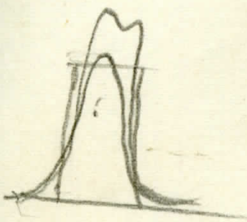
I Design ~~60~~ I.F. For M-2 A-scope

Params,



$$B.W. = \frac{.5}{T} = \frac{.5 \times 2}{.05 \times 10^{-6}s} = 20\ mc/s = \Delta f$$

Gain — ?

Freq should be at least 60 mc to avoid video coupling

KTB - Noise of input tube

$$E^2 = 4KT R_{eq} \Delta f$$

$\Delta f = 20 \times 10^6$

$K = 1.38 \times 10^{-23}$ joule/K

$T = 300°K$

$R_{eq} = 1.62 \times 10^3\ \Omega$

$$E^2 = 4 \times 1.38 \times 3 \times 10^2 \times 10^{-23} \times 1.62 \times 10^3$$

$$= 16.55 \times 1.62 \times 10^{-18}$$

$$= 26.8 \times 10^{-18} \times 2.0 \times 10^7$$

?OK This is Δf.

$$= 53.6 \times 10^{-11}$$

$$= 5.36 \times 10^{-10} =$$

Katy B

$$E = 2.3 \times 10^{-5} = 23\ \mu V$$

$$R_{eq} = \frac{I_p}{I_p + I_s}\left(\frac{2.5}{g_m} + \frac{20 I_s}{g_m^2}\right)$$

for 5702

$I_p = 13.2$ ma.

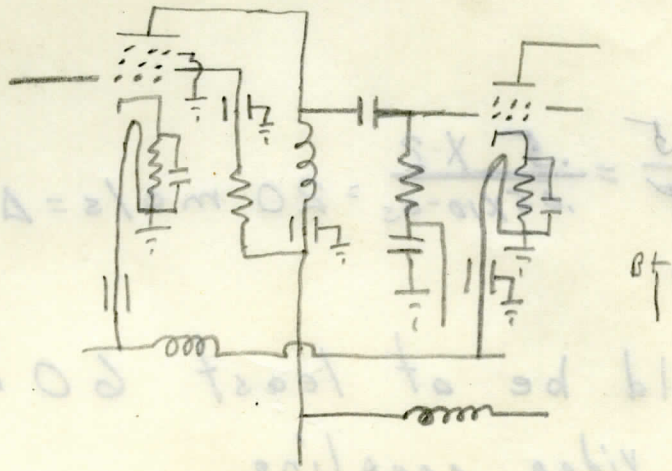
$I_s = 4.2$ ma

$g_m = 6900\ \mu$mhos.

$$R_{eq} = \frac{13.2 \times 10^{-3}}{17.4 \times 10^{-3}}\left(\frac{2.5}{6.9 \times 10^{-3}} + \frac{20 \times 4.2 \times 10^{-3}}{(6.9 \times 10^{-3})^2}\right)$$

$$= .758\left(.362 \times 10^3 + \frac{84 \times 10^{-3}}{47.6 \times 10^{-6}}\right) \approx 1.76 \times 10^3$$

$$= .758(.362 \times 10^3 + 1.76 \times 10^3) = .758(2.12 \times 10^3) = 1.62 \times 10^3\ \Omega$$



$X_L = 20 \times 10^{-6} \times 60 \times 10^{6} \times 6.3$

$= 1200 \times 6.3 = 7500$

$X_c = \frac{1}{1.5 \times 10^{-6} \times 60 \times 10^{6} \times 6.3}$

$= \frac{1}{90 \times 6.3} = .00176$

567.0

$500) 1,000$

II Preliminary Calculations

$\frac{60\Omega}{57.5}$ $.0174 \overline{)1.0000}$

try 3 & 4 triples of 5703's run as follows —

$g_m = 6900\ \mu mhos$

$C_T = C_{in} + C_{out} + C_s = 10.5\ \mu\mu f$

$C_{in} = 4.7\ \mu\mu f$
$C_{out} = 3.8$
$C_s = 2.0$
10.5

$$G\beta = \frac{g_m}{2\pi C} = \frac{6.9 \times 10^{-3}}{6.28 \times 10.5 \times 10^{-12}} = \frac{6.9 \times 10^{-3}}{6.6 \times 10^{-11}}$$

$$G\beta = 104.5 \times 10^{6}\ \sim$$

120
.09
80

for 3 triples —

$BW\ reduction = 20 \times 1.06\sqrt[6]{3} = 25.3$

$$mean\ stage\ gain = \frac{104.5}{25.3} = 4.12$$

$db = 20 \log 4.12 = 20 \times .614 = 12.28$

overall gain $= 9 \times 12.28 = 110\ db$

Volt gain of $\frac{110}{20} = AL\ 5.5 = 3.16 \times 10^{5}$

However gain of ~~10^5~~ $3.16 \times 10^{5} \times 2.3 \times 10^{-5}$ volt gives noise voltage of 7.29 volts —

This gain is probably too high

Try reducing ~~input~~ tube drive

for bias of -1.5 5702 $g_m = 5 \times 10^{-3}$

$$G\beta = \frac{5}{6.28 \times 10.5} k = 75.8$$

First stage

f_1 Δf_1

$$\frac{60\ mc}{1.29} = 46.5\ mc \times .48 = 22.3$$

damping res.

$$\beta = \frac{g_m}{2\pi RC} \qquad R = \frac{1}{2\pi \beta C} = \frac{}{6.28 \times 22.3 \times 10^6 \times 10^{-11}}$$

$$= \frac{1}{6.28 \times 223 \times 10^{-6}} = 7.14 \times 10^3$$

not true

~~$g_m R = 2.68$~~ ~~$6 \times 10^{-3} = 447$~~

stage gain $= 6 \times 10^{-3} \times 7.14 \times 10^3 = 42.84 \times$

at center freq of 46.5 mc

$db = 20 \log 42.84 = 20 \log 6.3 = 12.6$

2nd stage

f_2

$60\ mc \times$ ~~.48~~ β 39.5

$$\text{damp res} = \frac{1}{2\pi \beta C} = \frac{1}{6.28 \times \frac{}{39.5} \times 10^{-3}} = 403\ \Omega$$

3rd stage

f_3

$60\ mc \times 1.29 = 77.4$ ~~$\times .48 = 37.9$~~ β_3

$\times .48 = 37.9\ mc$

$$Res = \frac{1}{2\pi \beta C} = \frac{1}{6.28 \times 37.9} =$$

III

stage gain of 570Ω at 6×10^{-3} mho —

$G = \frac{GB}{B} = \frac{75.8}{25.3} \simeq 3X$ $\quad db = 20 \lg 3 = 20 \times .477 = 9.54$

$9 \times 9.54 = 85.8$ db Volt gain $= \frac{85.8}{20} = 4.29 = 1.95 \times 10^4$

for katy B noise of 2.3 nV

noise out at detector $= .23 \times 10^{-4} \times 1.95 \times 10^4 = .448$

This may be low — however increasing G merely involves changing R_{KS}

$R_K + R_S$ for −1.5

$I_P = .01A \quad R_K = \frac{1.5}{.01} = 150\Omega$

~~$R_S =$~~

I.F. strip for G-30 mod.

$F = 60$ mc

Max possible B

$T = .08\ \mu sec$

$$opt\ B = \frac{1.2 \times 2}{.08 \times 10^{-6}} = 15\ mc \times 2 = 30\ mc$$

Try for this -

Gain = 120 db

With 6AK5 tubes -

at 6000 μ mhos — this is near max

$I_b = 9.5$ ma Pl. diss $e_g = 1.71$ Watts

$E_p = 180$
$.095$

$$GB = \frac{g_m}{2\pi C} = \frac{6 \times 10^{-3}}{6.28 \times 10^{-11}} = 95.5\ mc$$

For 5702 -

$$GB = \frac{6 \times 10^{-3}}{6.28 \times .9 \times 10^{-11}} = 106\ mc$$

$I_b = 10.4$ ma @ 120 V

or $W_p = 1.24$ W

this is higher than normal but within max ratings

~~Physical Electronics~~

for Gain of 120 db + Q of 30

approx no. of stages are -

6AK5 $\frac{95.5}{30} = 2.89 = 20 \times .447 = 8.94$ db

5702 $\frac{106}{30} = 3 \times = 20 \times .477 = 9.54$

no tubes ~~for~~ $\frac{106}{39.5} = 2.68$ or $20 \times .428 = 8.56$ db

$\frac{12}{1712}$

$\frac{856}{10272}$

6AK5 $\frac{120}{8.94} \approx 13$

5702 $\frac{120}{9.54} \approx 12$

Try ~~3~~ ~~5~~ triples

B shrinkage See Sec 4 (RF Amp. MIT series)

$\sqrt{2^{1/m} - 1} \rightarrow .76 \quad \frac{30}{.76} = 39.5$

$\delta = \frac{B}{f_0} = \frac{39.5}{60} = .66 \quad d = .48 \quad \alpha = 1.29$

g

3.6
11.

44
03
132.

70 mm Cameras — Smock

5703 tubes

Batteries - BA-259/AM

First stage

$\delta = \frac{\beta}{f_0} = .66$

$f_1 = \frac{f_0}{\alpha} = \frac{60}{1.29} = 46.5$ $\quad \beta_1 = f_1 \times d = 46.5 \times .48 = 22.7$

$R_1 = \frac{1}{2\pi \beta C} = \frac{1}{6.28 \times 22.7 \times 10^6 \times 8.6 \times 10^{-12}} = 816\ \Omega$

2nd Stage

$f_2 = f_0 = 60\ mc \quad \beta_2 = 39.5\ mc$

$.8 \times 3 = 2.7$

$R_2 = \frac{1}{6.28 \times 39.5 \times 8.6} = 468\ \Omega$

$.4 \times 3 = 1.2$

$3.6 + .6 = 2.16$

3rd Stage

$f_3 = 60 \times 1.29 = 77.4\ mc \quad .66 \times 77.4 = 51.1\ mc$

$R_3 = \frac{1}{6.28 \times 51.1 \times 8.6} = 226\ \Omega$

$Gain = gm\ r = 3 \times 10^{-3} \times 22 = .66$

$Gain = .005 \times 468$

$.005$

1.404

~~10 k~~

~~$6.28 \times 60 \times 10^6 \times 1 \times 10^{-6}$~~

Looks fishy