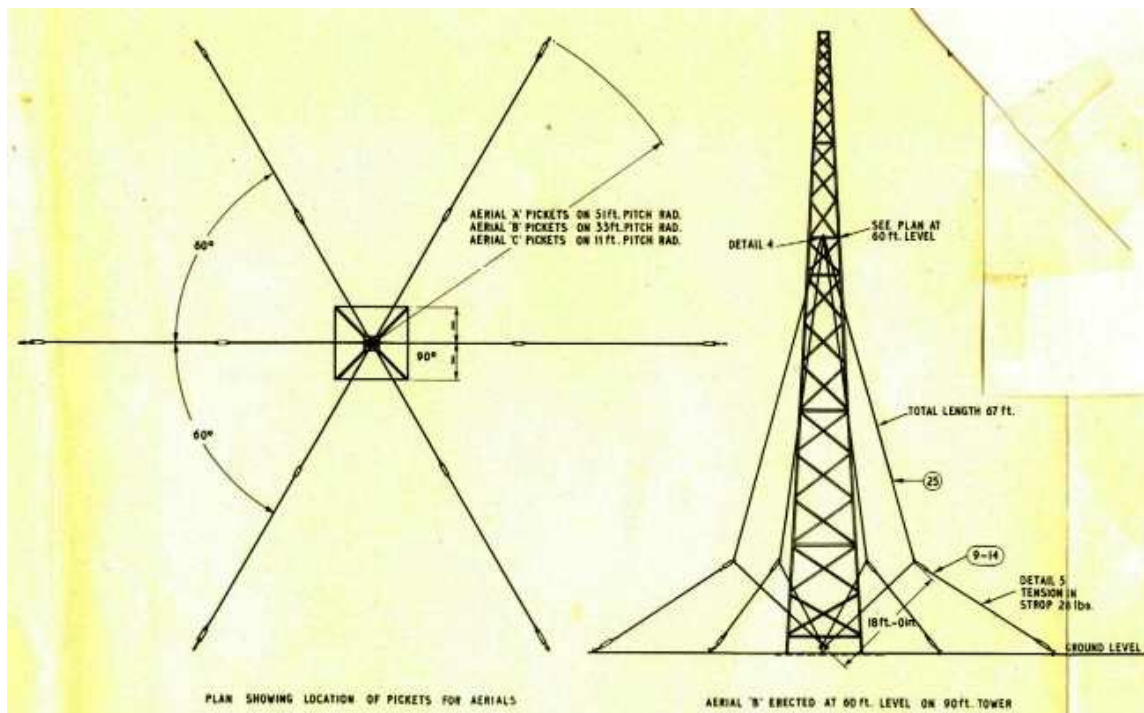
The vertical bi-conical aerial was a multi-wire form of vertical aerial. It was only used in the RAF for receiving. The multi-wire construction gave an increase in bandwidth, the frequency range was in the order of 3 - 1. The aerial was constructed in three standard sizes using 100lb per mile copper wire for the six elements. All three aerial sizes were terminated using a modified Type 12 Junction Box mounted on a standard Type 4 earthing mat. Aerial Type A was rigged from a special centre support column mounted on top of a 90ft wooden lattice tower. Aerial Type B was rigged from a special centre support mounted at the 60ft level of a 90ft wooden lattice tower. Aerial Type C was rigged from a gibbet arm mounted on a standard 28ft Air Ministry Works Department wooden pole.

Bi-Conical Aerial Type A.

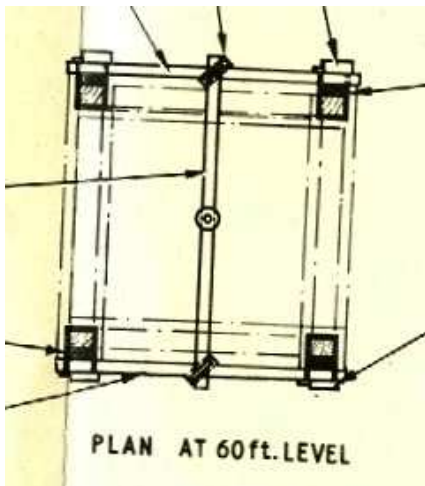


In the diagram above the aerial has an effective length of 106ft and a frequency coverage of 2 to 6 Mc/s. The construction and rigging details of the special support column (detail 1.) and the aerial head cone (detail 2.) are shown to the right of the photograph.

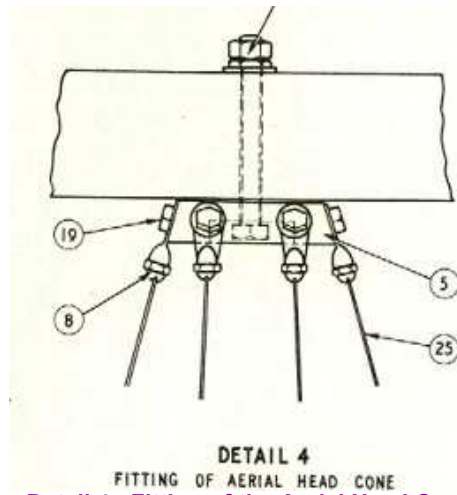
Bi-Conical Aerial Type B.



On the right of the diagram above the aerial rigged at the 60ft level of the 90ft wooden lattice tower has an effective length of 67ft and a frequency coverage of 3 to 10 Mc/s. On the left hand side of the diagram, the details of the layout of the six tensioning pickets for all three types of bi-conical aeriels is shown.

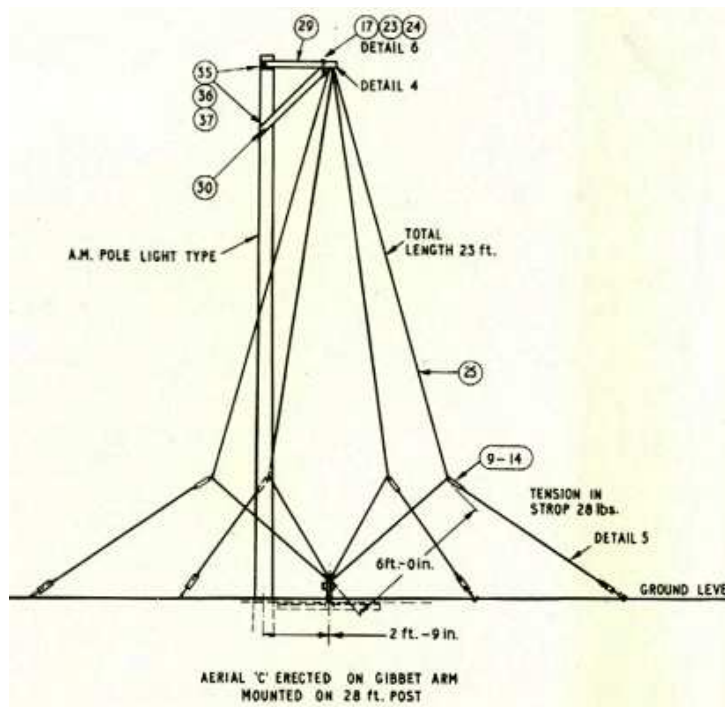


Rigging details of the Centre Supporting beam.

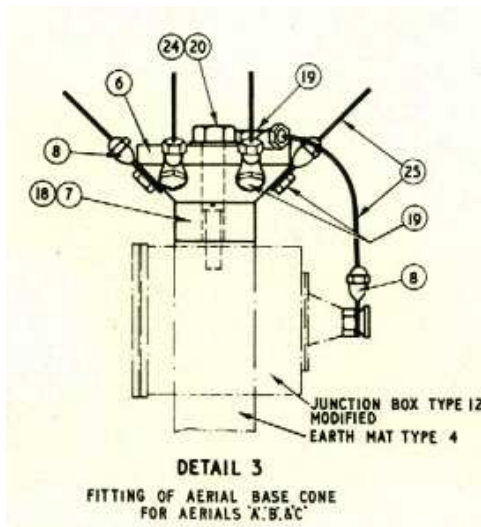


Detail 4 - Fitting of the Aerial Head Cone.

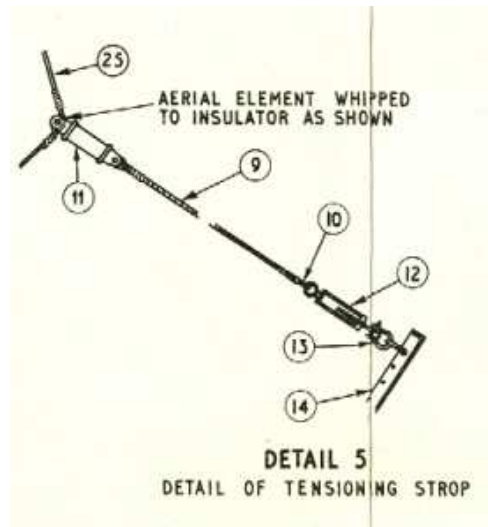
Bi-Conical Aerial Type C.



In the diagram above the aerial rigged from the gibbet had an effective length of 23ft and a frequency coverage of 9 to 30 Mc/s. The aerial head cone is fitted in the same manner as shown for the bi-conical aerial type B.



Detail 3 - The rigging of the Aerial Base Cone of all three types of bi-conical aerials.

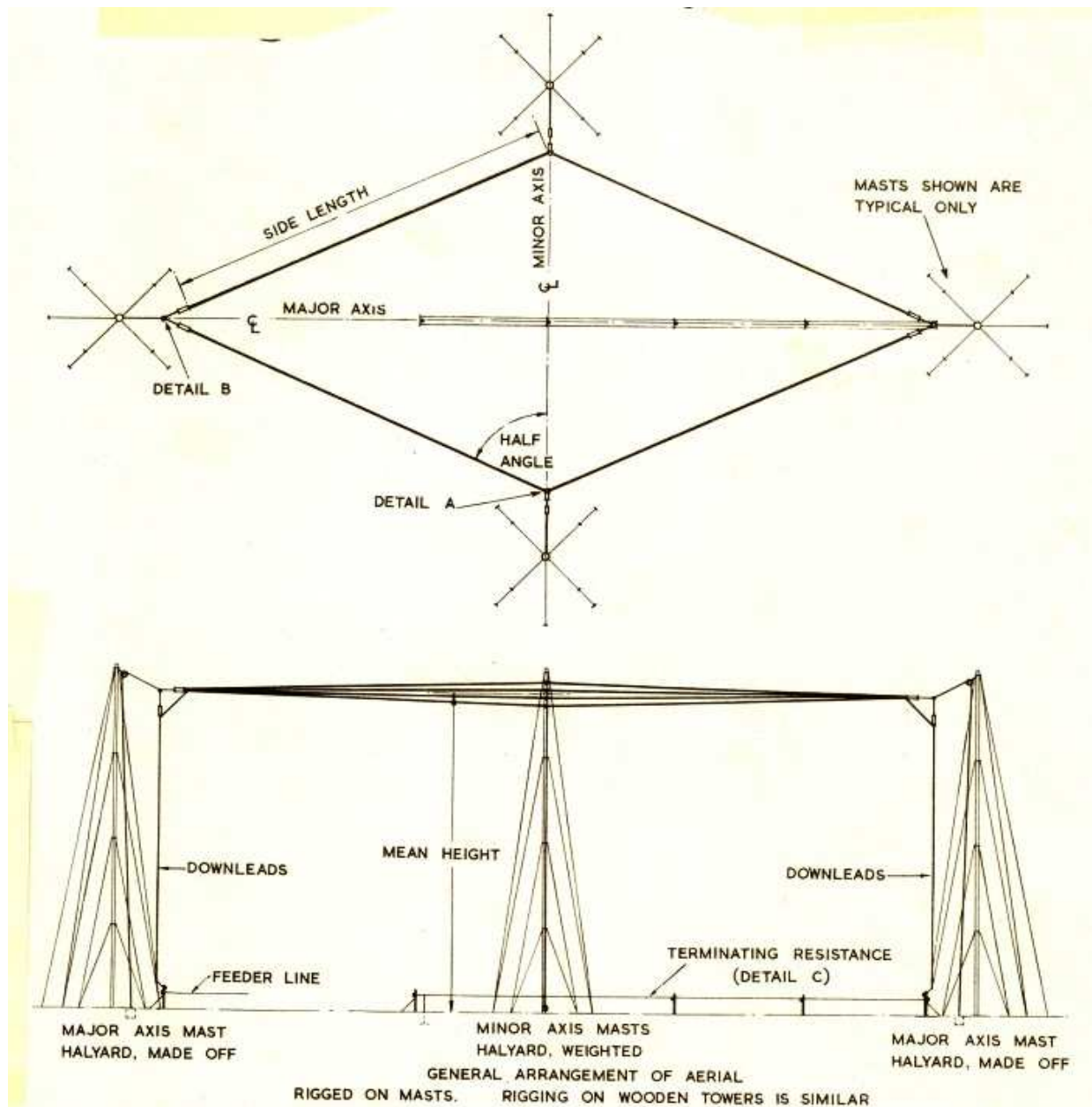


Detail 5 - The rigging and fitting of the tension strops and pickets of all three types of bi-conical aerials.

Two-wire, Three-wire and Four-wire Rhombic Aerials.

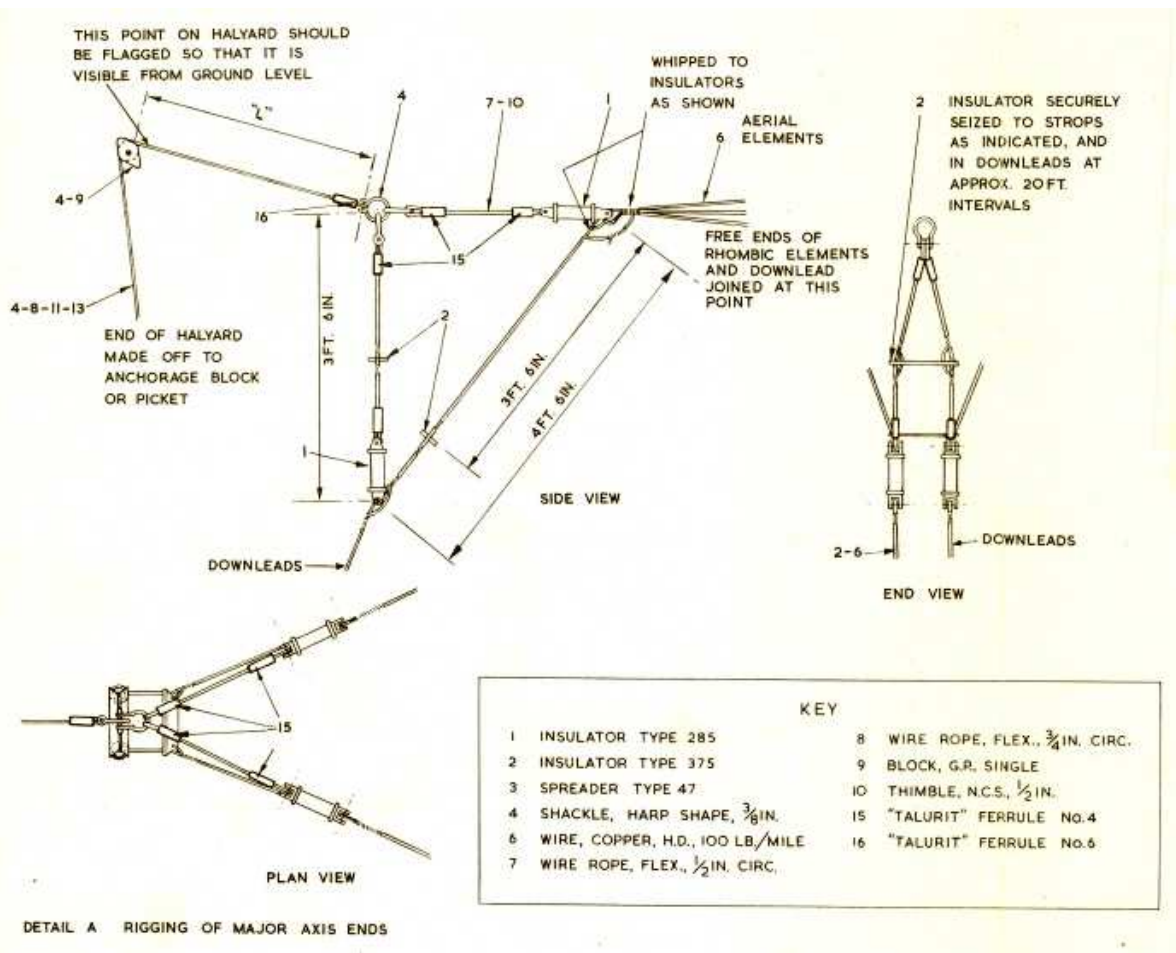
A rhombic aerial consists, basically, of four conductors joined to form a rhombus or diamond which concentrates the signal radiation in a forward direction. The RAF found that the insertion of a resistance at one end greatly improved the performance of the aerial for both transmitting and receiving. This made the rhombic the best and most effective aerial used by the RAF for long distance point to point signals traffic until the event of satellite communication.

The rhombic worked well for transmitting and receiving over a wide range of frequencies and the use of multi-wire rhombics gave an even greater bandwidth and thus better frequency ranges. The main disadvantage of the rhombic aerial was the large area required for their installation.



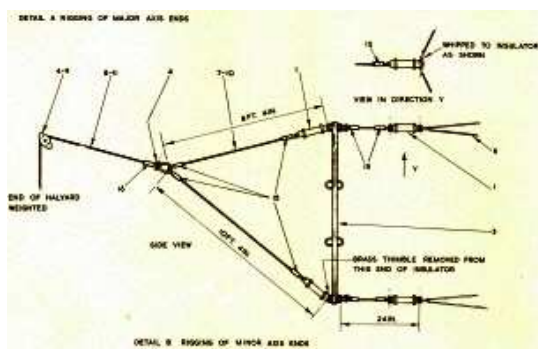
The above diagram shows the layout of a typical rhombic aerial and associated masts.
The direction of the forward signal radiation in this diagram is from left to right.

The Two-wire and Three-wire Rhombic aeralis were used for transmitting up to 25KW and for receiving. The Four-wire Rhombic aeralis were only used for transmitting at over 25KW. The aeralis elements of all three types of rhombic were constructed using 100lb per mile copper wire and were fed using the standard RAF 600 Ohm open-wire feeder systems

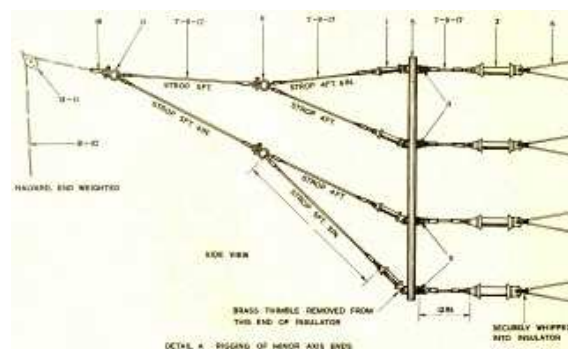


The above diagram shows the rigging details of the major axis ends of a typical rhombic aerial.

Until the end of the 1950s all the various types of strops and halyards were made by hand splicing the flexible steel wire rope. The introduction of the portable "Talurit" press made the job of manufacturing the strops and halyards much quicker and easier. The flexible steel wire rope was cut to size, the end fed through the appropriate sized "Talurit" ferrule, the eye was formed and the rope end fed back into the ferrule again. The ferrule was then placed into the press between the swage blocks and squeezed by a few quick pumps on the press lever and the job was done.

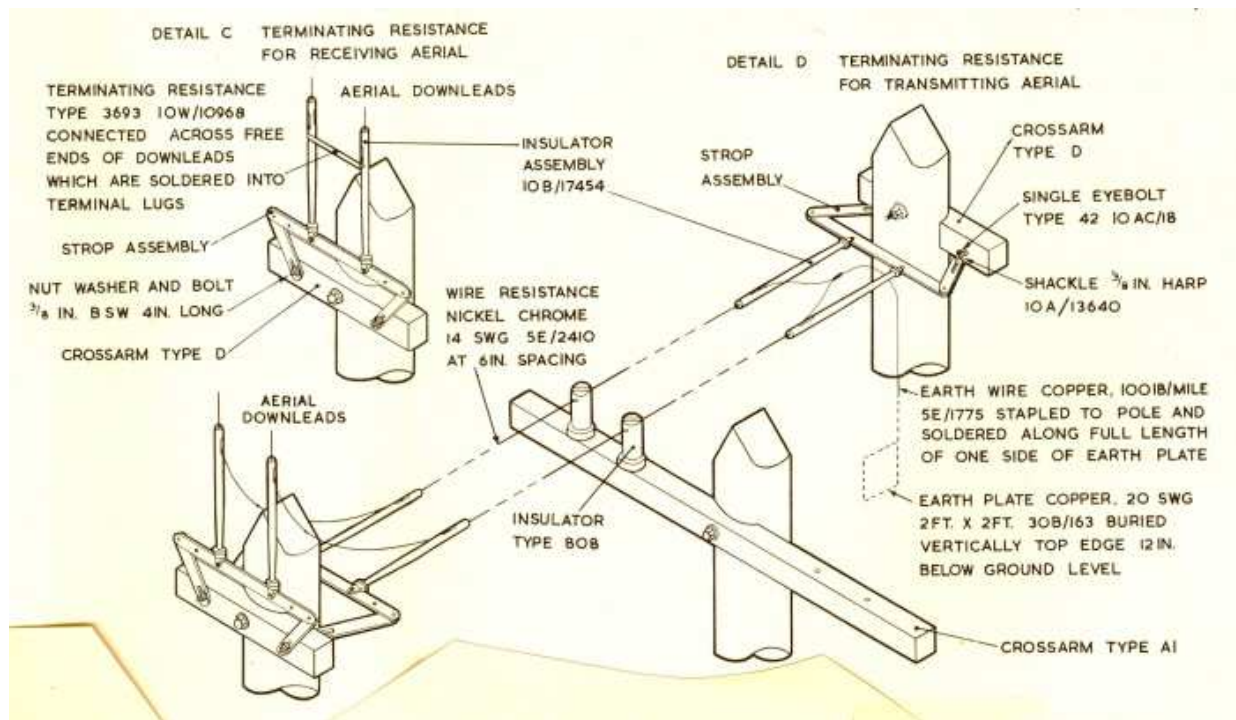


Rigging of the side axis of a two-wire rhombic.



Rigging of the side axis of a four-wire rhombic.

The side axis of a Three-wire rhombic was rigged using the same type 47 spreader as seen above but with a lug for the middle element positioned in the centre of the spreader. An additional bracing strop was inserted between the end of the halyard and the middle lug.

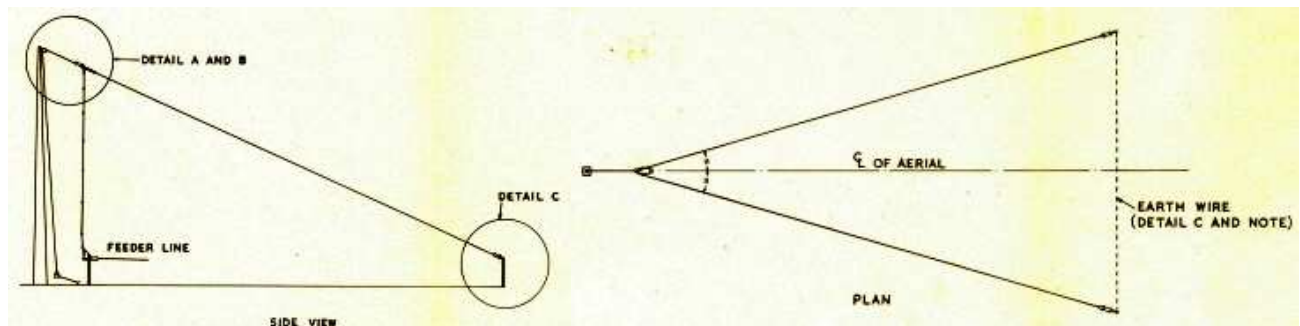


The termination resistance details of Transmitting and Receiving Rhombic Aerials.

All receiving rhombic aerials were terminated using a non-conductive carbon resistance inserted at the opposite major axis to the down feed from the aerial.

All transmitting rhombic aerials were terminated using a 400ft long resistance run built in the same manner as a 6inch spaced open wire feeder system at the opposite major axis to the transmission feeder run. The resistance run was constructed using 14 standard wire gauge nickel chrome resistance wire which was short-circuited and earthed using a buried 2ft x 2ft copper plate.

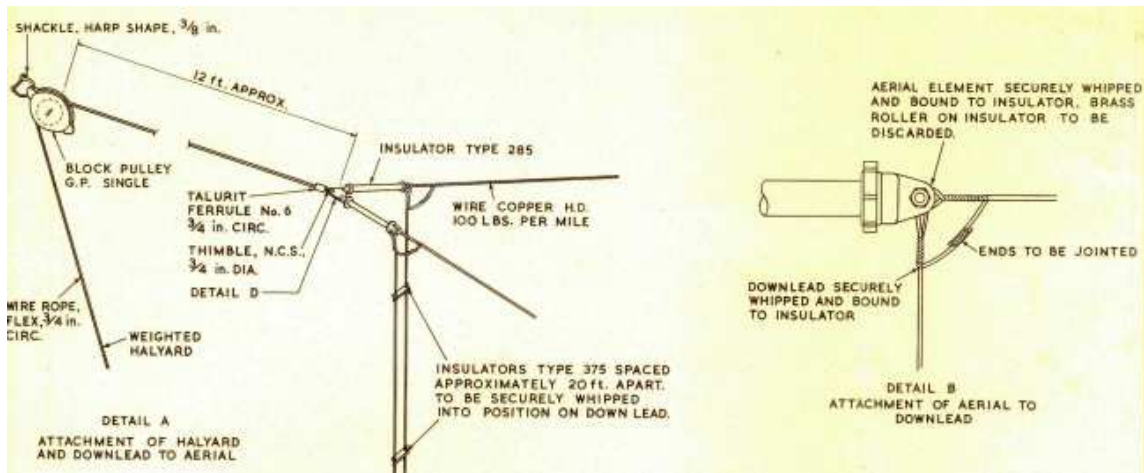
Terminated "V" Aerial.



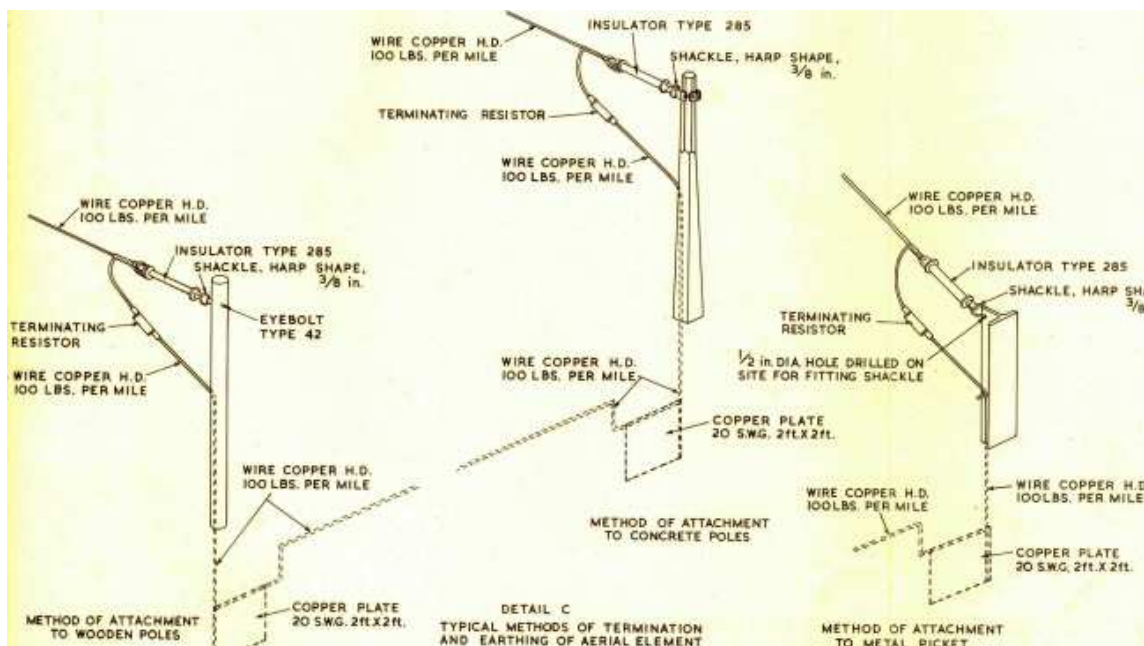
Side view of a Terminated "V" Aerial.

Plan view of a Terminated "V" Aerial>

The terminated sloping "V" aerial was a wide-band aerial which was normally only used for receiving in the RAF. However it was used successfully for transmitting on Ascension Island during the Falklands War in 1982. It was superior to a dipole aerial for reception from a given direction especially over long distances. From a practical point of view its big advantage was that it only needed one supporting mast or tower and in an emergency could even be rigged from a tall tree.



The rigging of the halyard and the elements at the apex of the aerial are shown above in Detail A. Detail B, on the right, shows the connection of the elements and the 6 inch spaced downfeed.



The different methods of attaching the aerial element ends and the terminating resistors to the earthing system using either wooden poles, concrete posts or steel pickets are shown above. The value of the terminating resistors could be changed to get the best possible working efficiency. The pairs of resistors available ranged from 50 Ohms to a maximum of 390 Ohms but 360 Ohms was, in general, the norm. The earthing system consisted of two 20 s.w.g. copper plates buried upright at least 6ins below ground level and linked to each other by a length of 100lb per mile copper wire.