# *New SQUID feed-back scheme for MiniGRAIL*

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## *Some humor to help you face the torture*

- How does Einstein begin a story?
  A: Once upon a space-time...
- Gravitation cannot be held responsible for people falling in love.
- What's the difference between an auto mechanic and a quantum mechanic?
  The quantum mechanic can get the car inside the garage without opening the door.

## *Course of the talk*

- Basics
- dc SQUID
- Feedback
- Analysis
- Transducers

# *Basics.*

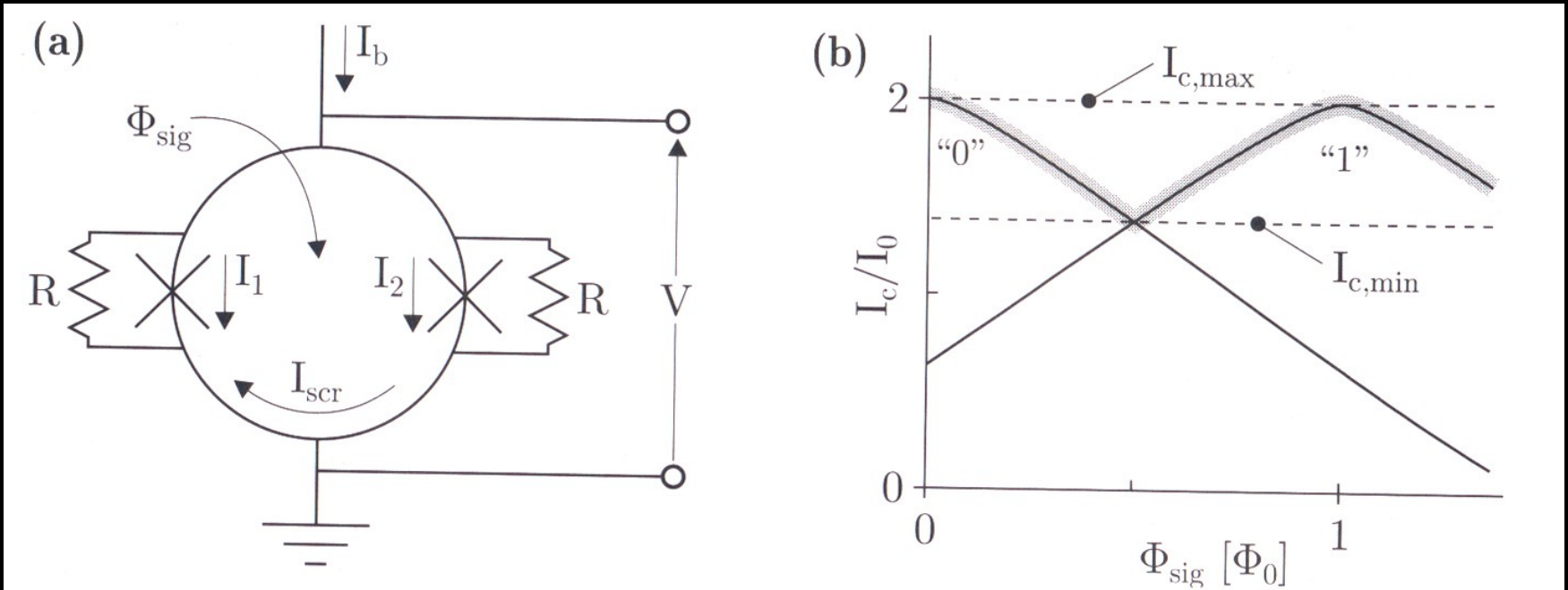
quantization

Josephson tunnel junction

dc SQUID

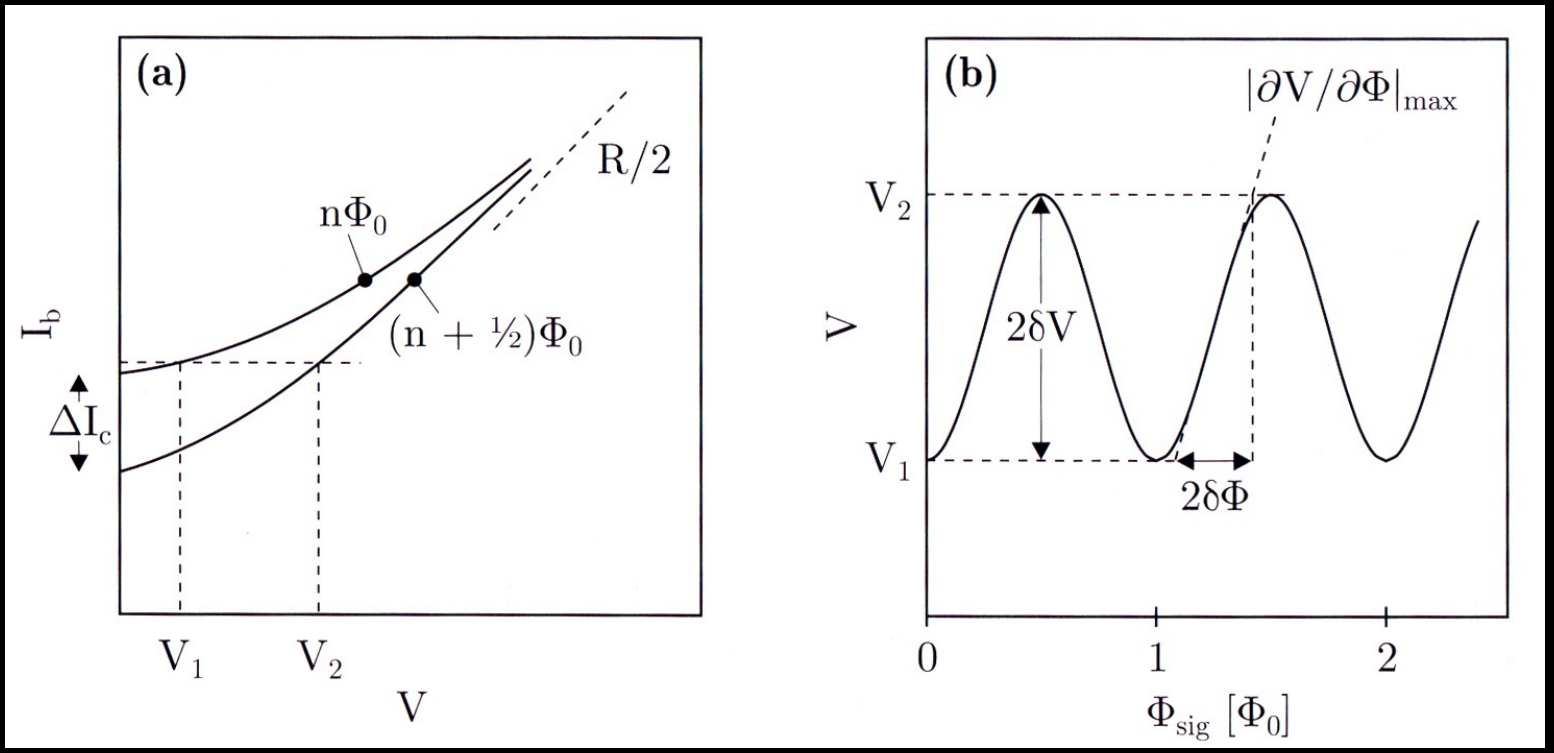
Screening Current

# *dc SQUID*

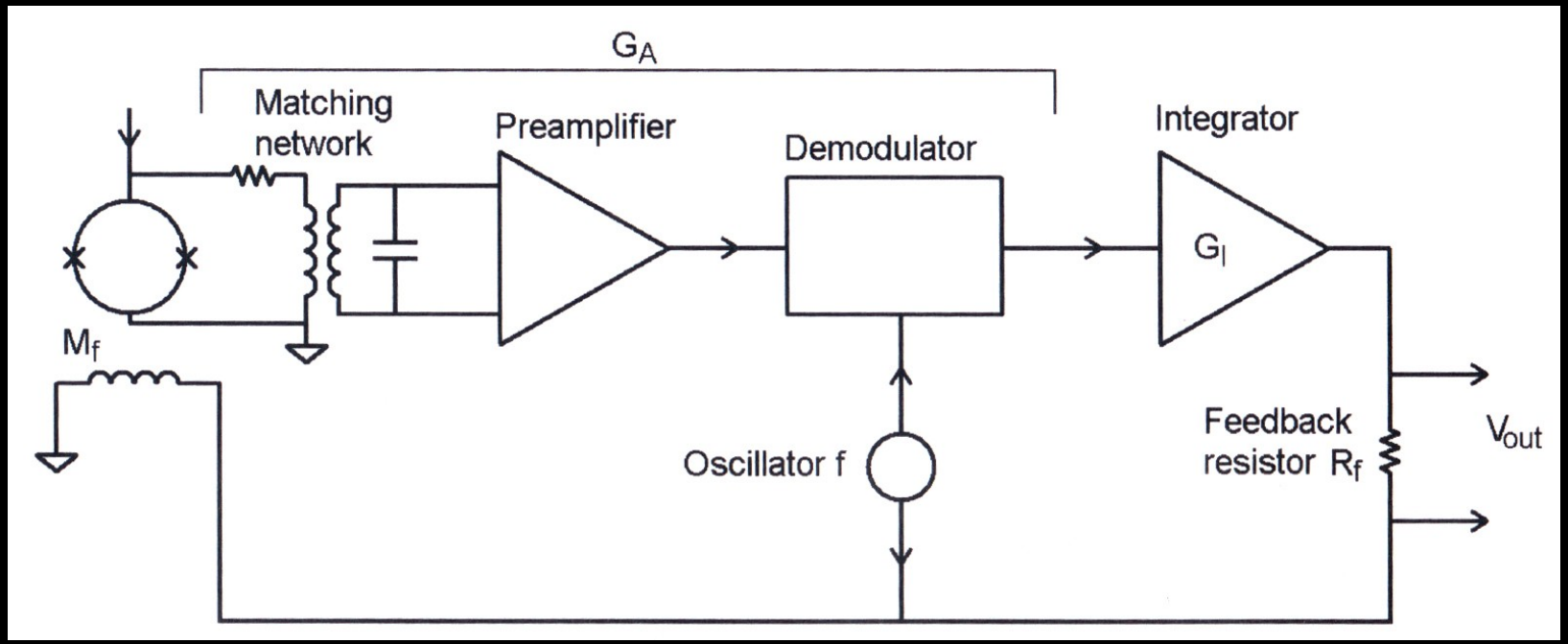



$$I_b = 2I_0 - 2I_{scr.}$$

*dc SQUID as flux to voltage converter.*

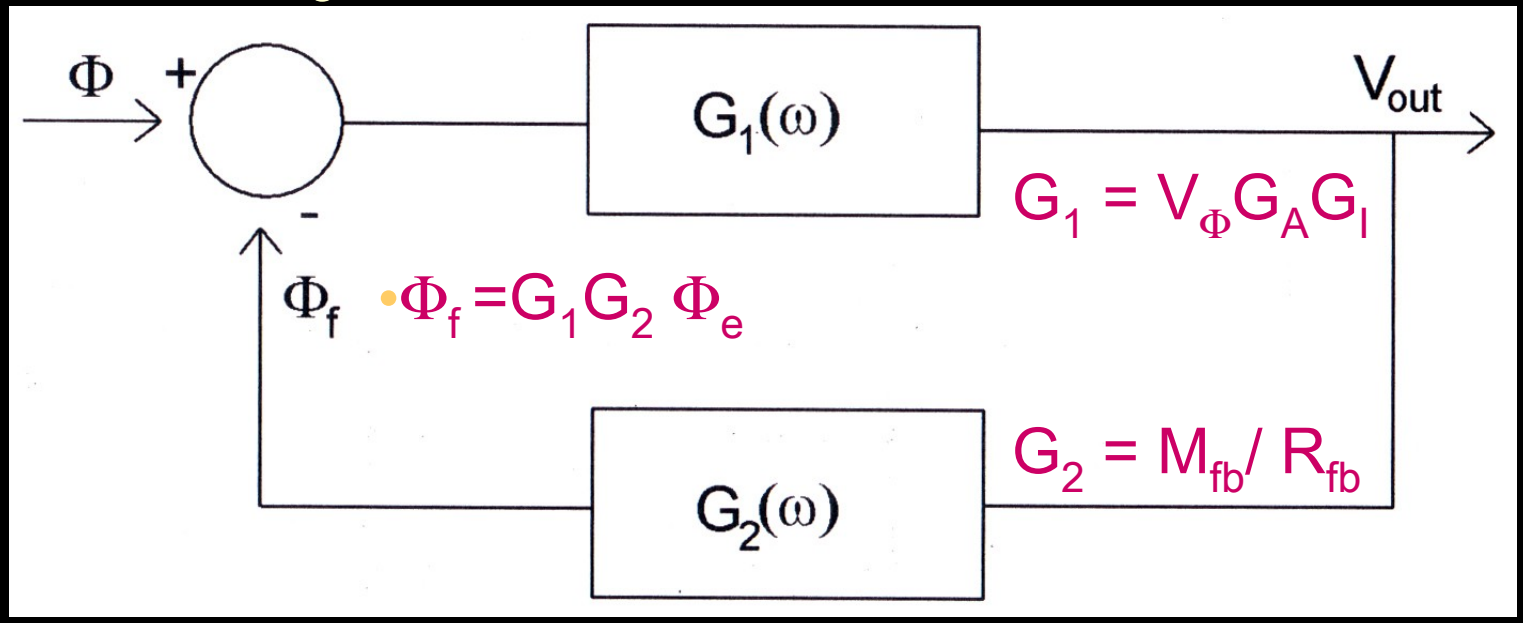


# *Flux Locked Loop.*



# *Schematic*

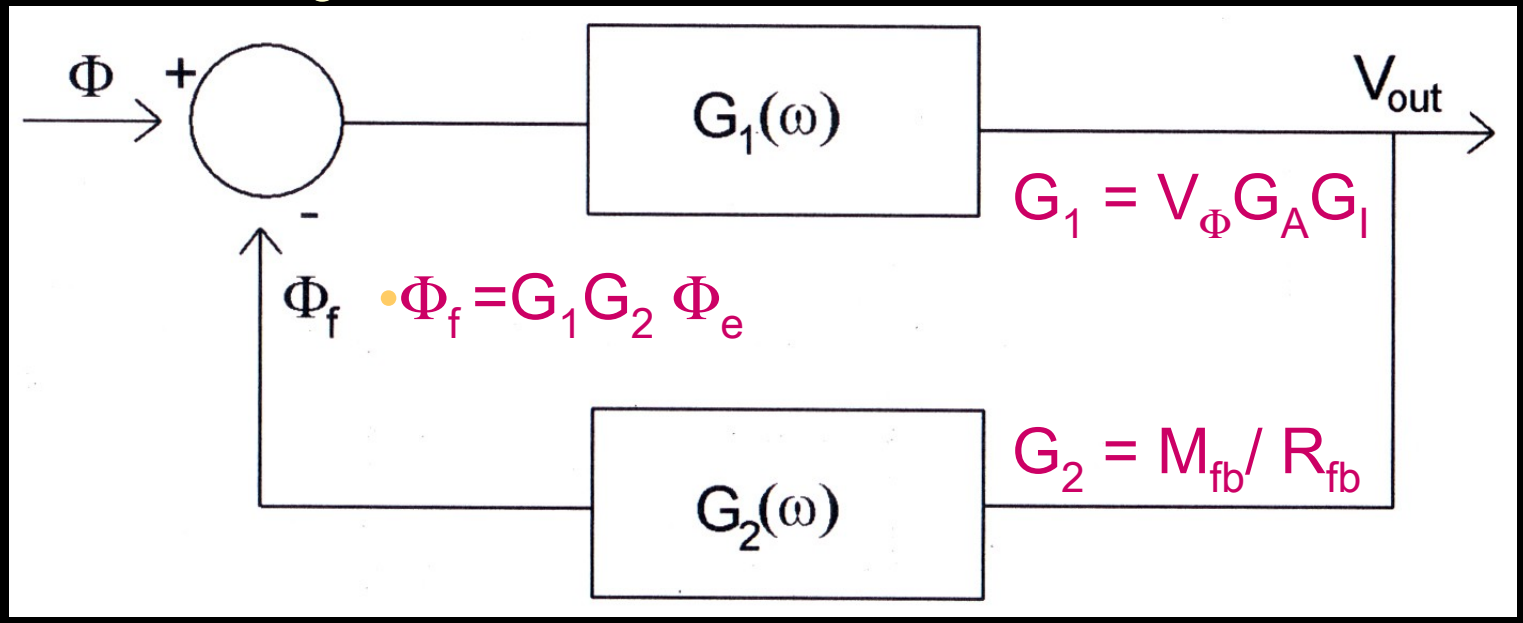
- $\Phi_e = \Phi_{sig} - \Phi_f$




- $G_A$ = gain of the amplifier
- $G_I$ = gain of the integrator
- $V_\Phi$ = flux to voltage transfer ratio

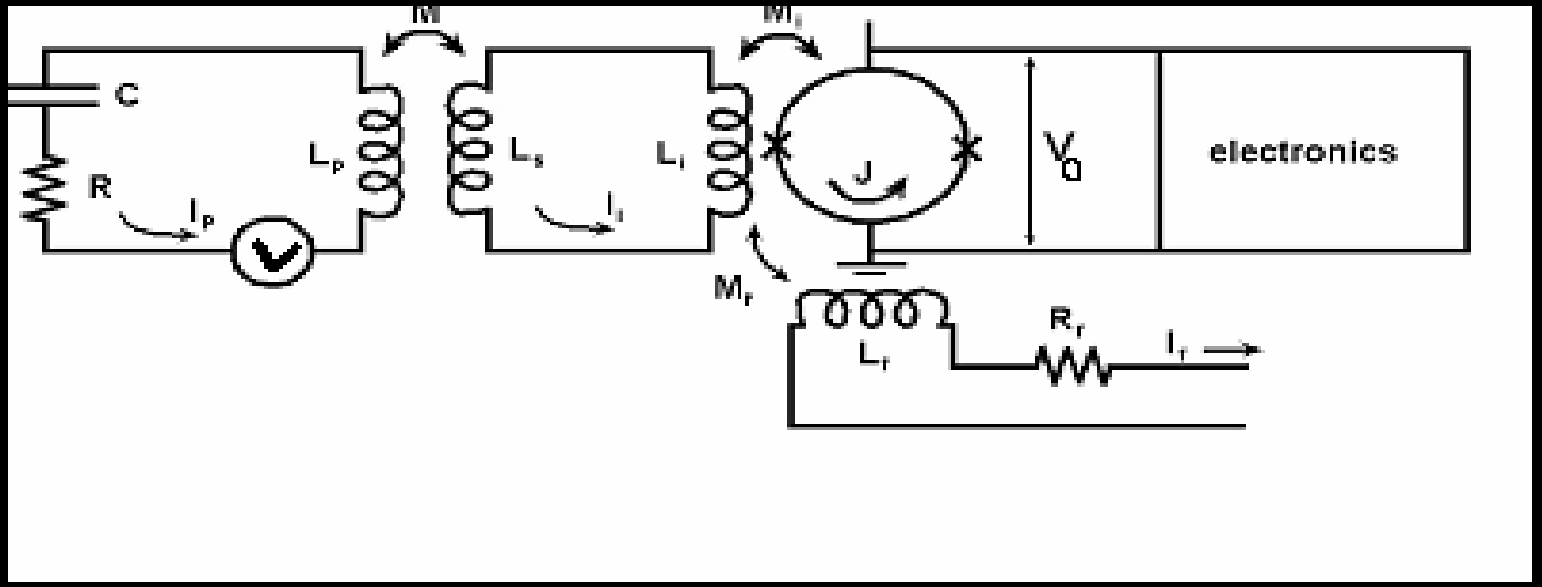
# *Schematic*

- $\Phi_e = \Phi_{sig} - \Phi_f$




- $\Phi_f = [G/(1+G)]^* \Phi$ where we have put $G = G_1G_2$
- $\Phi_e = [G/(1+G)]^* \Phi$
- $V_{out} = [G/(1+G)]\ R_{fb}/ M_{fb} * \Phi$

# *Analysis*



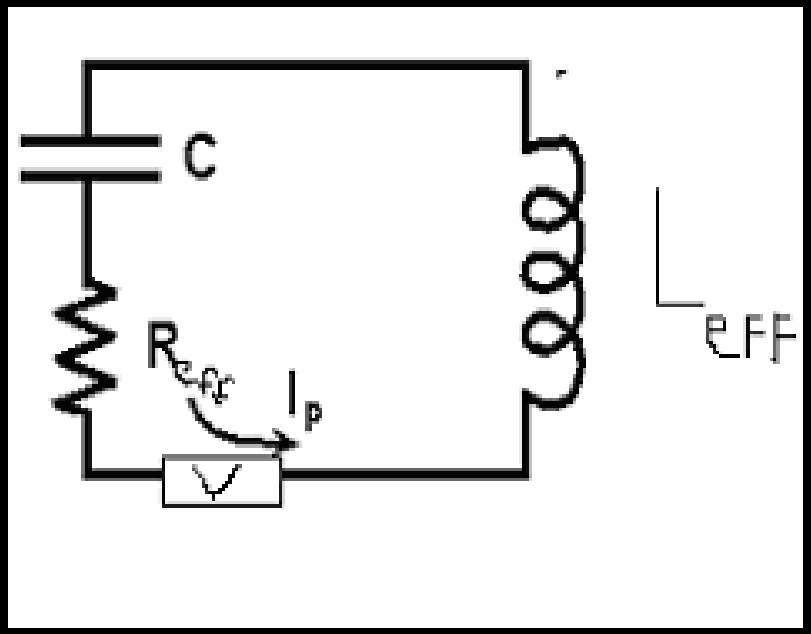

- $I_p(jwL_p+R+1/jwC)+jwMI_i=V$
- $MI_p+(L_s+L_i)I_i+M_fI_f+M_iJ=0$
- $MI_p+(L_s+L_i)I_i+M_fI_f = 0.$
- $MI_p+(L_s+L_i)I_i+[G/(1+G)]* M_iI_i=0.$

# *Analysis*

- $I_p[R + 1/jwC + jw(L_p - M^2/\{(L_s+L_i)+ G/(1+G) M_i\}] =V$
- $G/(1+G) = A + jB$
- $I_P[R + wBM^2M_i/\{(L_s+L_i+ A M_i)^2 + (BM_i)^2\}+ 1/jwC + jw\{L_p - M^2( L_s+L_i+AM_i)/ (L_s+L_i+ A M_i)^2 + (BM_i)^2)\}] = V$

# *Effective circuit.*

- $R_{eff} = R + wBM^2M_i/\{(L_s+L_i+ A M_i)^2 + (BM_i)^2\}$
- 
- $L_{eff} = \{L_p - M^2( L_s+L_i+AM_i)/ (L_s+L_i+ A M_i)^2 + (BM_i)^2)\}$
- 
- $C_{eff} = C.$
- 

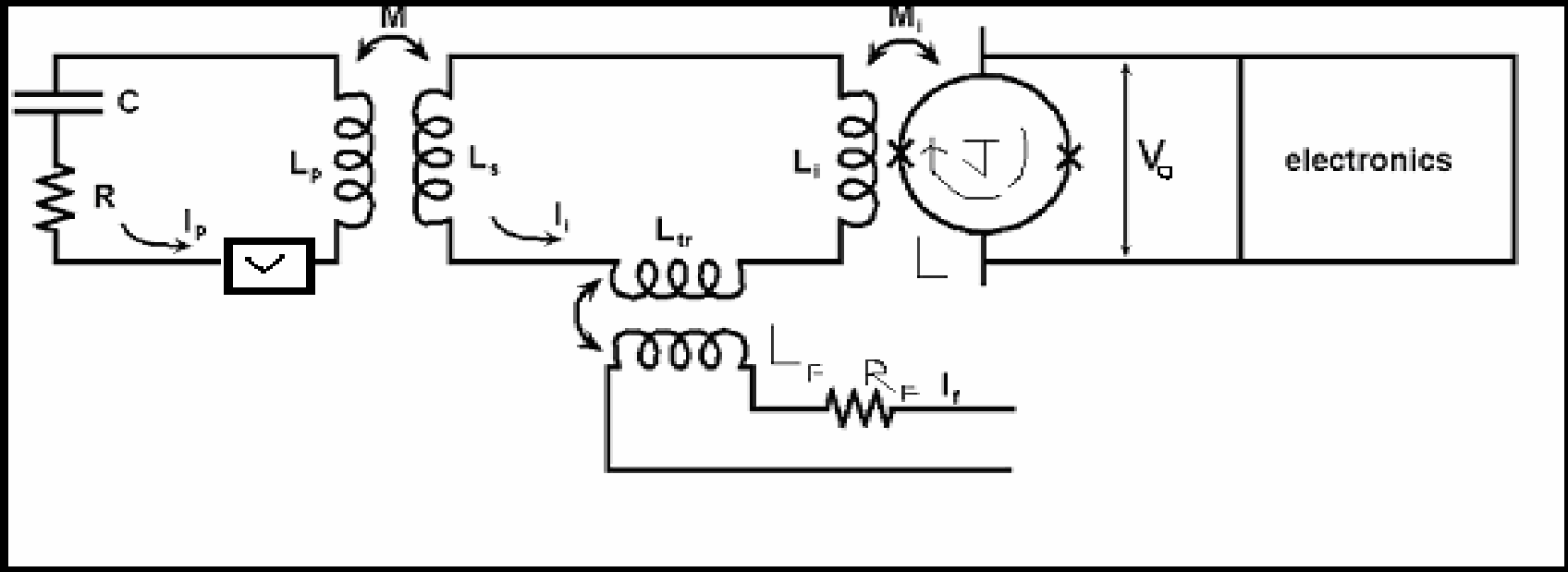


# *Q*

$$Q = wL_{eff} / R_{eff}$$

$$= \frac{w\{L_p - M^2( L_s+L_i+AM_i)/ (L_s+L_i+ A M_i)^2 + (BM_i)^2)\}}{R + \{R + wBM^2M_i/\{(L_s+L_i+ A M_i)^2 + (BM_i)^2\}}$$

# *The other way*



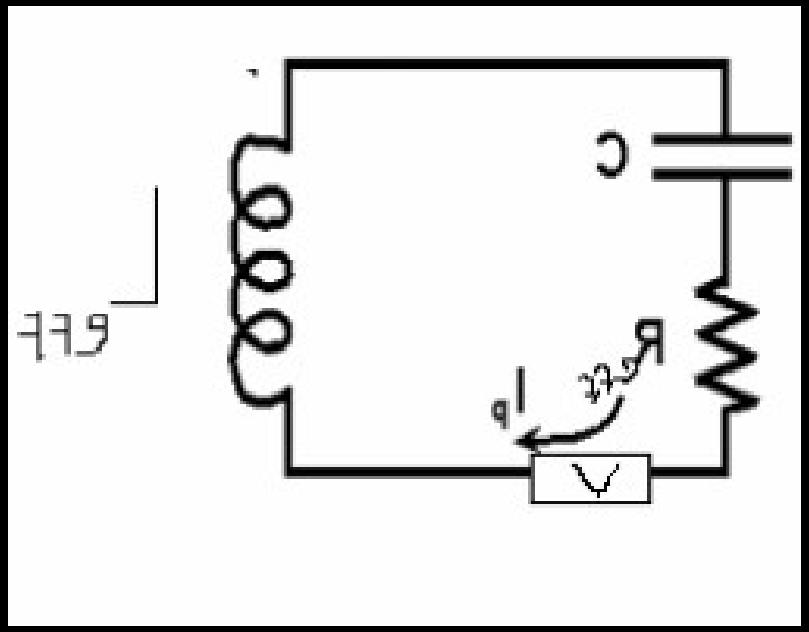

- $I' = V/jwL_{tr} = M_f I_f/L_{tr} = \Phi_f/L_{tr}$
- $I_e = I_i - I' = I - \Phi_f/L_{tr}$
- $\Phi_e = M_i I_e$
- $\Phi_f = G_1 G_2 \Phi_e = G\Phi_e = G M_i I_e$.

## *Otherway*

- Proceeding as before:
- $I_p[R+1/jwC +jw(L_p-M^2/((L_s+L_{tr}+L_i)+ G\ M_i)] = V.$
- $G(w)=A+jB$

# *Effective circuit*

- $R_{eff} = R+w M^2(M_iB)/((L_s+L_{tr}+L_i+M_iA)^2+(M_iB)^2)$
- $L_{eff} = ((L_p-M^2(L_s+L_{tr}+L_i+M_iA))/((L_s+L_{tr}+L_i+M_iA)^2+(M_iB)^2)$



# $Q$

$$Q = L_{eff} / R_{eff}$$

$$= w\frac{((L_p - M^2(L_s + L_{tr} + L_i + M_i A))}{((L_s + L_{tr} + L_i + M_i A)^2 + (M_i B)^2}$$

$$[R + w\, M^2 (M_i B)/((L_s + L_{tr} + L_i + M_i A)^2 + (M_i B)^2)].$$

## *comparison*

- $I_p[R + 1/jwC + jw(L_p - M^2/\{(L_s+L_i)+ G/(1+G) M_i\}] =V$
- $I_p[R+1/jwC +jw(L_p- M^2/((L_s+L_{tr}+L_i)+ G M_i)] = V$

# *Transducers*

What is a transducer?

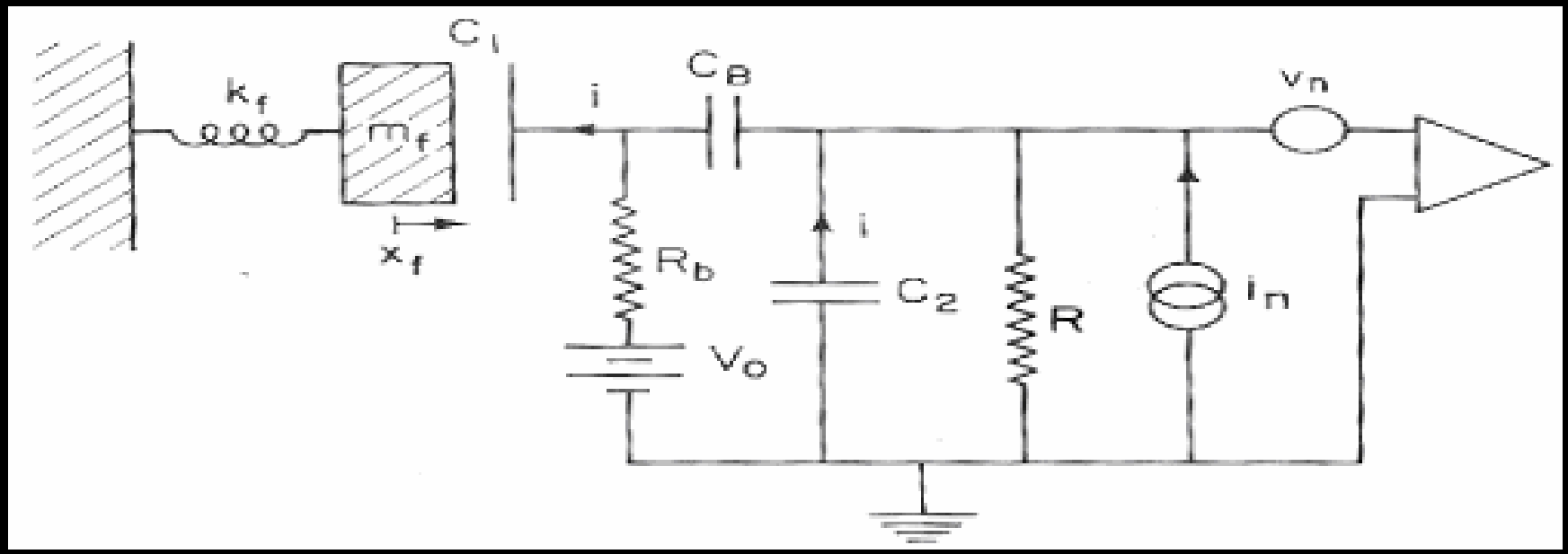
Types of transducer:

1) passive

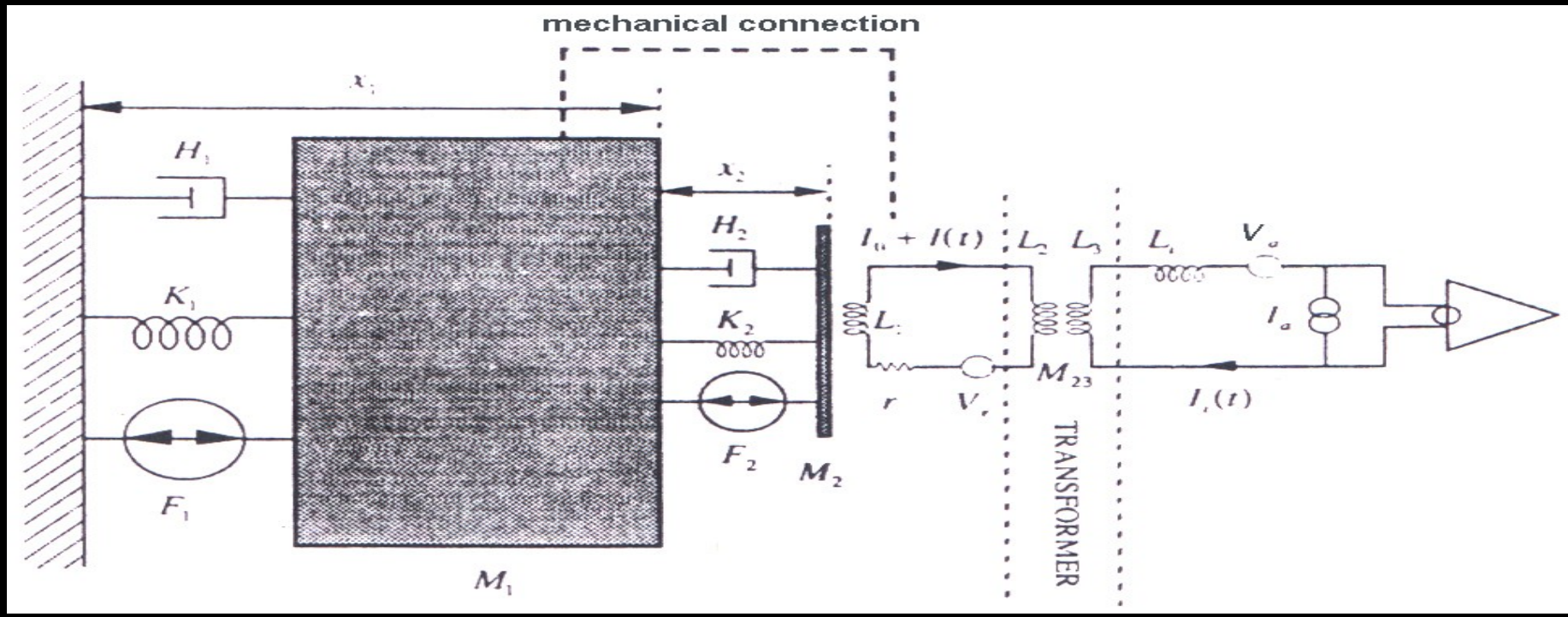
2) parametric

# *Passive transducer*

- Capacitive



# *Different designs*

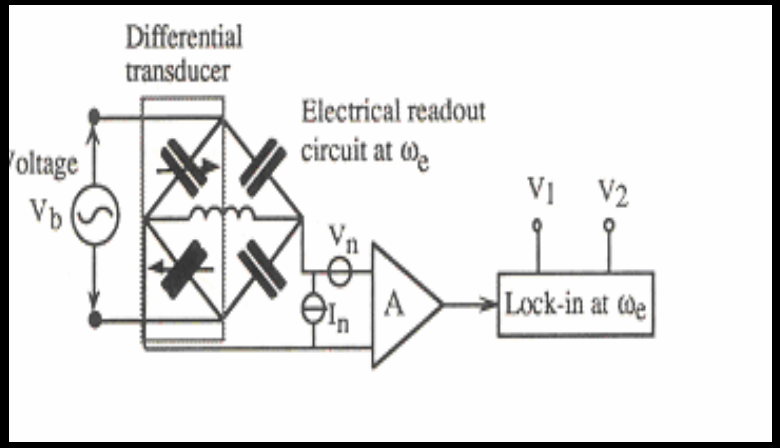


# *Different designs*

- **SiNb thin film Transducer**
- **Lever transducer**:$\delta = G^{2/3}$.
- **Allegro** :single coiled, mushroom shaped
- **Rosette Resonators**
- **Back Action Evasion transducer**

# *BAE*

- $\eta_z$=0 , BA noise has no effect.
- $\alpha_{BAE}=E_oQ_e/4$, $Q_e$ = exp (6)
- T= 100 mk, d=25 uM,E=2.5 exp (6)=> $T_{eff}$=2uK



# *Conclusion*

- The mathematical basis of negative Q's were searched and new feedback topology was suggested. Further work has to be done keeping the above analysis in mind to determine the stability of the system.

# *FINALY*

*Venture far, to see the nearby*
*With new eyes.*
*Perceive yesterday's gravity,*
*Whether acting on man or mass,*
*As today's free float.*
*In the movement of the mass*
*Grasp the message of the medium:*
*"I, medium that grips you,*
*Man and mass,*
*And tells you how to move*
*Am not space*
*I am* ***SPACETIME***