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**Publisher's version / Version de l'éditeur:**
https://doi.org/10.4224/21273012
*Report (National Research Council of Canada. Radio and Electrical Engineering Division : ERB), 1950-05*

REPORT ERB - 240

UNCLASSIFIED

NATIONAL RESEARCH COUNCIL OF CANADA

RADIO AND ELECTRICAL ENGINEERING DIVISION



# NOTES ON A SUBMINIATURE RADAR INTERMEDIATE-FREQUENCY AMPLIFIER

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OTTAWA

MAY 1950

N.R.C. NO. 2140

Report No. ERB-240
Unclassified.

The National Research Council of Canada

Radio and Electrical Engineering Division

# NOTES ON A SUBMINIATURE RADAR INTERMEDIATE FREQUENCY AMPLIFIER

by

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Photo No.2482

ABSTRACT

A 30-megacycle broad band i-f amplifier suitable for radar use has been built as a very compact oil-filled unit. The over-all gain is about 100 db and the bandwidth is seven megacycles.

## NOTES ON A SUBMINIATURE RADAR INTERMEDIATE FREQUENCY AMPLIFIER

To investigate the techniques of very compact construction of high-gain units, a broad-band i-f strip using subminiature tubes was built (see photo). Although the design was not finalized, it was carried to a point where most of the essentials were determined.

### MECHANICAL DESIGN

Temperature rise is an important factor in the design of compact units. The life of components is shortened, particularly if hot spots are allowed to develop. The close spacing of connections also makes condensation of moisture a serious problem. Operation of the unit in oil aids heat distribution, and prevents condensation, corrosion, etc. The use of oil imposes certain limitations in construction. The unit must be completely sealed, with oilproof bushings for input, output, and power cables. Provision must also be made for oil expansion due to temperature changes. Usually, this will amount to three to five per cent of the volume of oil used. A small bellows can be fastened either outside or inside the case. The heat generated within the case and distributed to it evenly by means of the oil must be dissipated from its outside surface. This can usually best be done by a combination of convection of air and conduction to other parts of the radar which can be efficiently cooled by convection. Sufficient conduction can be obtained by firmly clamping the case to a flat surface. The importance of this can be seen when it is realized that the temperature rise of the experimental i-f strip is about 120°F when cooling is obtained only by convection of still air. It would take a fairly high air velocity[1] to reduce this to less than 50°F simply by blowing air on it. If it is assumed that structural members of the main equipment can be used to dissipate heat, it is more economical to use low air velocity and provide for conduction from the case to the main cabinet.

The use of oil also means that no rubber or rubber-base cements may be used in the wiring. Neoprene and polyvinyl chloride may be used for insulation. The particular unit built has over-all outside dimensions of 9 by 2 by 1 inches and ordinarily employs 10 subminiature tubes[2]. The tubes are mounted 3/4-inch apart in grommets on a flat tray 9 by 1 inches long. Vanes, which act as electrostatic shields, are soldered to the tray between tubes.

1. "The Temperature Rise of Unventilated Cabinets" (ERB-238), C.W.McLeish.
2. A germanium crystal diode has been actually used in tests in place of a vacuum diode which was not available at the time.

## ELECTRICAL DESIGN

The i-f amplifier is stagger-tuned on a center frequency of 30 mc, using three sets of "triples" tuned to 26 mc, 30 mc, and 34.5 mc. The over-all bandwidth is about 7 mc and the gain of the i-f stages is about 100 db. The tubes used for i-f amplification are Raytheon type-CK6050X (roughly equivalent to the type-6AK5), the detector is at present a GE type-1N48 germanium diode, and the cathode-follower video-output tube is a type-SN953D tube. All tuning coils are wound on Neosid iron-dust type-CH2 choke cores. Using #30 Formex wire, separated by plastic spaghetti from the core, the resonant frequency of a single-layer coil can be as high as 100 mc. The Q is about 50, and, because the core is so small (0.150" x 0.375"), the field of the coil is restricted, resulting in little interstage stray coupling. The effect on the coils of immersion in oil is to lower the Q by less than 10 per cent and to lower the resonant frequency (by increasing capacities in the stage) by 2 to 3 per cent.

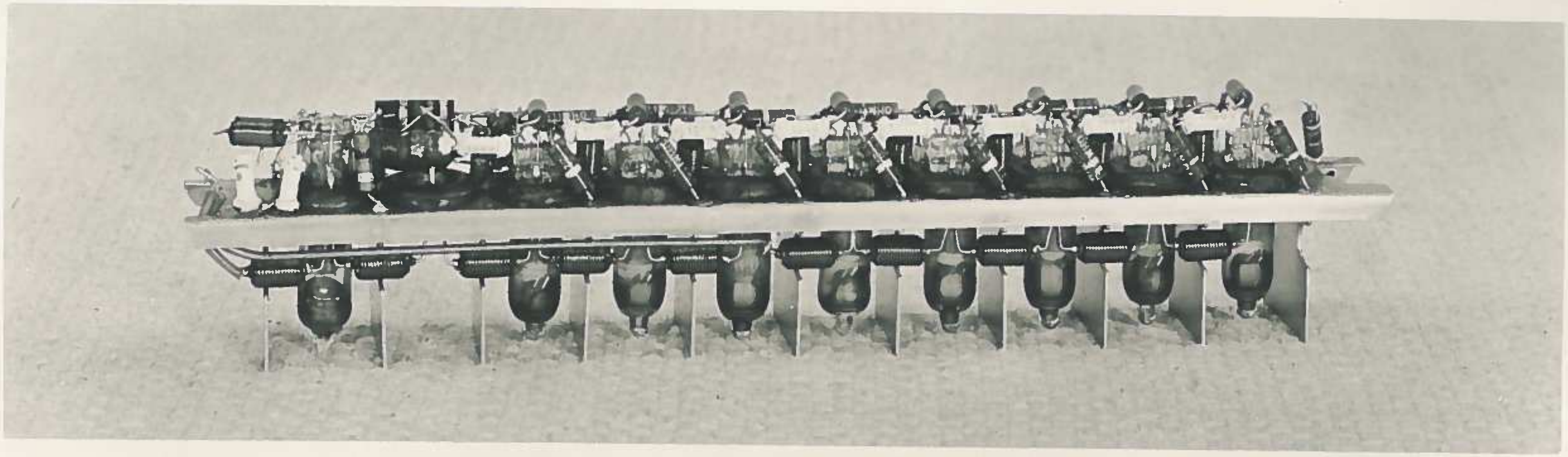
Plate, screen, and heater bypassing is done by one triple 1000-μμf condenser per stage. Heater decoupling was found necessary, so type-CH2 choke forms were wound with #24 Formex wire to give 1.3 μh (220 ohms) decoupling per stage. Resistors (220 ohms) are used as plate supply decoupling.

The detector output is bypassed for intermediate frequencies by a 10-μμf condenser and decoupled from the grid of the cathode follower by a 50-μh National type R-33 choke. As there was still some i-f energy getting out on the video output cable, a low-pass pi-filter, consisting of a 4-μh choke (type-CH2, iron-core) and two 330-μμf ceramic condensers, provided cut-off at 6 mc for the 75-ohm line. This eliminated all traces of regeneration in the strip, and response curves took on a normal appearance.

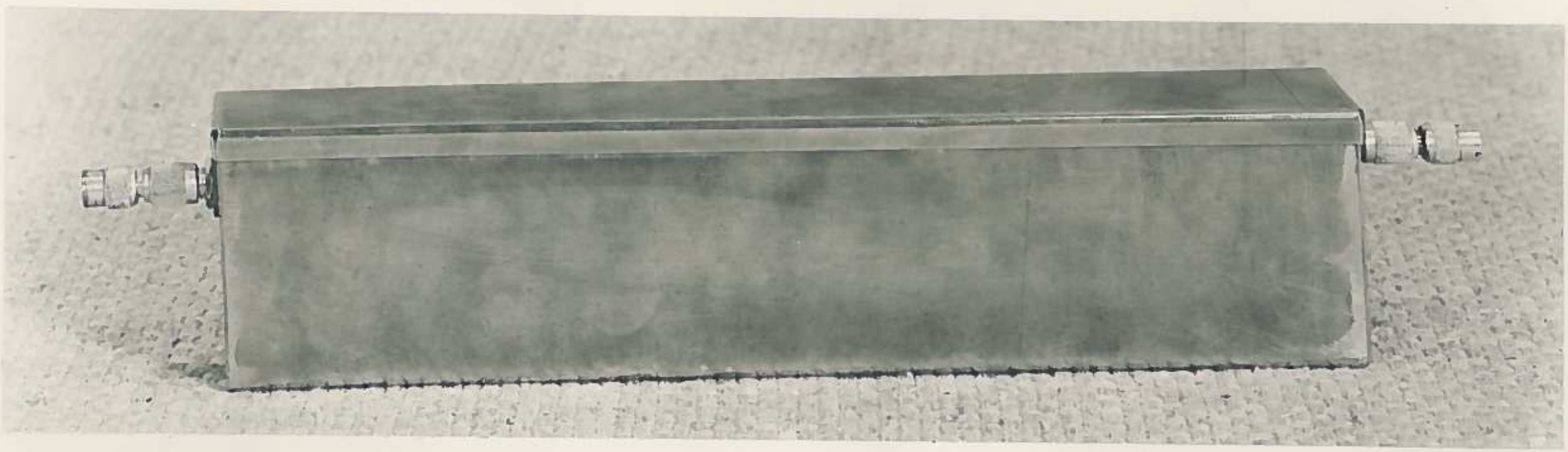
## CONCLUSIONS

It seems quite practical to use gains of the order of 100 db in a nine-inch chassis providing some extra precautions are taken. Decoupling between stages of all wiring must be fairly complete and care must be taken in choosing a ground point for the intermediate frequencies at each stage. Mechanically, there are some slight difficulties in sealing, but none which have not been solved elsewhere.

It might be argued that such a unit is very difficult to service in the field. It is felt that repairs on such units as receivers are seldom satisfactory when done in the field, and that such a small unit as this can quickly be replaced by a complete spare, all servicing being done at a proper base.



INTERIOR VIEW



EXTERIOR VIEW OF OIL-SEALED UNIT

SUBMINIATURE RADAR INTERMEDIATE FREQUENCY AMPLIFIER
($\frac{3}{4}$ OF ACTUAL SIZE)