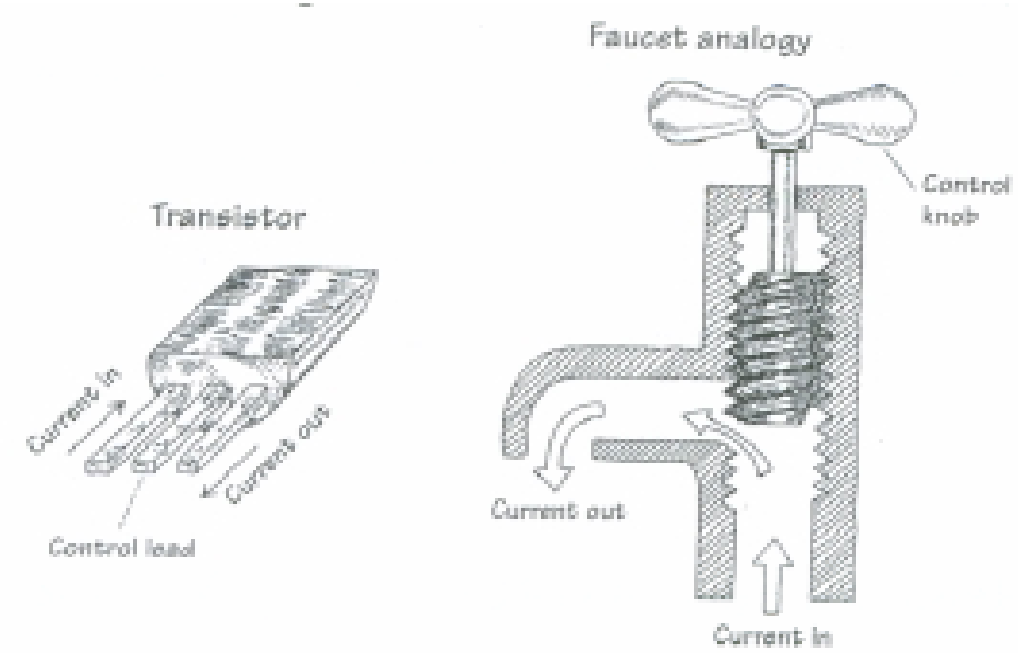
Lecture 13

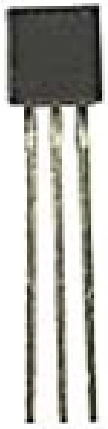
Transistor

- A semiconductor device that acts as
  - An electrically controlled switch
  - A current amplifier

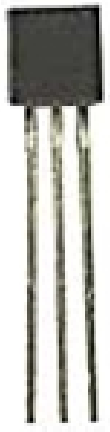


BJT, JFET, and MOSFET

- **B**ipolar **J**unction **T**ransistor
  - NPN and PNP
- **J**unction **F**ield **E**ffect **T**ransistor
- **M**etal **O**xide **S**emiconductor **FET**



BJT transistor

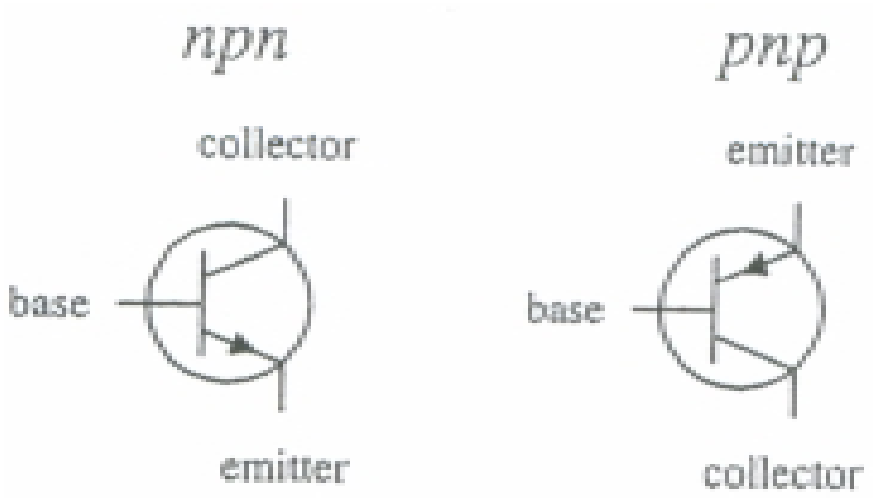


JFET

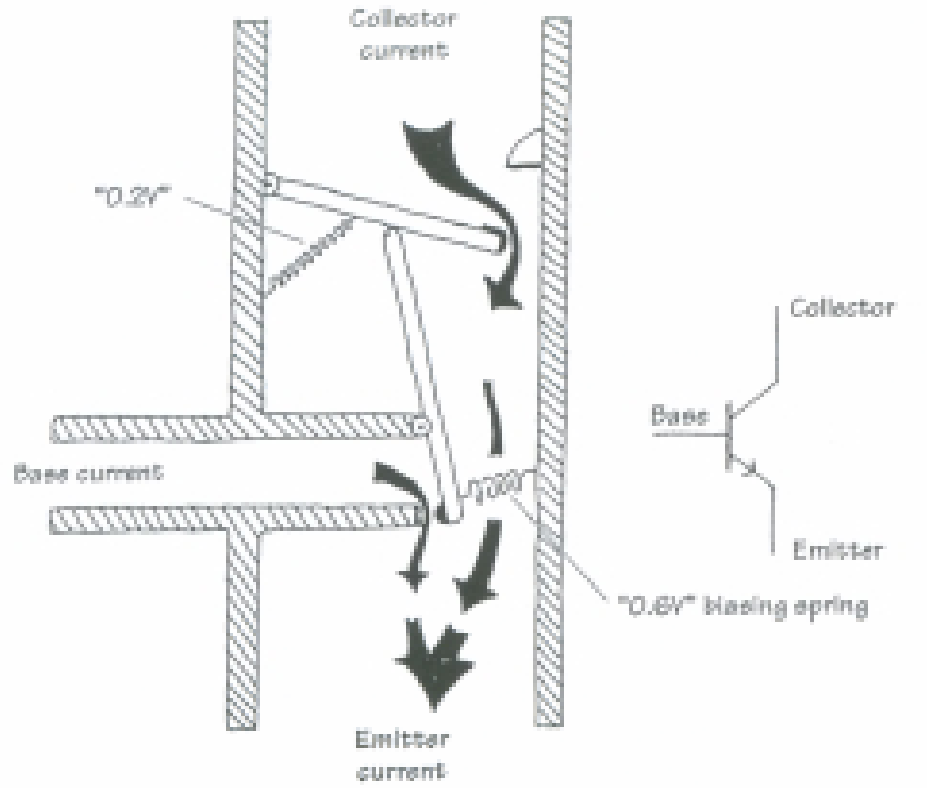
MOSFET

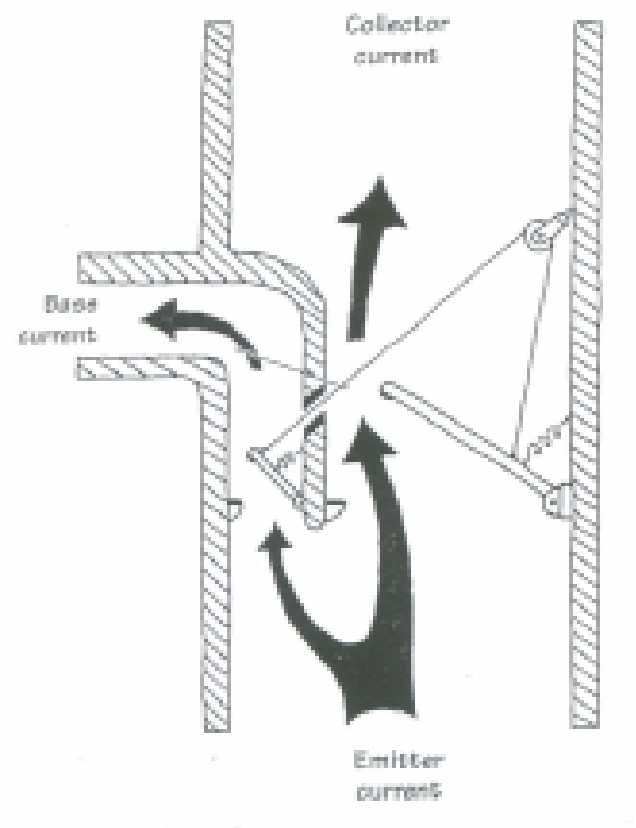
BJT

- NPN: a small input current and a positive voltage applied at base allows to flow from collector to emitter
- PNP: a small output current and a negative voltage at base allows a much larger current to flow from emitter to collector



BJT Water Analogy

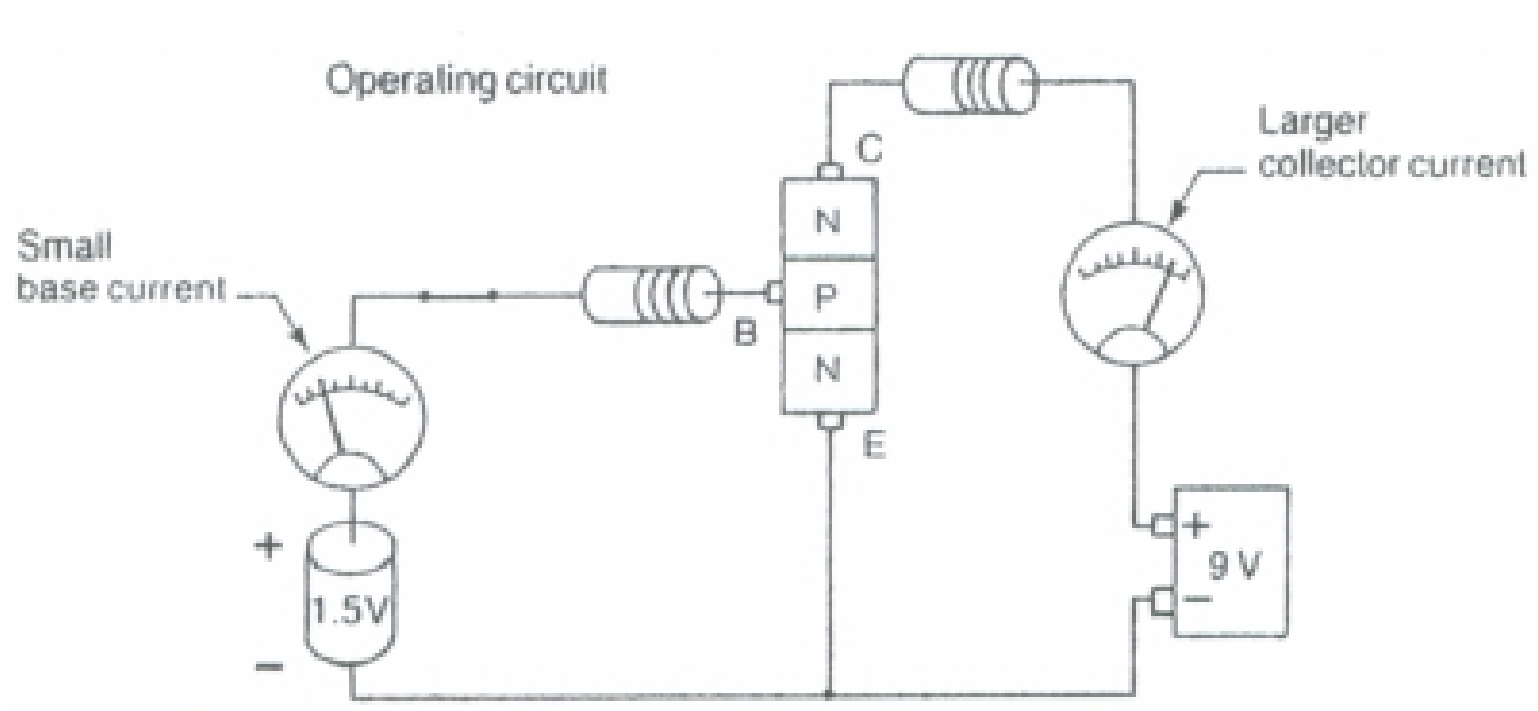




NPN ($V_B > V_E$)

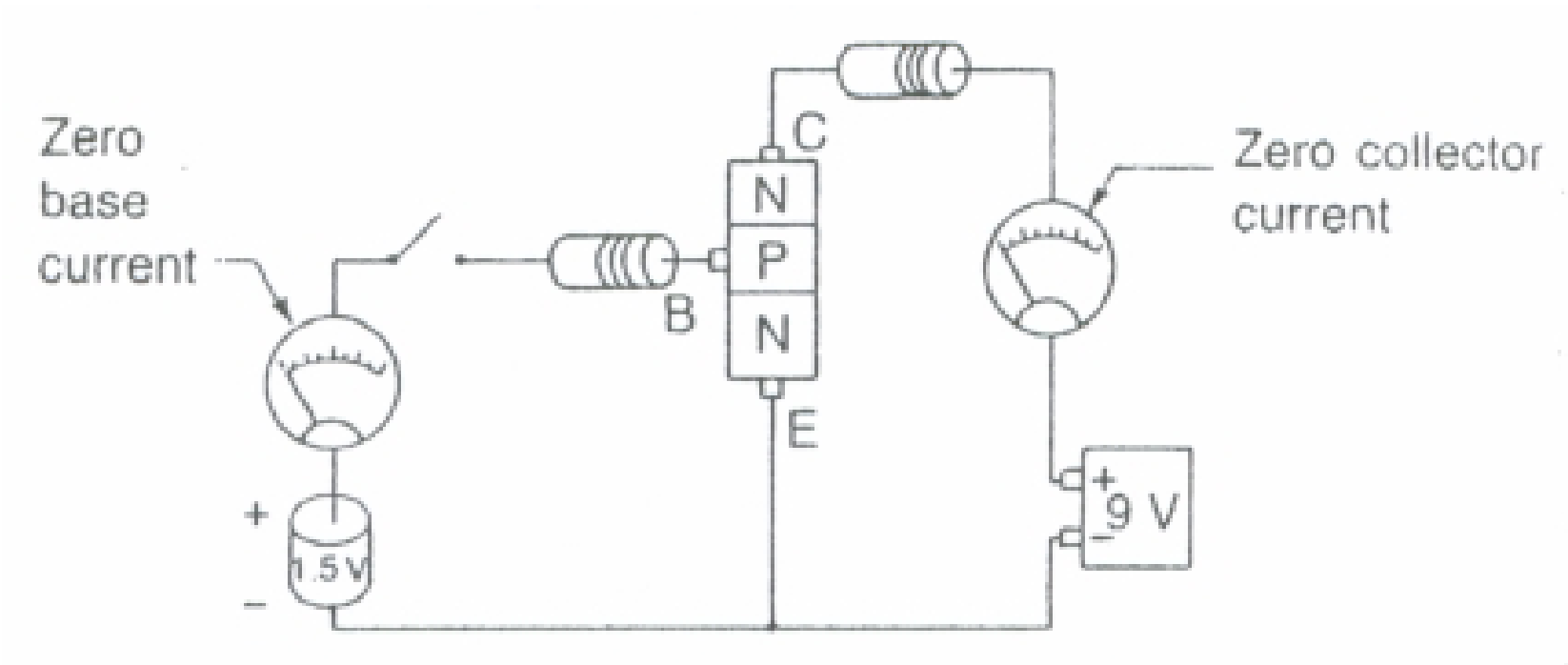
PNP ($V_B < V_E$)

NPN Transistor in a Circuit 1



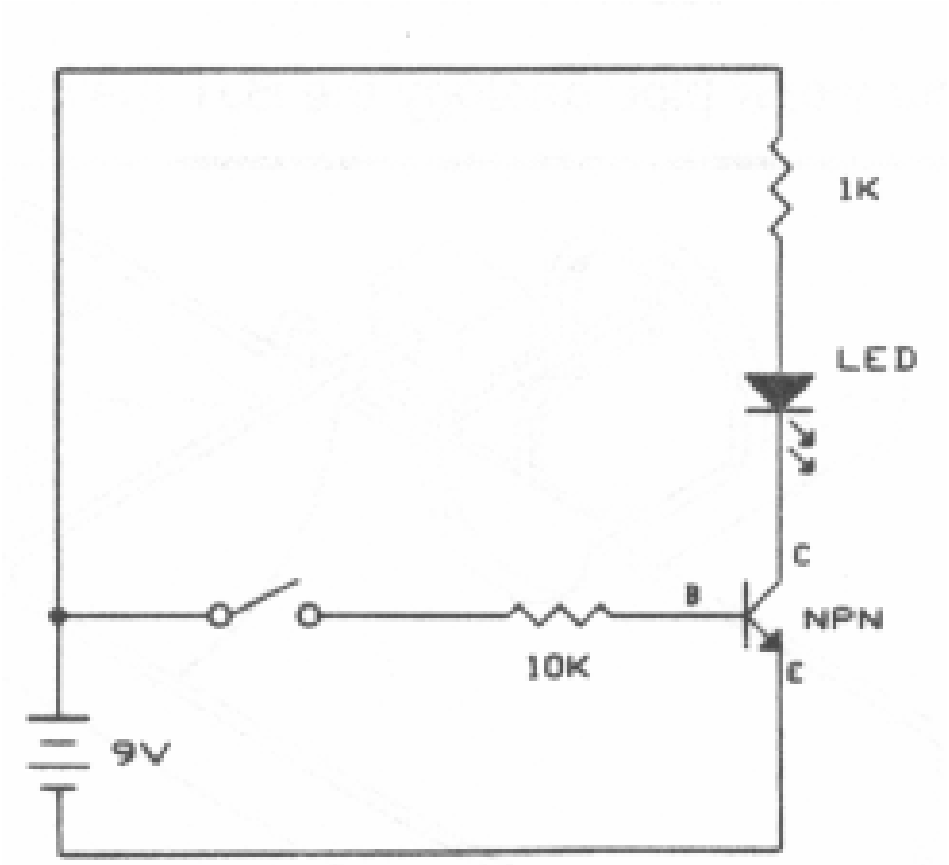
NPN ($V_B > V_E$)

NPN Transistor in a Circuit 2

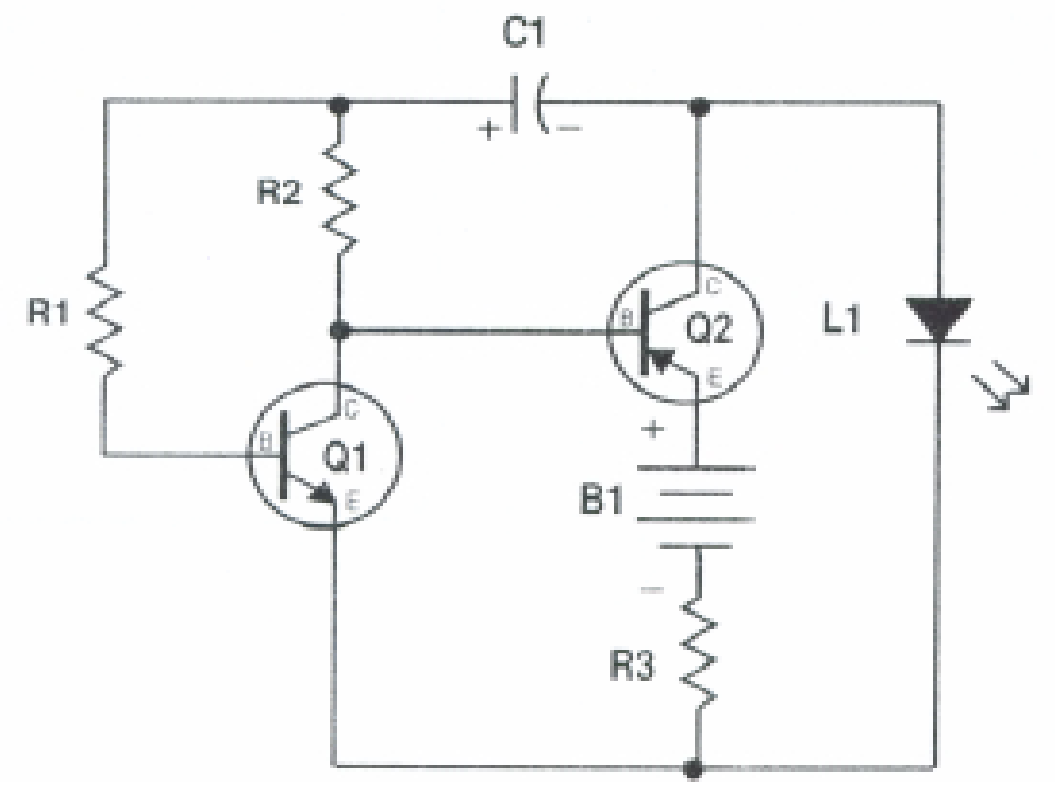


NPN ($V_B = V_E$)

Transistor Experiment 1



Transistor Experiment 2

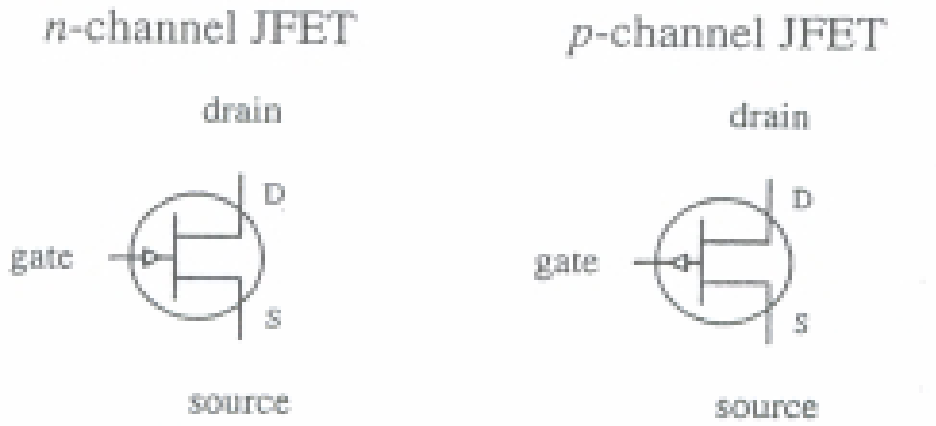


C1	1uF
L1	LED
Q1	NPN transistor
Q2	PNP transistor
R1	4.7kΩ
R2	10MΩ
R3	100Ω

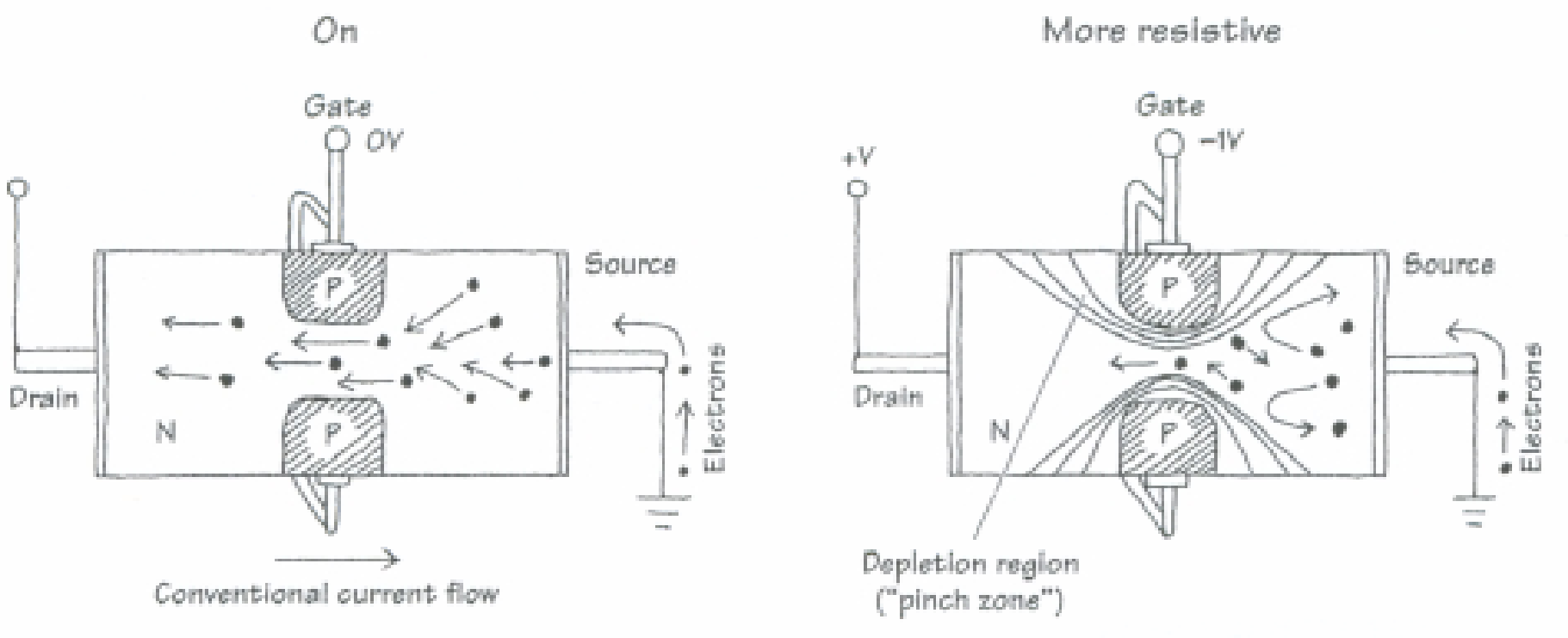
Oscillator

JFET

- Junction field effect transistor
- Electrically controlled switches
- Current amplifiers
- Voltage-controlled resistors
  - Do not require a bias current
- Normally on when $V_G - V_S = 0$

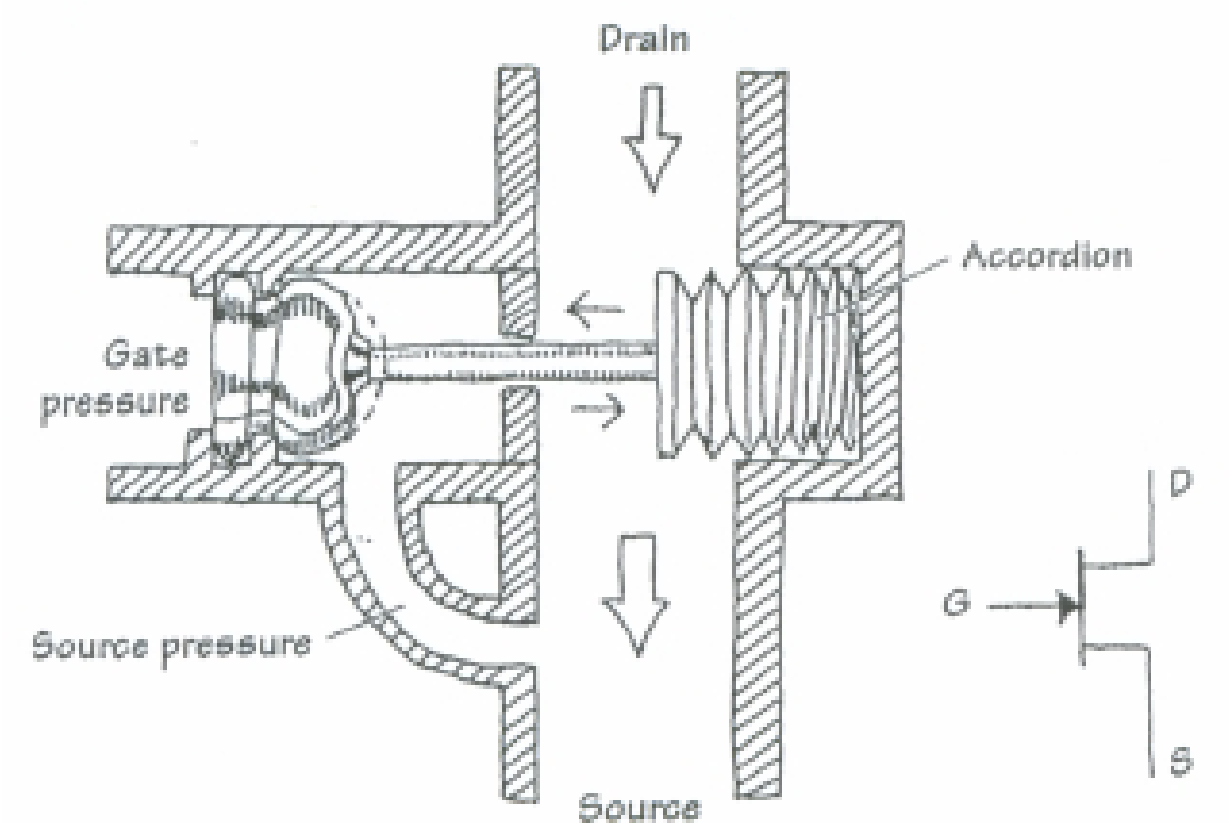


JFET: How It Works



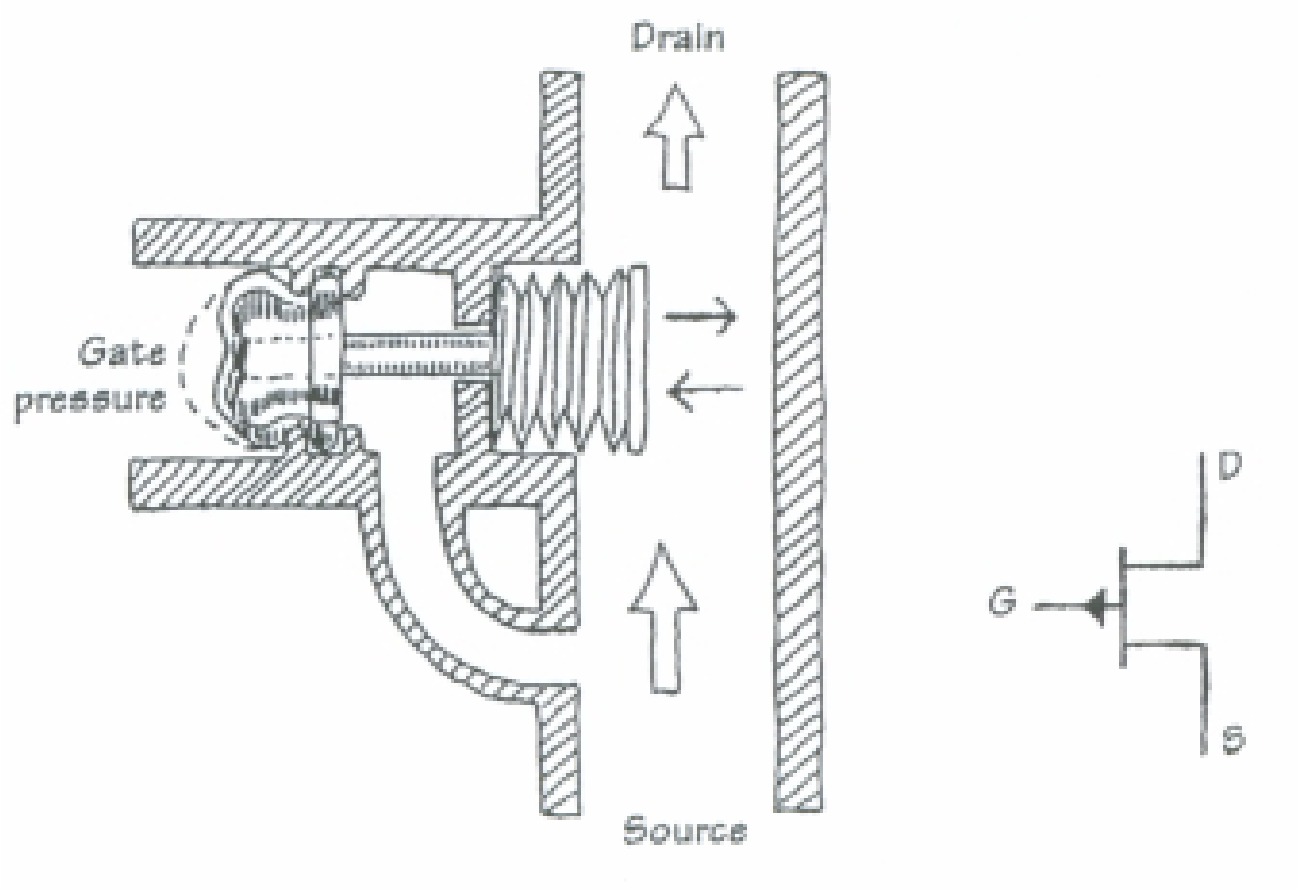
N-channel JFET: a negative voltage is applied at gate to reduce current flow from drain to source

JFET Water Analogy 1



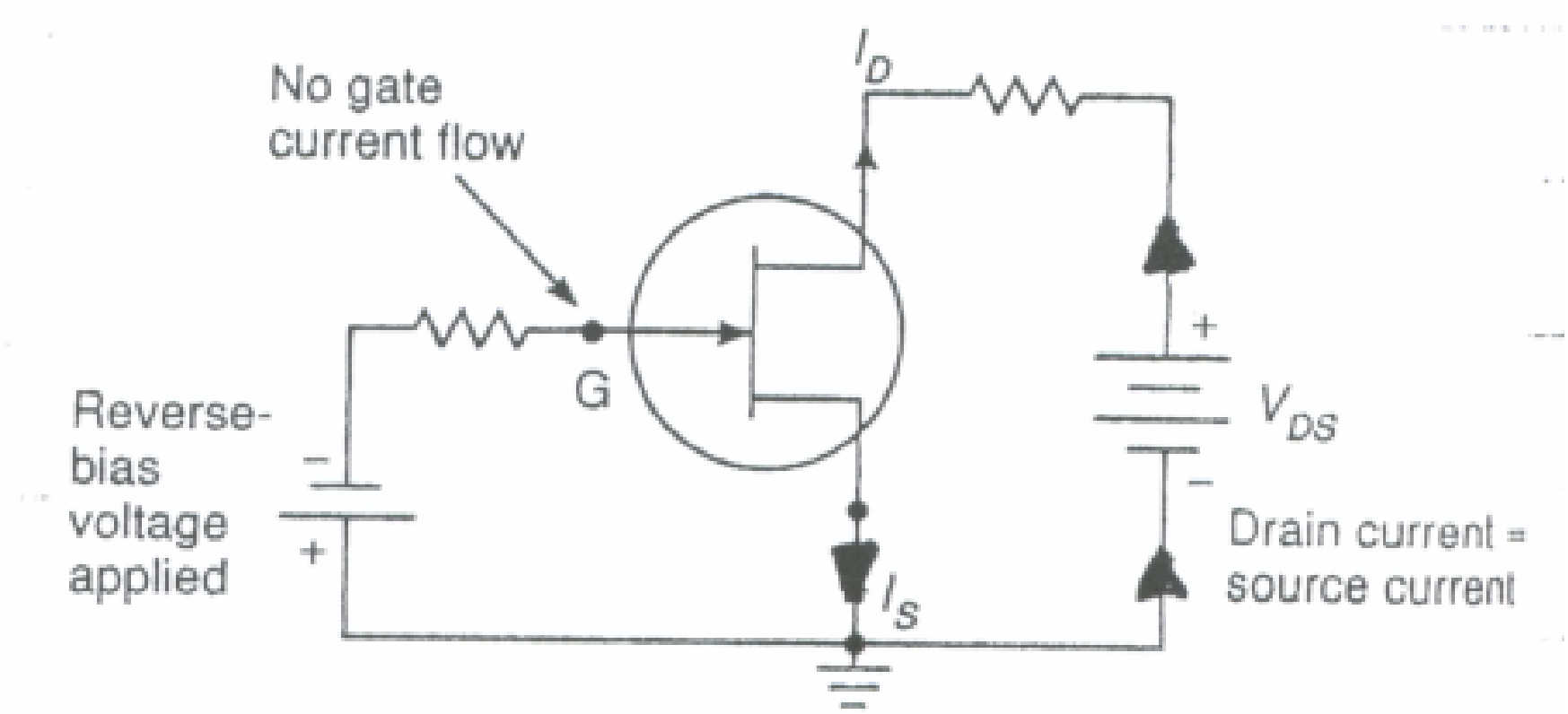
N-channel JFET

JFET Water Analogy 2

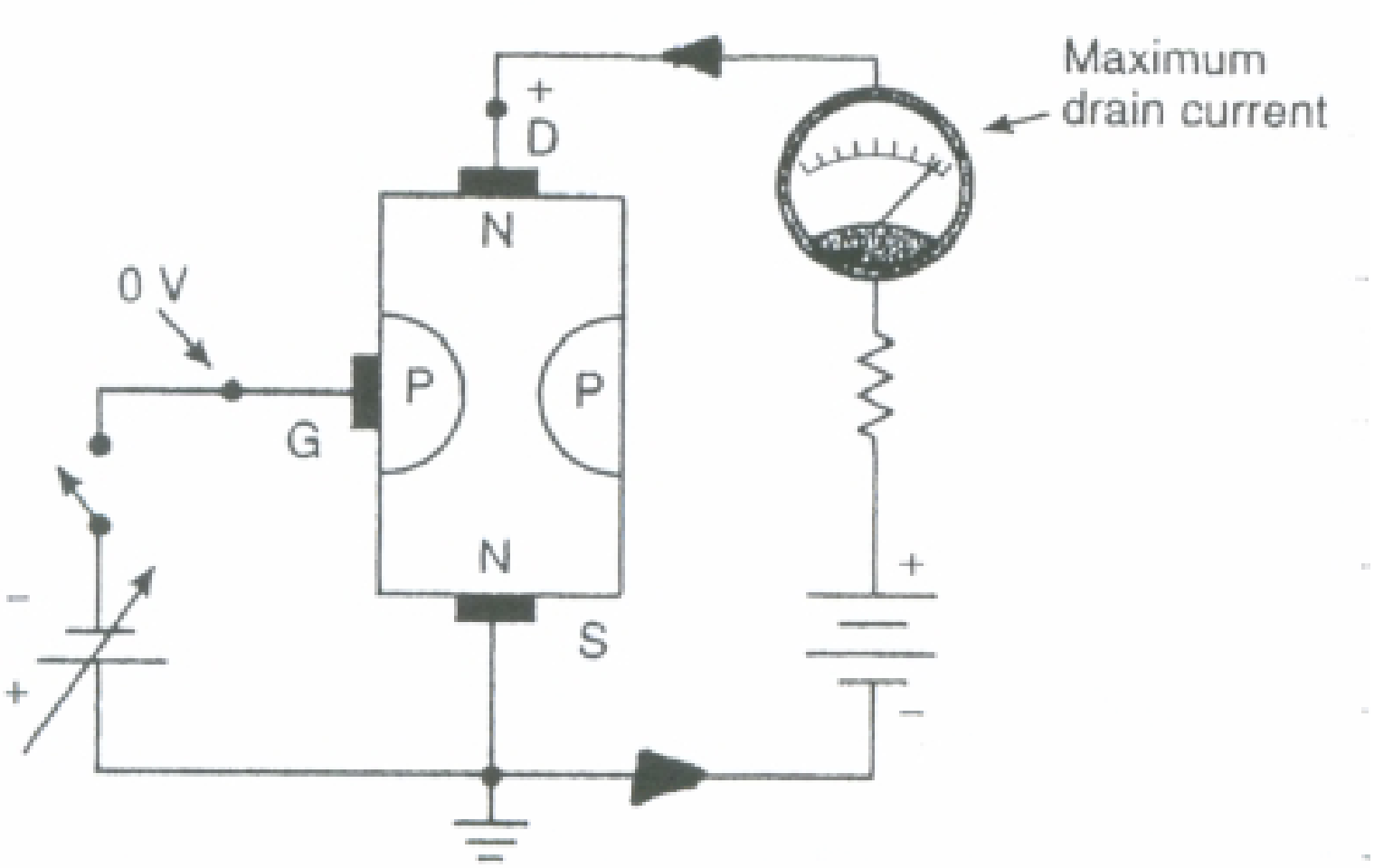


P-channel JFET

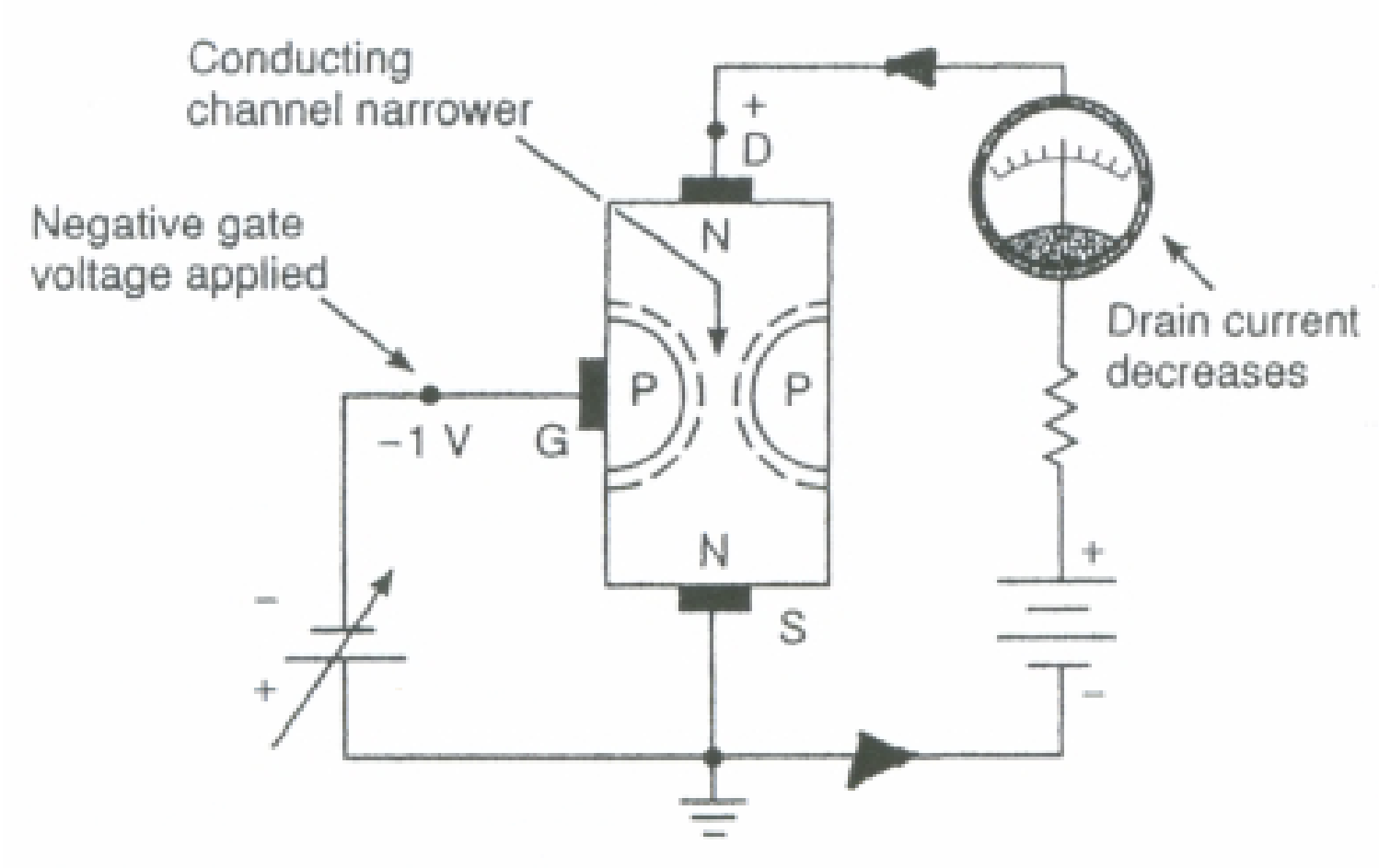
JFET Current



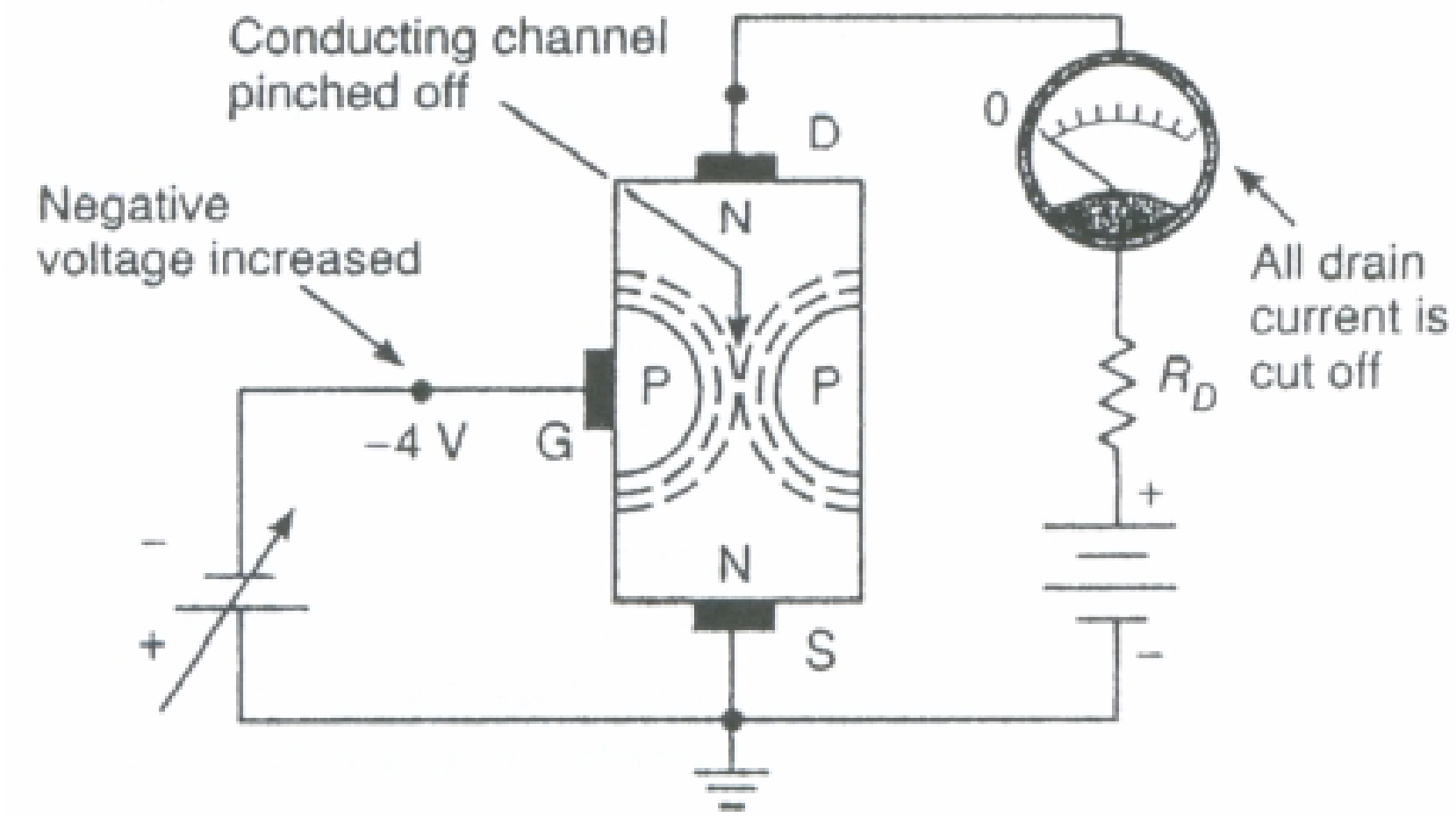
Full Current Passes



Reduced Current Passes

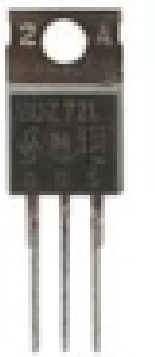


No Current Passes



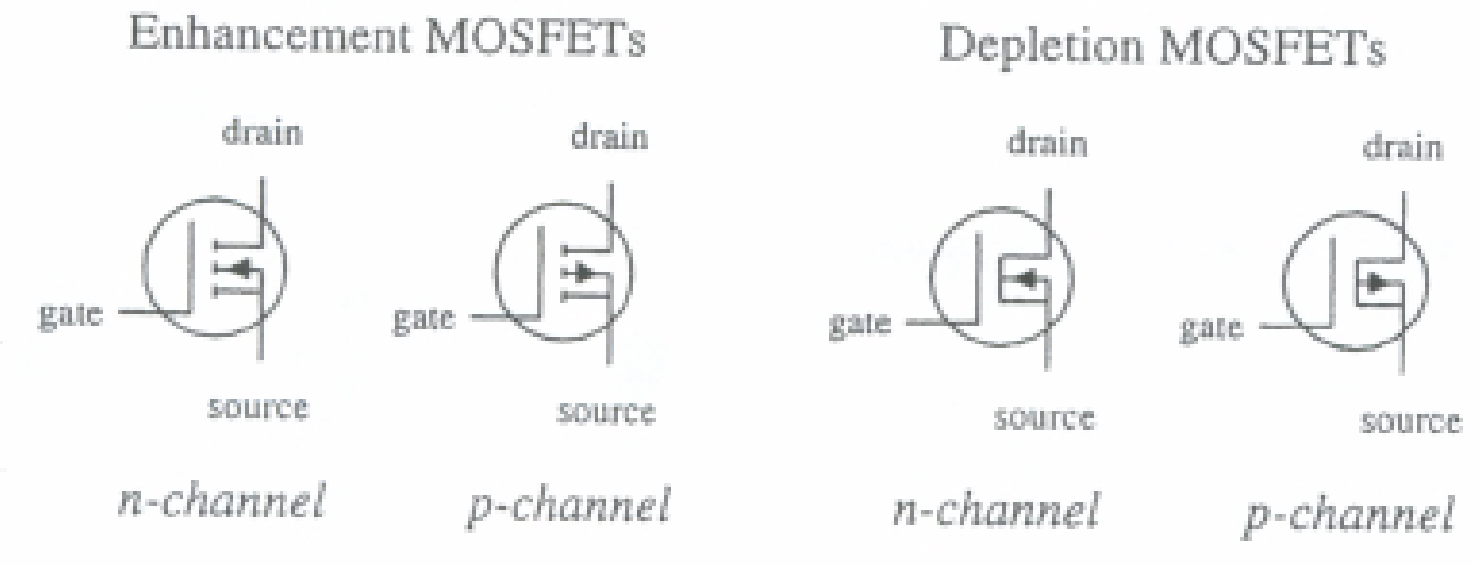
MOSFET

- Metal oxide semiconductor FET
- Similar to JFET
- High impedence ($10^{14}\Omega$)

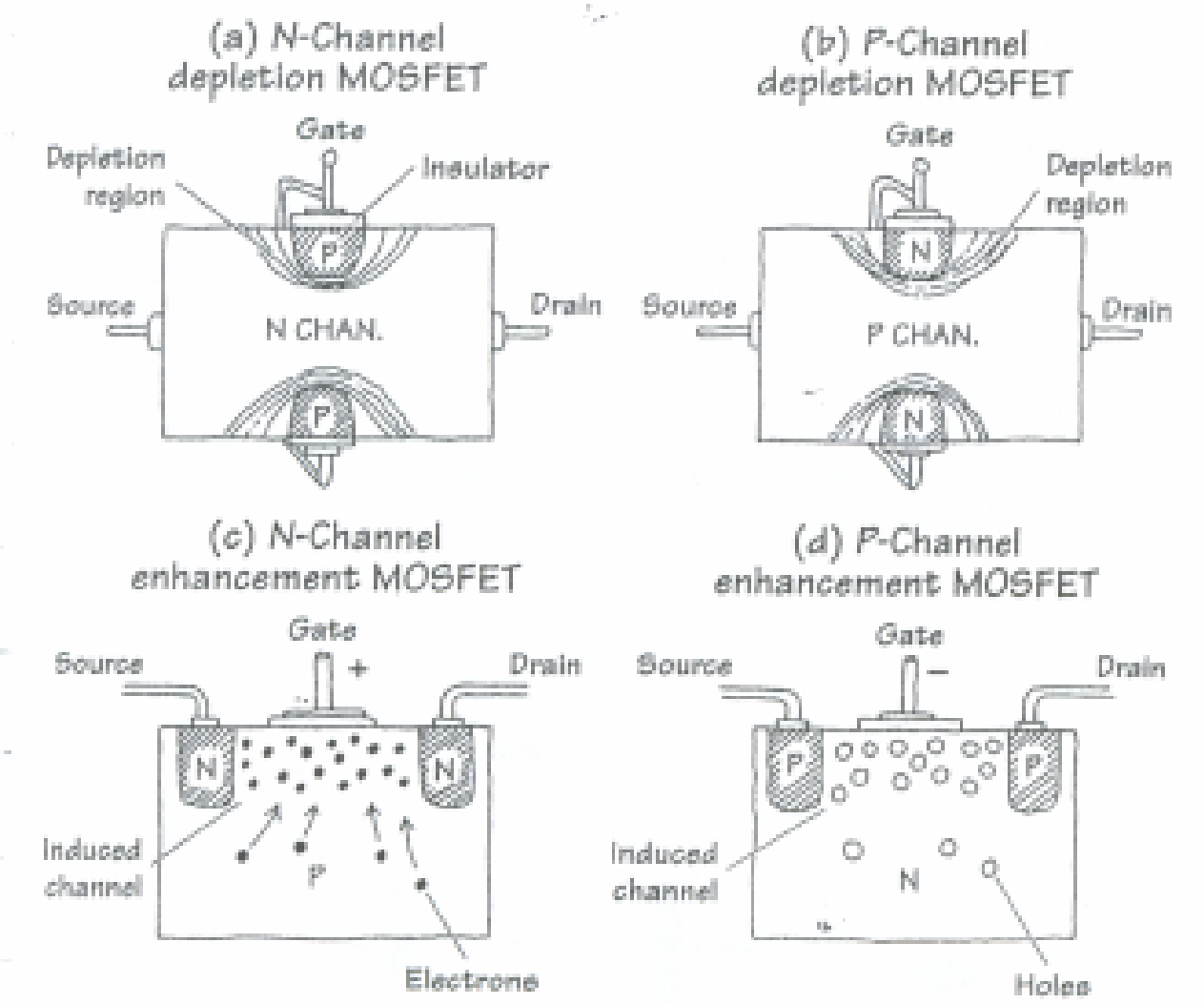


MOSFET Type

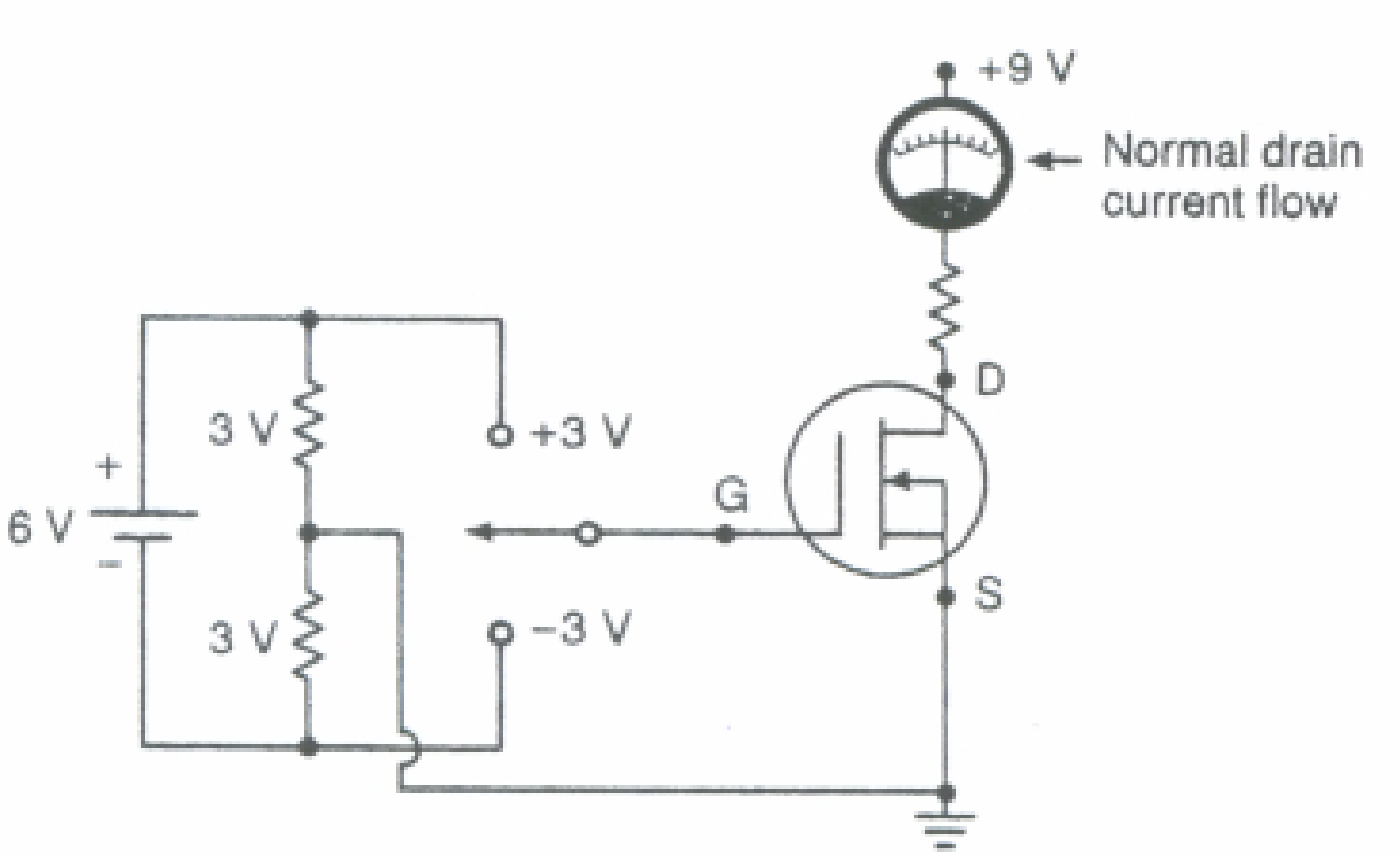
- Depletion type
  - Normally on ($V_G = V_S$)
- Enhancement type
  - Normally off



MOSFET: How It Works

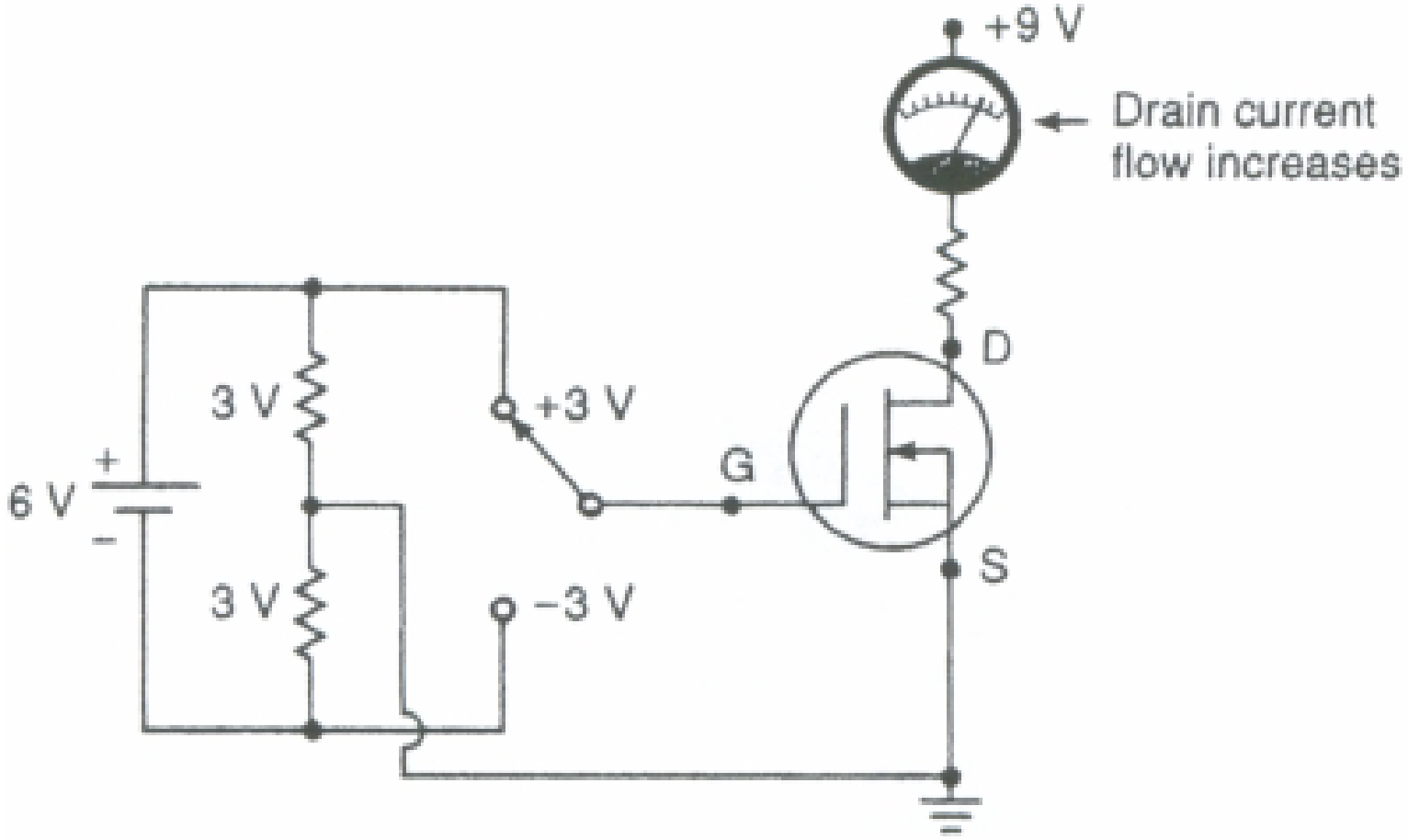


MOSFET Experiment 1



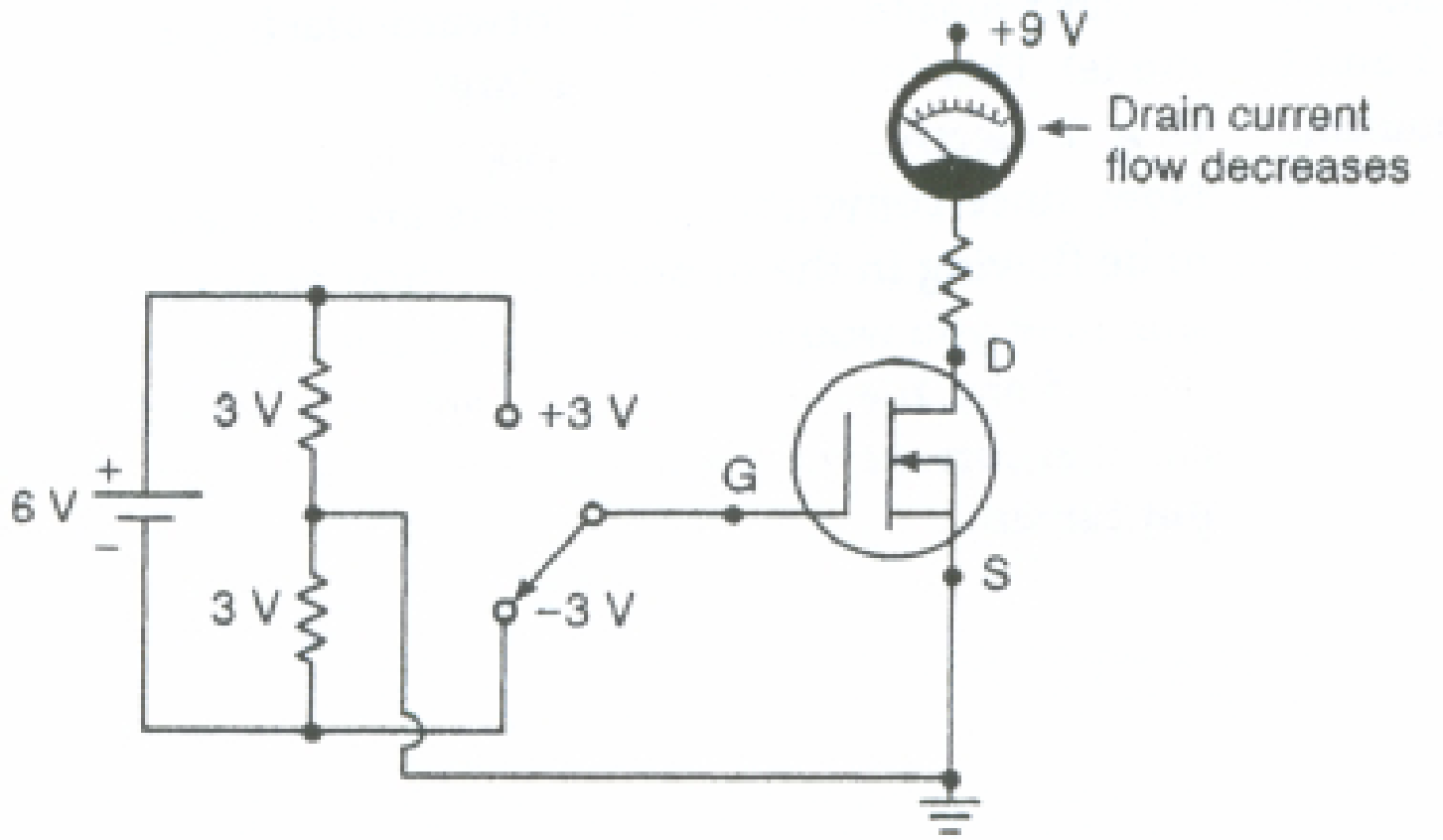
A. Zero gate-to-source voltage

MOSFET Experiment 2



B. Positive gate-to-source voltage

MOSFET Experiment 3



C. Negative gate-to-source voltage

Transistor Experiments

Experiments	Chapters
What's micro controller	
Basic A and D	
Earth measurements	
Robotics	
StampWorks	
Others	