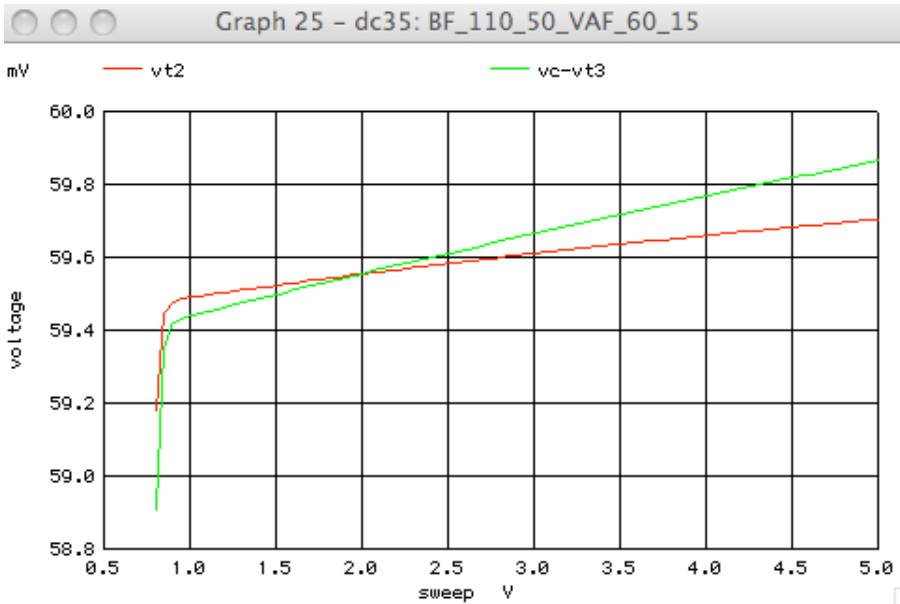


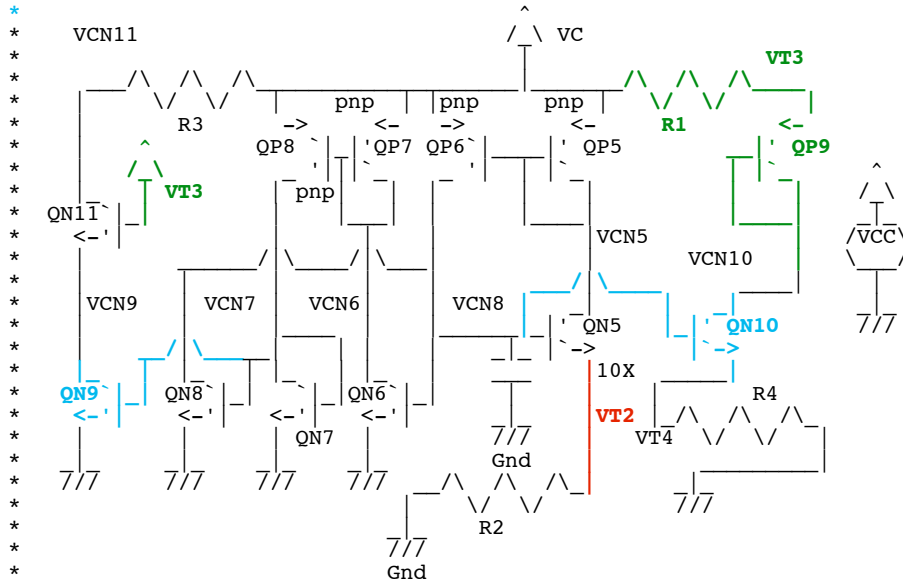
====Balanced_BandGap_4_Biasing====

HOW TO BIAS UP A CIRCUIT USING A BALANCED BANDGAP.



Balanced_BandGap_4_Biasing.cir

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Patent No.: US 6,614,293 B1

```
.OPTIONS gminsteps = 1
```

Component	Value	Component	Value	Component	Value
VCC	VC	0	DC	5	
QN5	VCN5	VCN8	VT2	NPN1	10
QN6	VCN6	VCN8	0	NPN1	1
QN7	VCN7	VCN7	0	NPN1	1
QN8	VCN8	VCN7	0	NPN1	1
QN9	VCN9	VCN7	0	NPN1	1
QN10	VCN10	VCN8	VT4	NPN1	10
QN11	VCN11	VT3	VCN9	NPN1	1
QP5	VCN5	VCN5	VC	PNP1	1
QP6	VCN8	VCN5	VC	PNP1	1
QP7	VCN6	VCN6	VC	PNP1	1
QP8	VCN7	VCN6	VC	PNP1	1
QP9	VCN10	VCN10	VT3	PNP1	10
R2	VT2	0	60K		

```

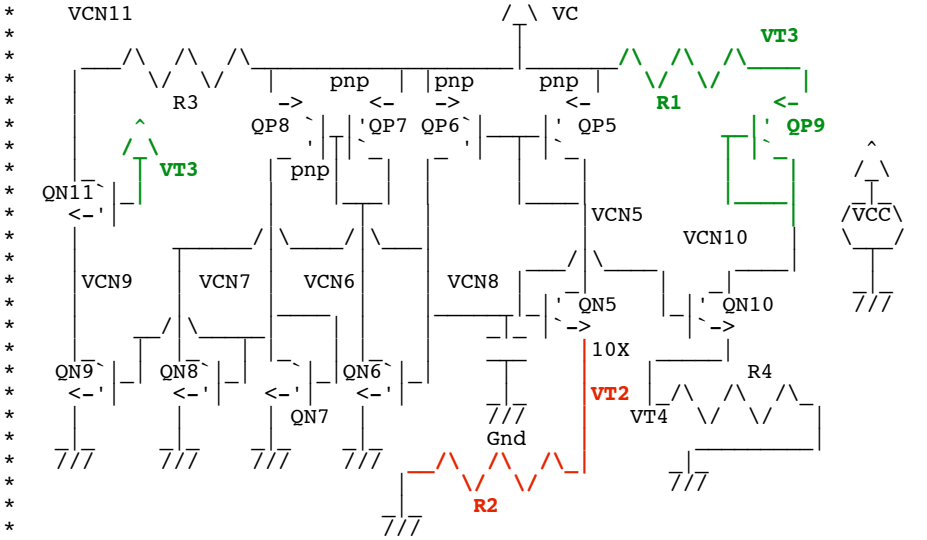
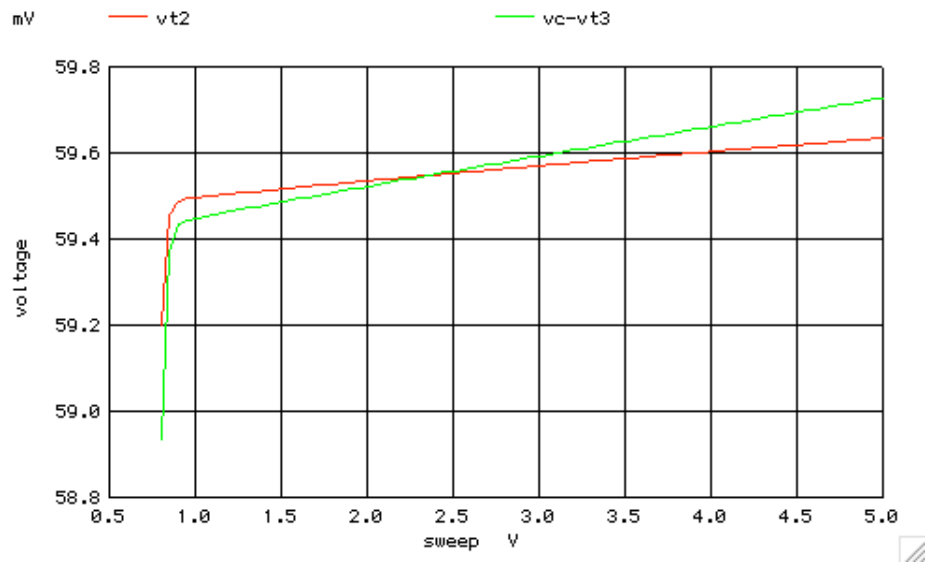
R1      VT3      VC      60K
R3      VCN11   VC      60K
R4      VT4      0      60K
C2      VCN8     0      1P
.dc     VCC     .8      5      .05
*#0====Can_The_Balanced_BandGap_Balances_Out_A_Load====

.control
*#1====Start_Off_With_Normal_Levels_Of_Beta_And_VAF====
run
echo    "=====bf set to 110 for NPN====="
plot    vt2      vc-vt3      title    BF_110_50_VAF_60_30
*#2====Test_The_Effects_Of_Cutting_NPN_Beta_BY_50%====
altermod npn1      bf=50
run
plot    vt2      vc-vt3      title    BF_50_50_VAF_60_30
echo
echo    "=====set bf to 50 for NPN====="
*print  vt2      vc-vt3
*#3====Test_The_Effects_Of_Cutting_PNP_Beta_BY_50%====
altermod npn1      bf=110
altermod pnp1      bf=25
run
plot    vt2      vc-vt3      title    BF_110_25_VAF_60_30
*#4====Test_The_Effects_Of_Cutting_NPN_VAF_BY_50%====
altermod pnp1      bf=50
altermod npn1      vaf=30
run
plot    vt2      vc-vt3      title    BF_110_50_VAF_30_30
*#5====Test_The_Effects_Of_Cutting_PNP_VAF_BY_50%====
altermod npn1      vaf=60
altermod pnp1      vaf=15
run
plot    vt2      vc-vt3      title    BF_110_50_VAF_60_15
echo
echo    "=====set bf to 25 for PNP====="
.endc
.model  NPN1      NPN(    BF=110 VAF=60 )
.model  PNP1      PNP(    BF=50  VAF=30 )
.end

*#1====Start_Off_With_Normal_Levels_Of_Beta_And_VAF====
run
plot    vt2      vc-vt3      title    BF_110_50_VAF_60_30

```

Graph 21 - dc31: BF_110_50_VAF_60_30

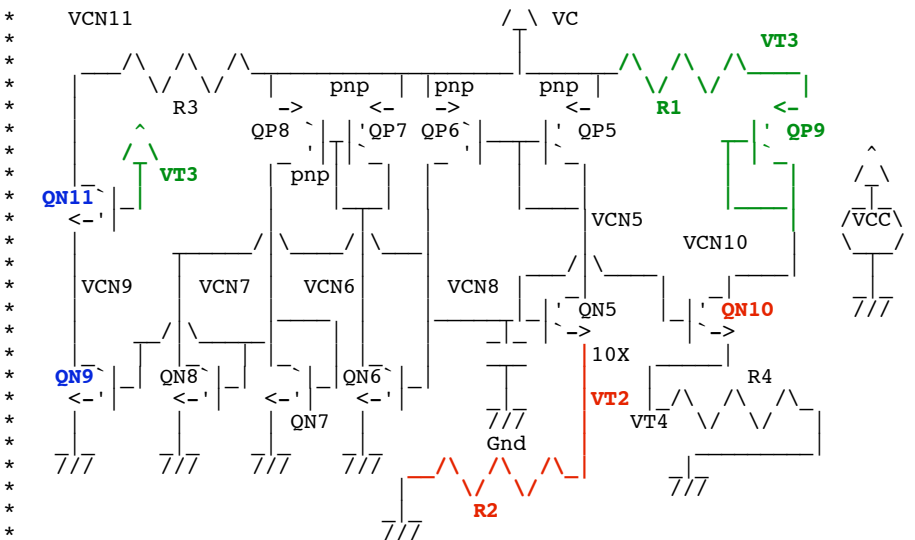
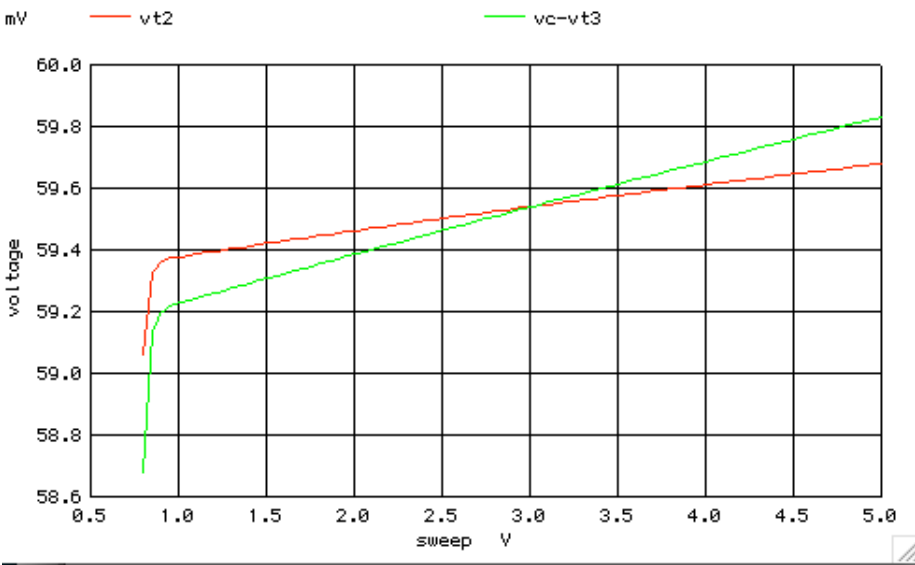


The Goal is to make a current through R1 always equal R2

```

*#2====Test_The_Effects_Of_Cutting_NPN_Beta_BY_50%====
altermod npn1      bf=50
run
plot               vt2          vc-vt3          title    BF_50_50_VAF_60_30
    
```

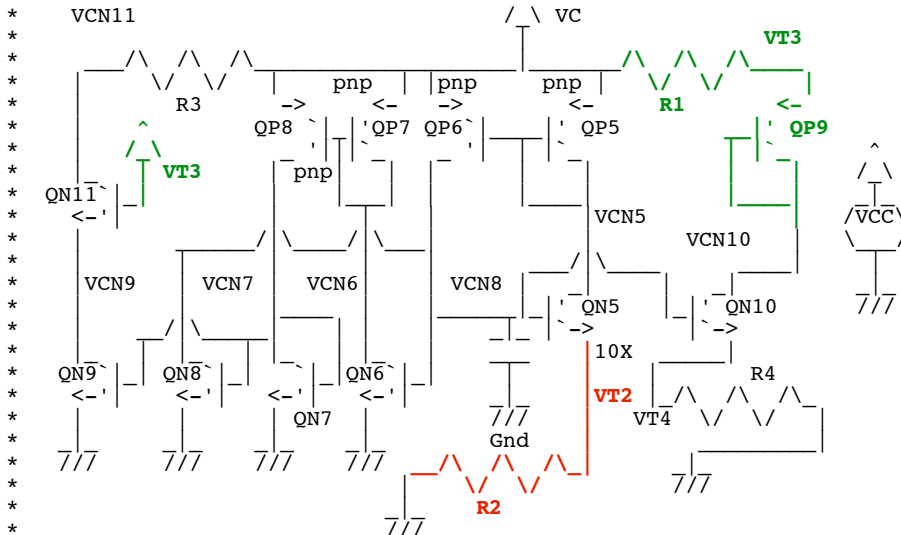
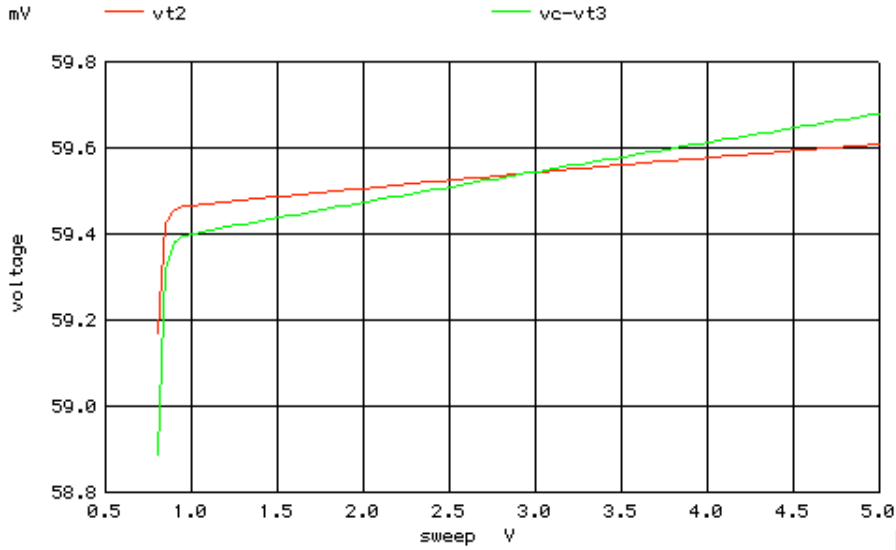
Graph 22 - dc32: BF_50_50_VAF_60_30



Transistors QN9, QN11 and QN10 are balanced NPN Beta Loads

```
*#3====Test_The_Effects_Of_Cutting_PNP_Beta_BY_50%====
altermod npn1 bf=110
altermod npn1 bf=25
run
plot vt2 vc-vt3 title BF_110_25_VAF_60_30
```

Graph 23 - dc33: BF_110_25_VAF_60_30

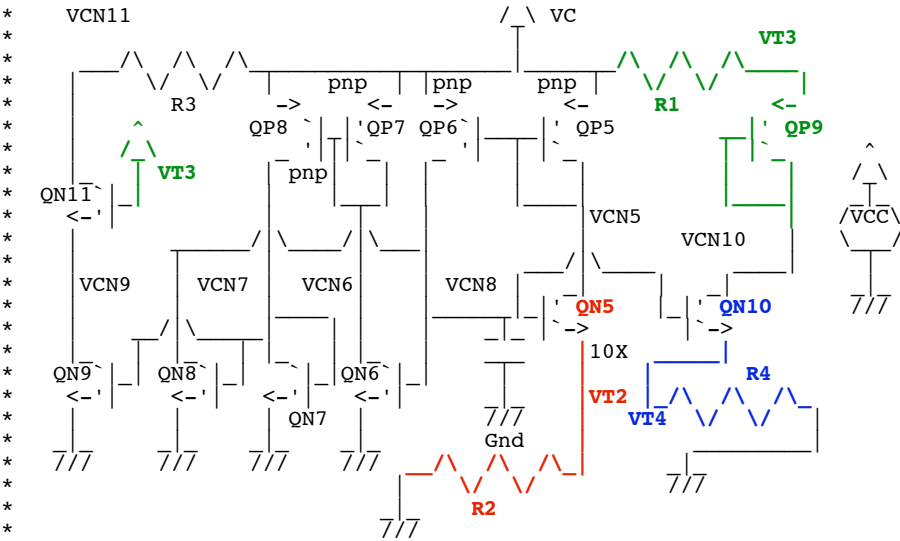
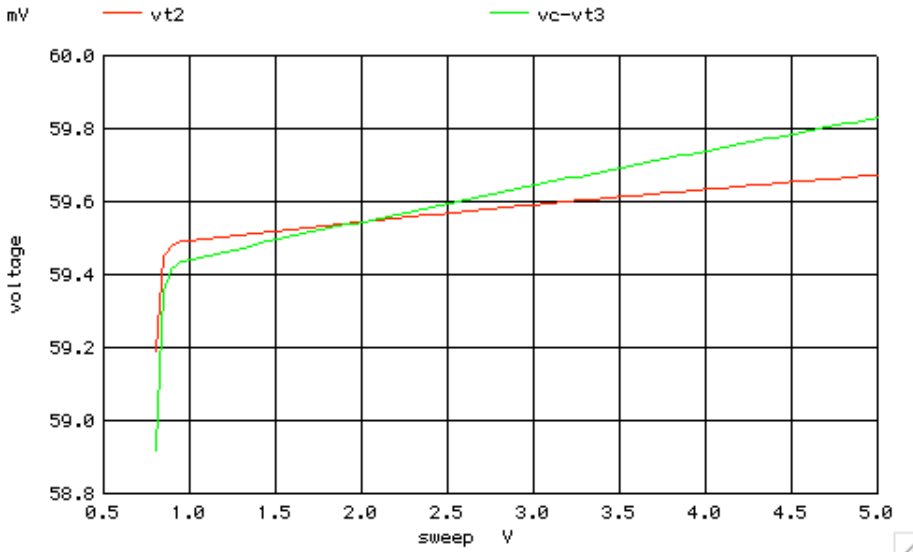


Similar methods could be used to balanced PNP Beta Loads

```

*#4====Test_The_Effects_Of_Cutting_NPN_VAF_BY_50%====
altermod  pnp1    bf=50
altermod  npn1    vaf=30
run
plot      vt2      vc-vt3      title  BF_110_50_VAF_30_30
    
```

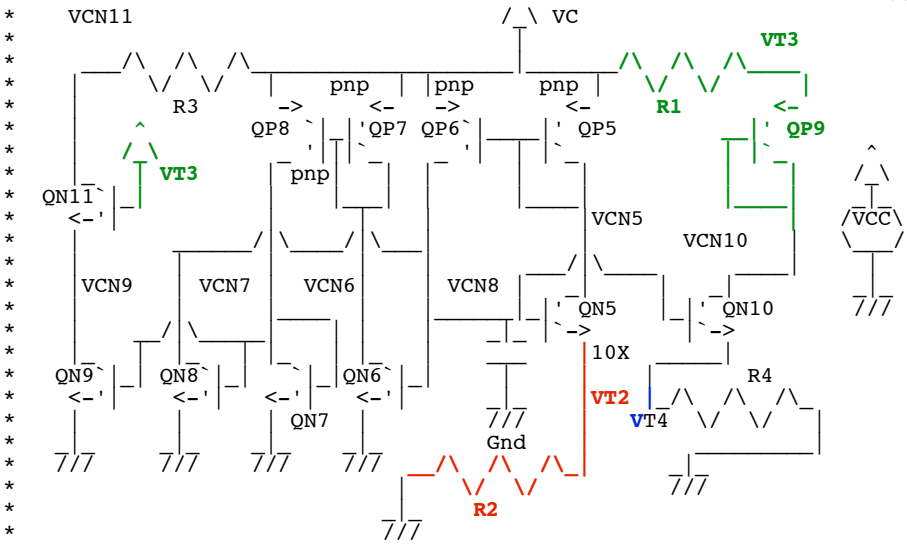
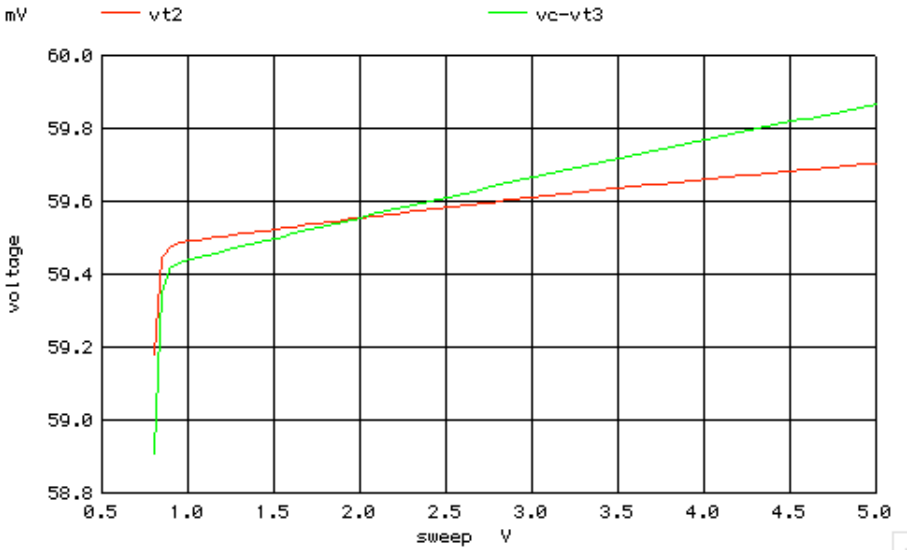
Graph 24 - dc34: BF_110_50_VAF_30_30



Transistors **QN10** and **QN5** are biased the exact same

```
*#5====Test_The_Effects_Of_Cutting_PNP_VAF_BY_50%====
altermod npn1 vaf=60
altermod pnp1 vaf=15
run
plot vt2 vc-vt3 title BF_110_50_VAF_60_15
```

Graph 25 - dc35: BF_110_50_VAF_60_15

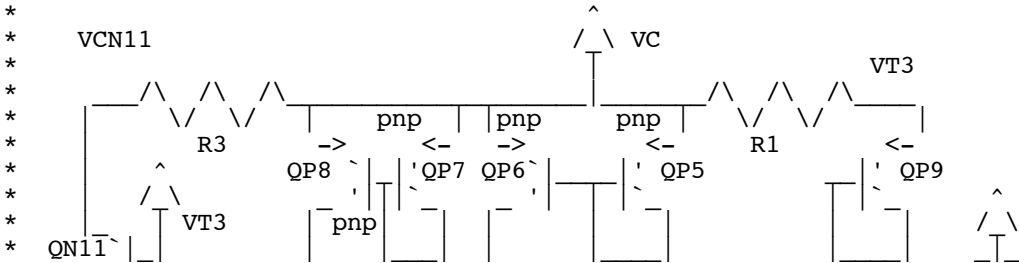


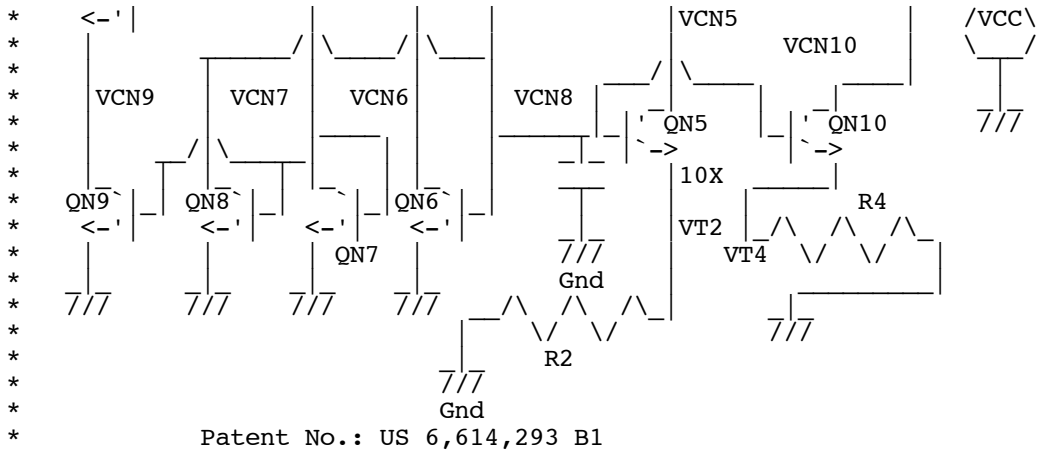
Similar methods could be used to balanced PNP VAF

A BandGap can be made as precise as it errors can be known.
 Any Known Errors can be "balanced"out.
 Precision modeling of silicon is the next step.

*#1=====WinSpiceVersion=====

Balanced_BandGap_4_Biasing.cir
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Patent No.: US 6,614,293 B1

```
.OPTIONS    gminsteps = 1
*=====
VCC        VC          0                DC          5
QN5        VCN5       VCN8             VT2         NPN1      10
QN6        VCN6       VCN8             0            NPN1      1
QN7        VCN7       VCN7             0            NPN1      1
QN8        VCN8       VCN7             0            NPN1      1
QN9        VCN9       VCN7             0            NPN1      1
QN10       VCN10      VCN8             VT4          NPN1     10
QN11       VCN11      VT3             VCN9         NPN1      1
QP5        VCN5       VCN5           VC            PNP1      1
QP6        VCN8       VCN5           VC            PNP1      1
QP7        VCN6       VCN6           VC            PNP1      1
QP8        VCN7       VCN6           VC            PNP1      1
QP9        VCN10      VCN10          VT3           PNP1     10
R2         VT2        0              60K
R1         VT3        VC              60K
R3         VCN11      VC              60K
R4         VT4        0              60K
C2         VCN8       0              1P
.dc        VCC        .8            5           .05

*#0====Can_The_Balanced_BandGap_Balances_Out_A_Load====

.control
*#1====Start_Off_With_Normal_Levels_Of_Beta_And_VAF====
run
echo      "=====bf set to 110 for NPN====="
plot      vt2          vc-vt3           title    BF_110_50_VAF_60_30
*#2====Test_The_Effects_Of_Cutting_NPN_Beta_BY_50%====
alter    npn1         bf=50
run
plot      vt2          vc-vt3           title    BF_50_50_VAF_60_30
echo      "=====set bf to 50 for NPN====="
*print   vt2          vc-vt3
*#3====Test_The_Effects_Of_Cutting_PNP_Beta_BY_50%====
alter    npn1         bf=110
alter    pnp1         bf=25
run
plot      vt2          vc-vt3           title    BF_110_25_VAF_60_30
*#4====Test_The_Effects_Of_Cutting_NPN_VAF_BY_50%====
alter    pnp1         bf=50
alter    npn1         vaf=30
run
plot      vt2          vc-vt3           title    BF_110_50_VAF_30_30
*#5====Test_The_Effects_Of_Cutting_PNP_VAF_BY_50%====
alter    npn1         vaf=60
alter    pnp1         vaf=15
run
plot      vt2          vc-vt3           title    BF_110_50_VAF_60_15
```



```
echo
echo "=====set bf to 25 for PNP======"
.endc
.model NPN1 NPN( BF=110 VAF=60 )
.model PNP1 PNP( BF=50 VAF=30 )
.end
```