

# RF Connectors

- Hertz 1879 - 1886
  - First reported coax transmission line
- Rayleigh 1897
  - Mathematically showed propagation in hollow metal tubes
- 1930s two wire transmission lines dominate
  - shortwave applications
- WW2 Development of radar and the opening up of the UHF/microwave spectrum

## Development of coaxial cable

- Problem finding suitable dielectric
- Polythene developed by ICI early in WW2
- Superior RF dielectric properties to existing materials
- Losses 10 times better
- $\epsilon_r = 2.25$  compared to 3.1 for rubber.
- DuPont licenced production of polythene in US
  - production allocated to defence for cable production.
- Performance of early cables was often quite poor
  - often exhibited resonances due to discontinuities

## **The UHF Connector**

- In 1940s the only RF coaxial connector was the so-called UHF connector (PL259/SO239)
- Developed by E C Quackenbush of the American Phenolic Company (later Amphenol, still later AMP) Deemed unsuitable for use at the Radar frequencies in use (10cm and 3cm)

## The N-type and friends

- In early 1940s Joint Army and Navy RF cable coordinating committee set up.
- They specified many of the RF connectors we are familiar with today
  - N-type plug UG21/U (Union/Guide 21/ Universal)
  - N-type socket UG22/U (Union Guide 22/ Universal)

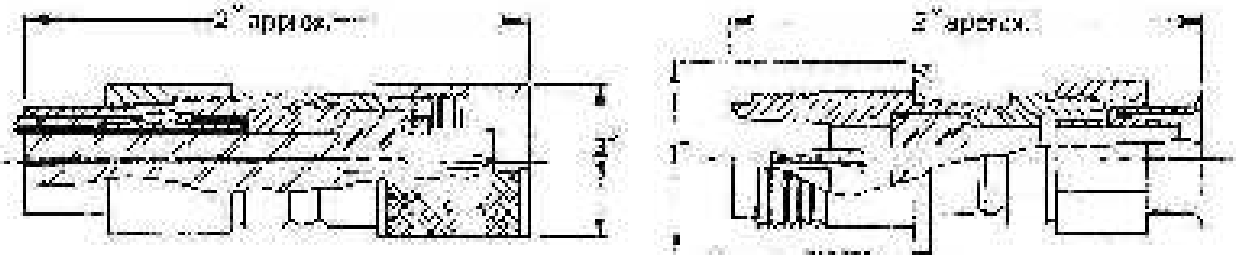


FIG. 5-134.—Type N connectors, UG-21/U, UG-22/U.

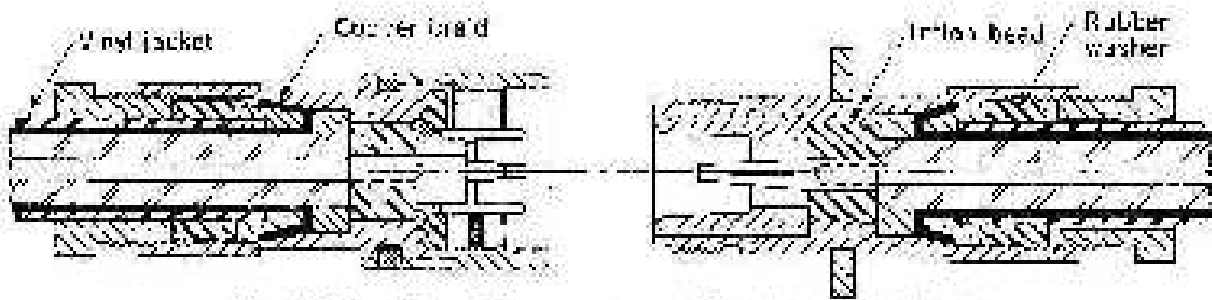
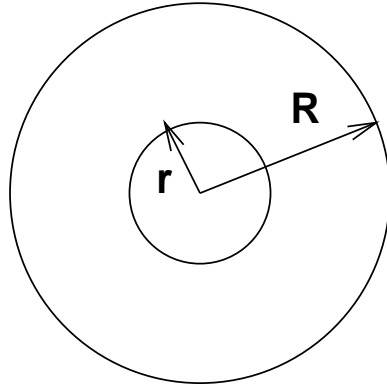


FIG. 5-135.—Type N connectors, UG-21/U, UG-22/U.

- Named after Paul Neill.

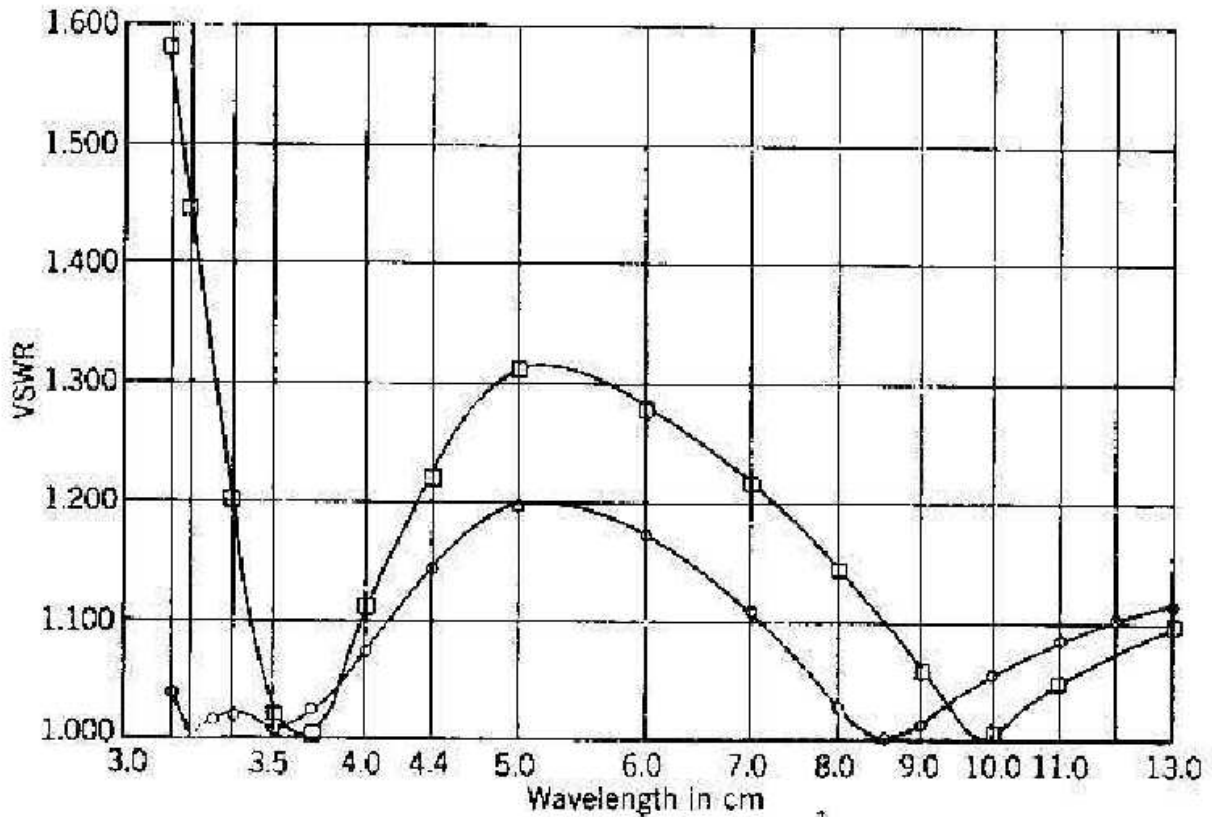
## Impedance of coaxial line



$$Z_o = \sqrt{\frac{\mu_r}{\epsilon_r}} 138 \log_{10} \left( \frac{R}{r} \right)$$

## Problems with early N-types

- The early N-type was not a constant impedance device
- Stepped construction



- Performance was good in the radar frequency bands at 10cm and 3cm
- /(bu Designed with standard piece parts to be procured from a variety of sources

## **Further development**

- In the early 1960s the connector specs were changed to define only the mating interfaces in MIL-C-39012
- This allowed individual manufacturers to improve the performance of connectors.

## **The BNC connector**

- BNC (Baby N connector) also developed about this time.
- HN, C which are still in use also emerged at this time.
- The TNC appeared in the late 1950s primarily for airborne systems.
- Waveguides were still the preferred form of transmission line in the period at the end of WW2.



## **The need for wideband systems**

- In the late 1950s and 60s RF and Microwave technology improved to the point where it was possible to design systems that operated over several octaves of bandwidth
  - test equipment
  - TWTs, BWOs etc
  - electronic warfare systems

## **Coaxial systems triumph!**

- The increasing need for wideband systems makes coax more attractive.
- SMA connectors are developed.
- Useful in wideband systems were there are a number of interconnected modules.
- Connectors become a significant part of microwave integration process

## **Specialised connectors**

- Heliax connectors
- Measurement connectors