Structured Electronic Design

Feedback model of Black

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Invention of negative feedback

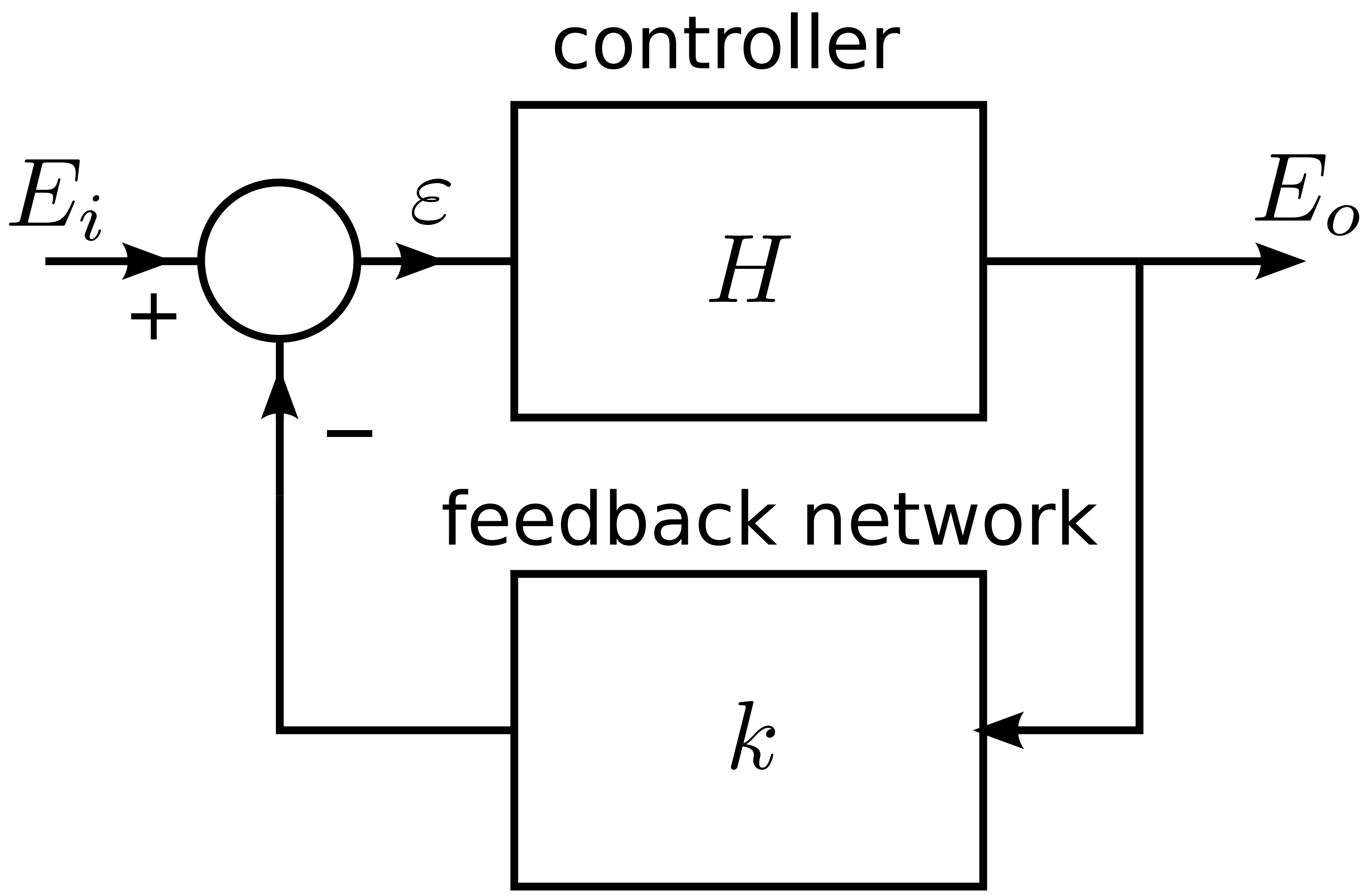
1927: Black: first negative feedback amplifier

1932: Black: Wave translation system

1932: Nyquist: Regeneration theory

1945: Bode: Network analysis and Feedback Amplifier Design

Black's feedback model



Equations:

$$\varepsilon = E_i - kE_o,$$
$$\varepsilon = \frac{1}{H} E_o.$$

Input-output transfer:

$$\frac{E_o}{E_i} = \frac{H}{1+Hk}$$

loop gain: Hk

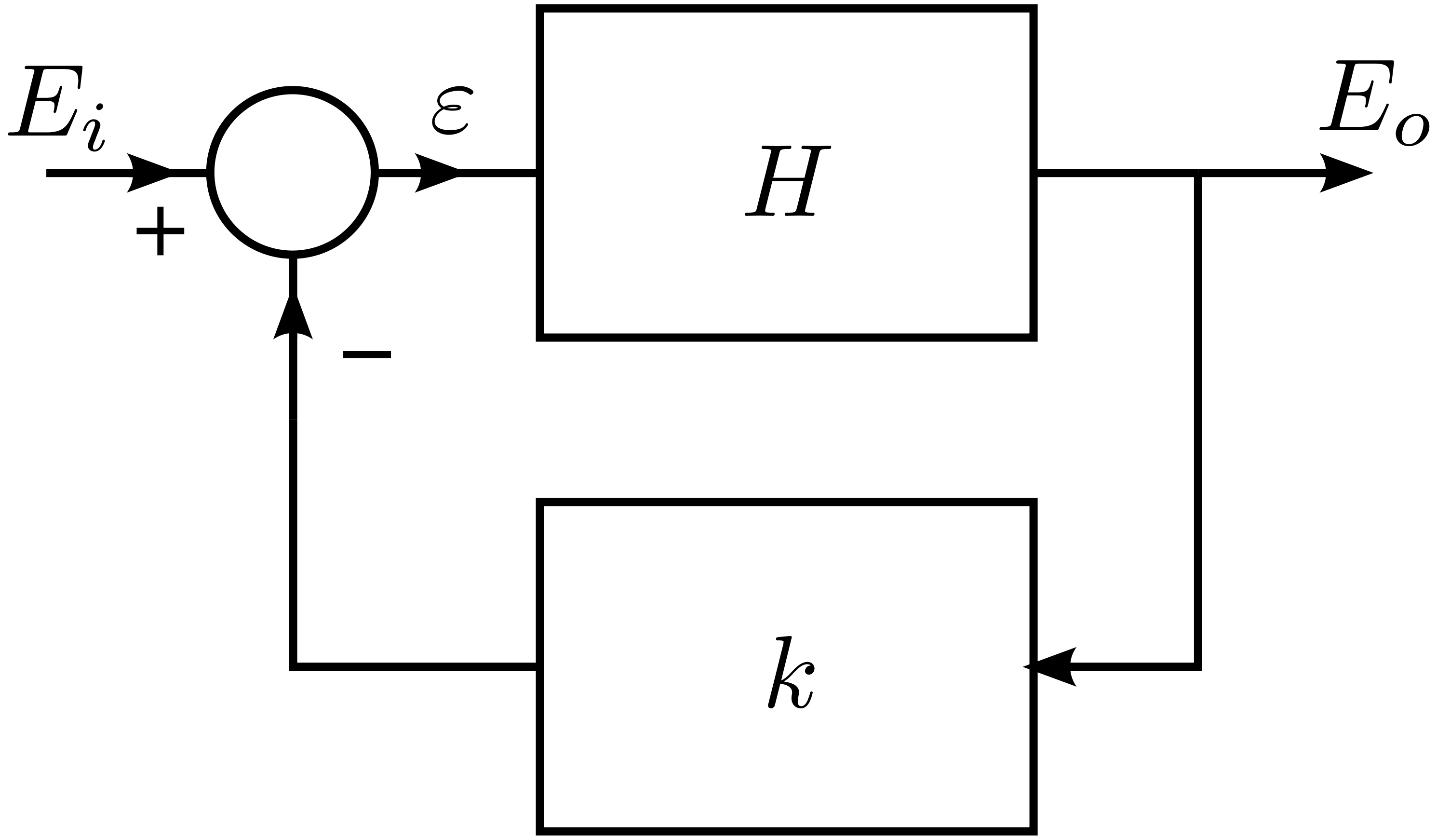
Ideal gain: $Hk \to \infty$

$$\lim_{Hk\to\infty}\left(\frac{E_o}{E_i}\right) = \frac{1}{k}$$

Input-output transfer, rewritten:

$$\frac{E_o}{E_i} = \frac{1}{k}\left(\frac{Hk}{1+Hk}\right)$$

Black's feedback model, assumptions



Ideal subtraction requires infinite CMRR, subtraction result does not depend on:

- Source impedance
- Input impedance controller
- Output impedance feedback network

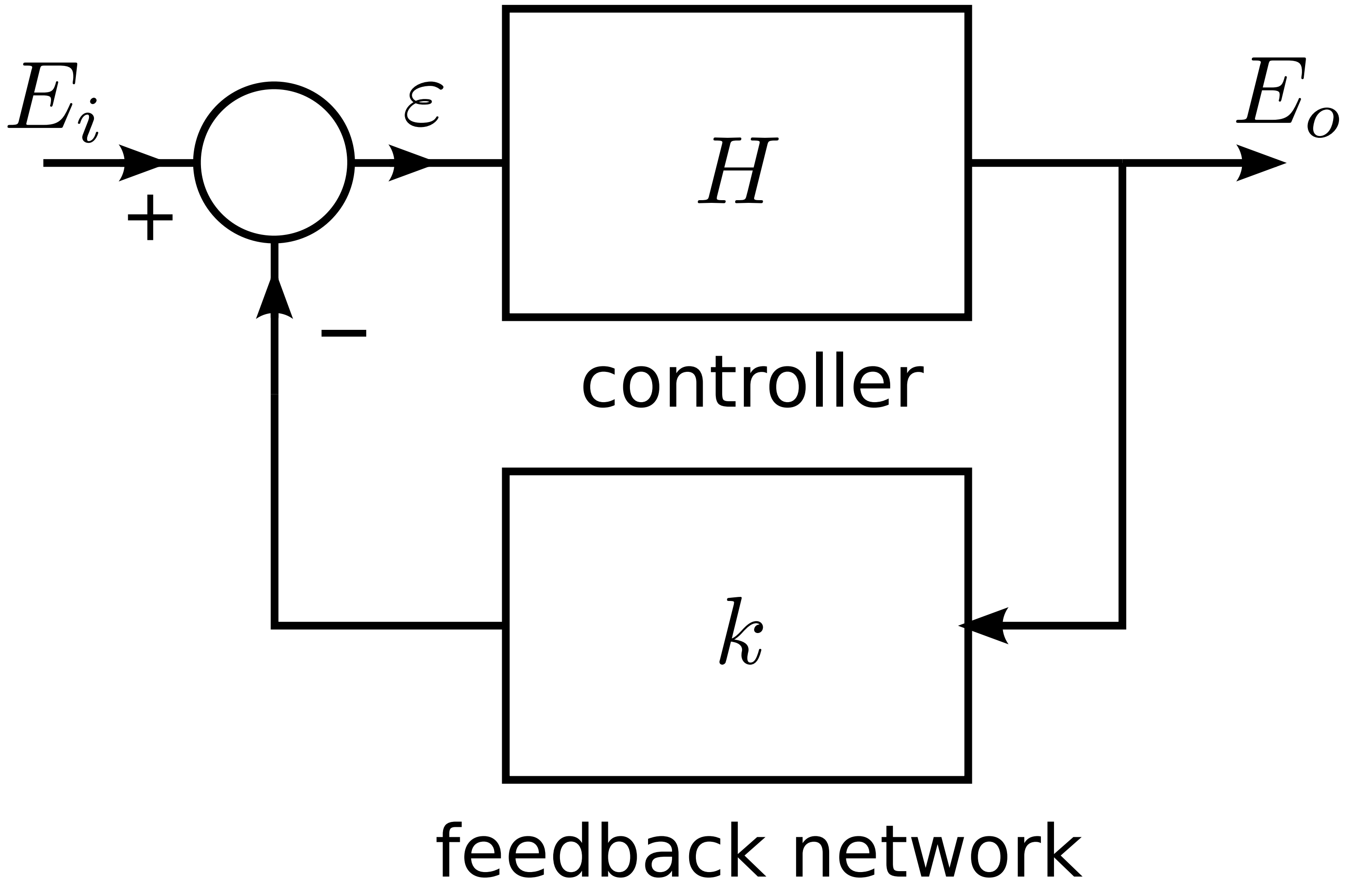
No direct transfer from input to output.

No reverse transfer in the controller and in the feedback network.

The controller gain does not depend on:

- Input impedance feedback network
- Load impedance

Black's feedback model, conclusions



Loop gain not simply the product of the controller gain (H) and the gain of the feedback network (k)

Suited for system-level analysis (no interaction between blocks)

Not suited for obtaining design information on circuit level

See example 10.1 and 10.2