

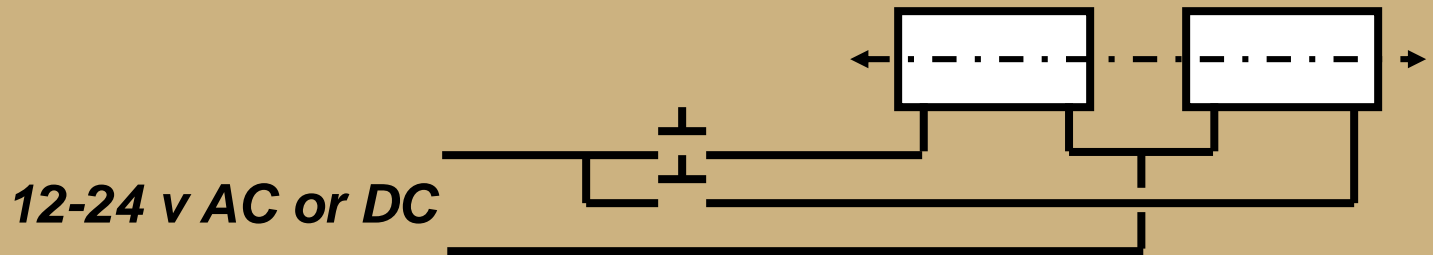
Tortoise™

***Switch Machines
Installation & Wiring***

Conventional Twin Coil Switch Machines

- ✓ *In use since developed by Walthers in early 1930's*
 - *Long time standard for remote operation*
 - *Currently: Rix, Atlas, etc.*

Electrically:

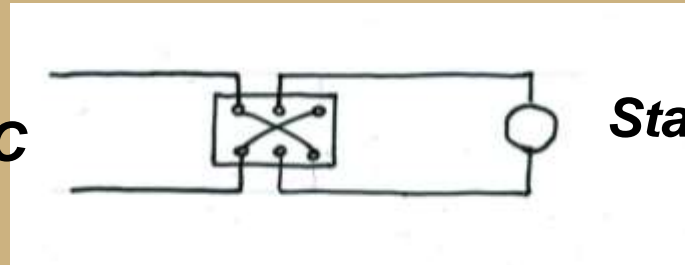


- ✓ *Brief, high current (~2-5 ohm coils) yields brief power pulse, requires heavy wire*
- ✓ *Difficult to fire more than 2 or 3 at the same time*
- ✓ *? If any available today have reliable electrical contacts*
- ✓ *Bad things happen if power stays on*
 - *Most capacitive discharge powers supplies are fail safe*

Tortoise (Stall Motor) Machines

Electrically:

12 VDC



Stall Motor

DPDT Switch

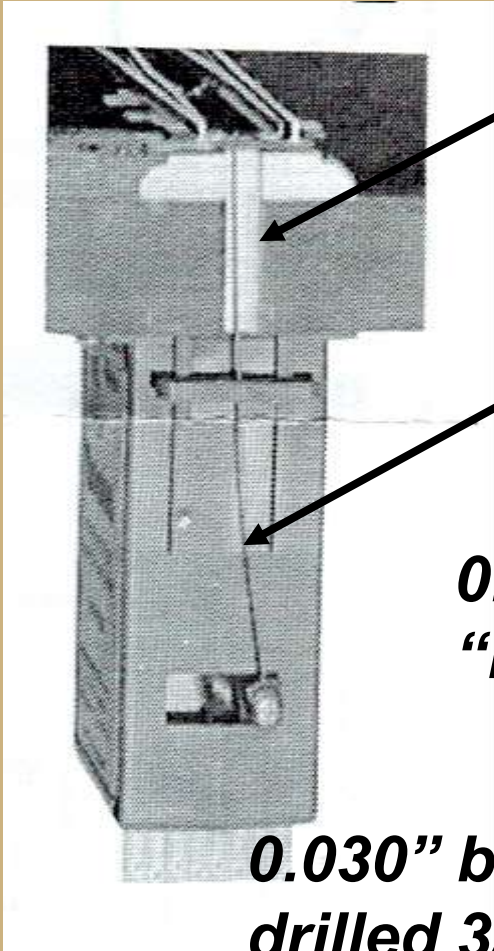
- ✓ ***Continuous low current (~20 ma) allows light wiring***
 - ***20 ma ideal to power LED In series with Tortoise***
- ✓ ***Relatively long throw, continuous force while power on***
- ✓ ***Slow, realistic turnout motion***
- ✓ ***Two sets reliable SPDT contacts***
 - ***Carry 4 amps, switch 1 amp***
 - ***Frog power, signals, panel lights, etc***

- ✓ ***Tortoise contacts:***
- ✓ ***Tell signals which way Turnout is thrown***
- ✓ ***Control frog & point polarity***
- ✓ ***Can also power LEDs on panel, etc***



“Normal” Installation

Tortoise Directions



1/4" to 3/8" hole

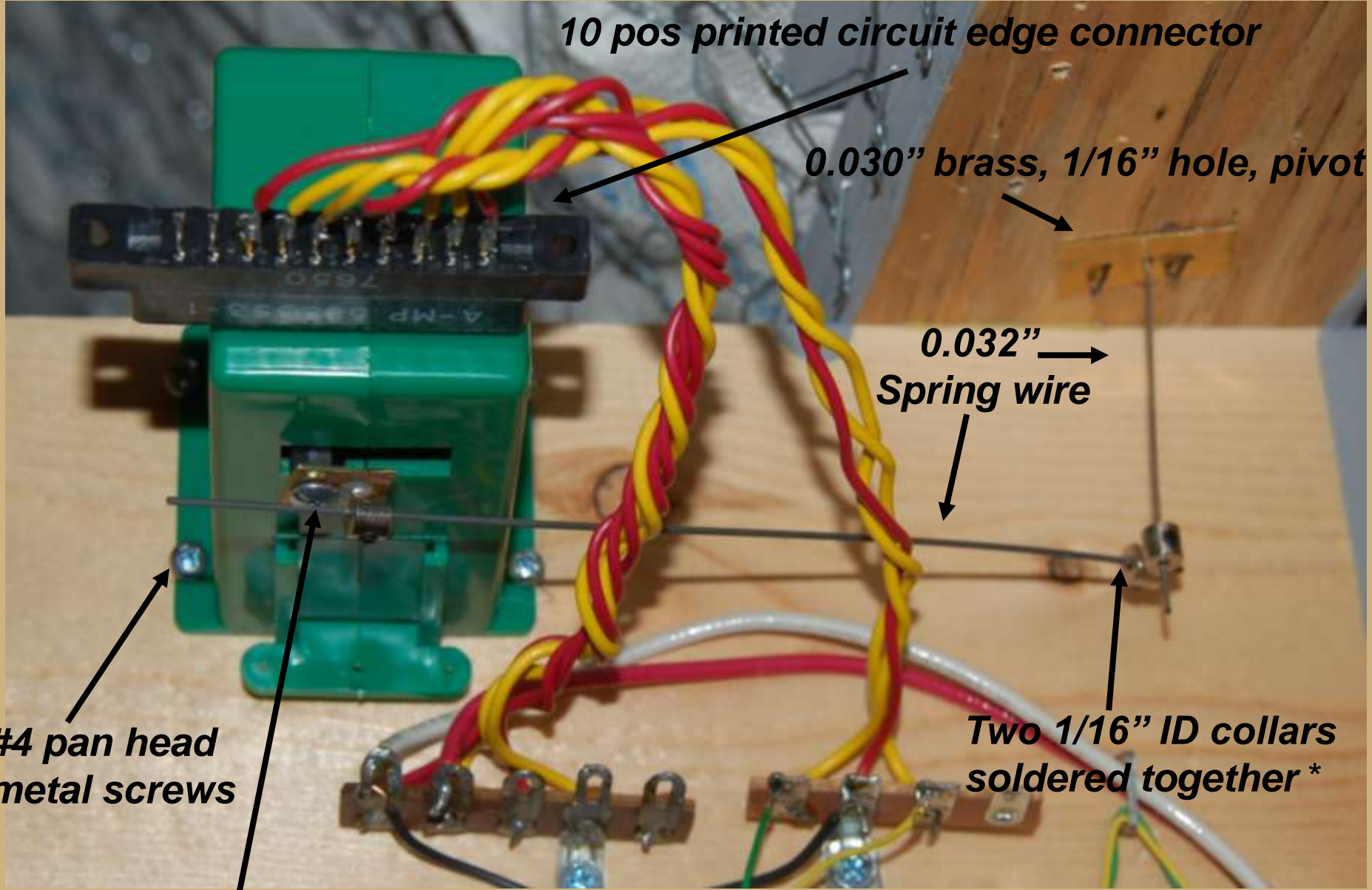
**0.024" wire, bent
as directed**

**0.032" wire, ~1/16"
“L” at top end**

**0.030" brass, 3/8" x 1/2",
drilled 3/32" for screw,
1/16" ID collar soldered on**

Modified Installation





10 pos printed circuit edge connector

0.030" brass, 1/16" hole, pivot

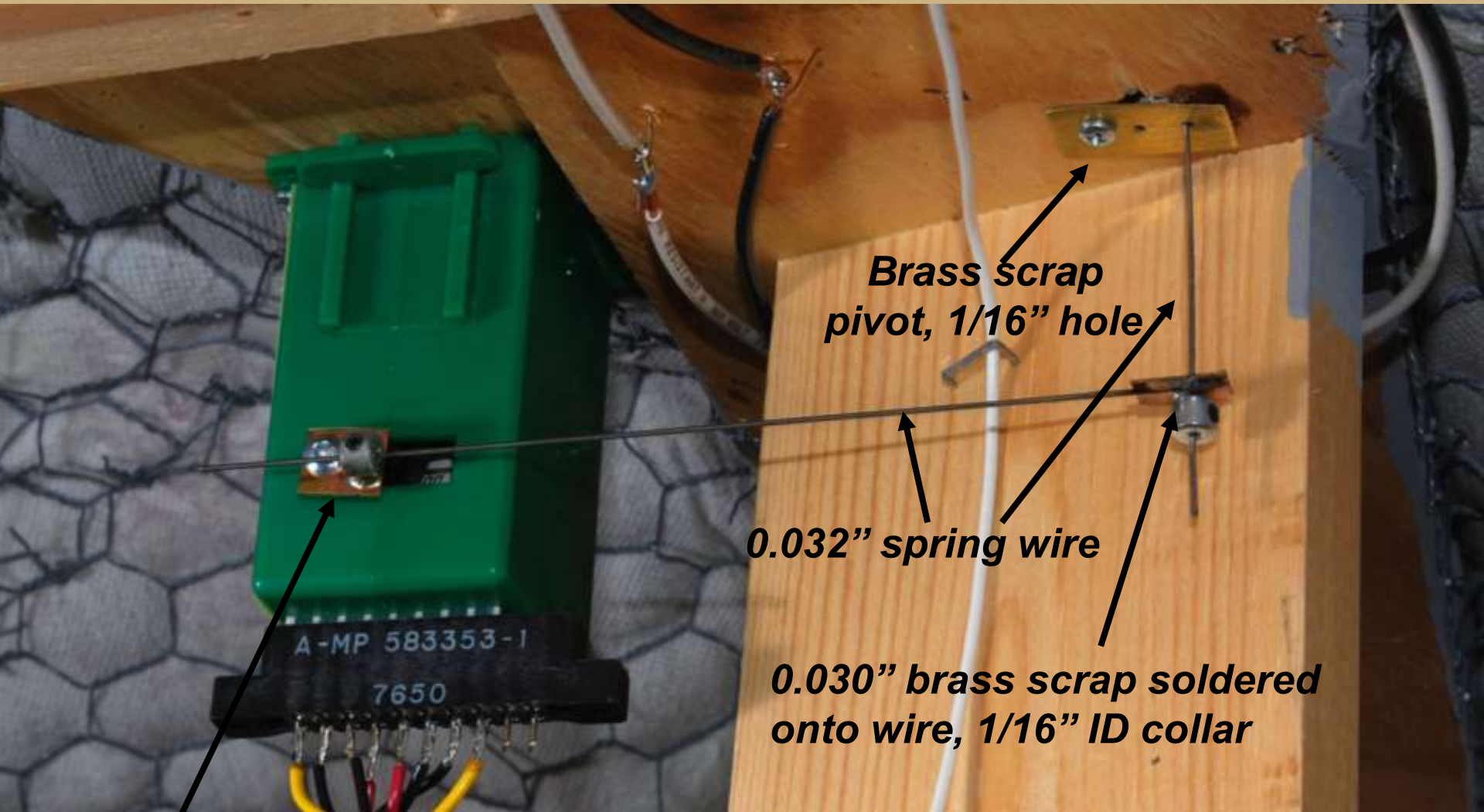
0.032" Spring wire

Two 1/16" ID collars soldered together *

#4 pan head metal screws

0.030" brass, 3/8 x 1/2 " 3/32" drill for SM screw, 1/16" ID collar soldered on

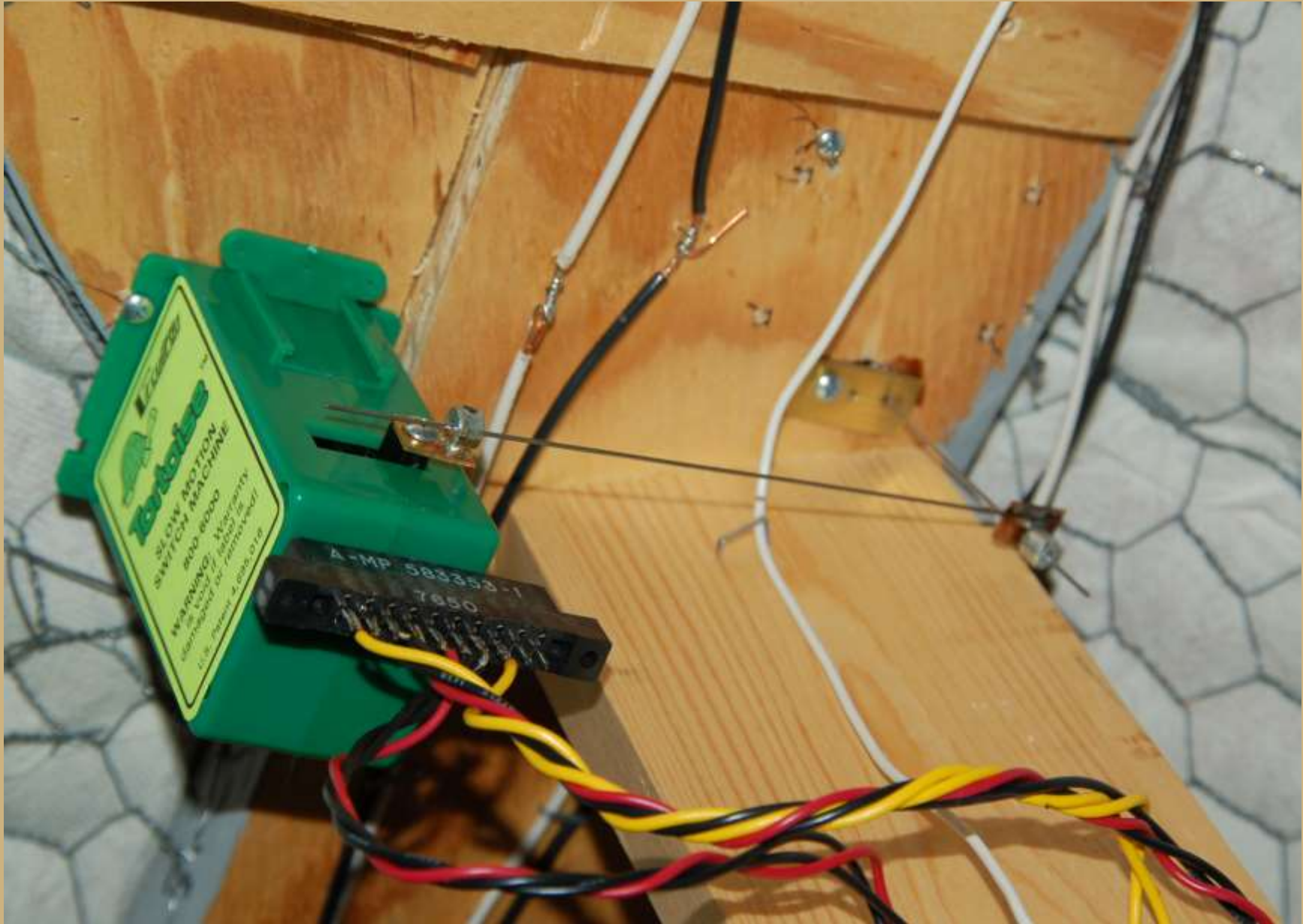
Typical "Offset" Installation

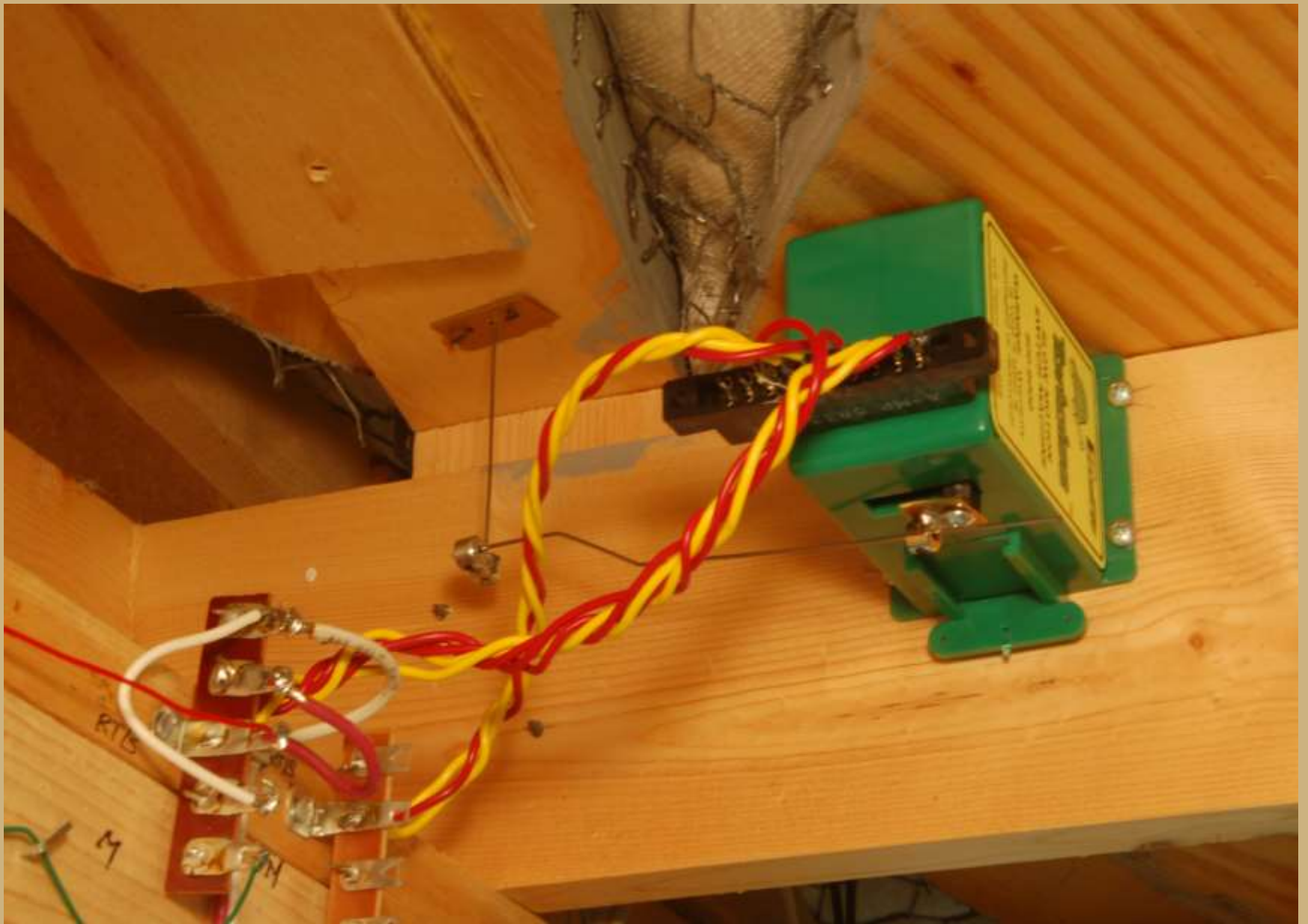


0.030" Brass, 3/8"x1/2", 3/32" Drill for SM screw, 1/16" ID Collar soldered on

Typical offset Tortoise mount

SM mounted with #4 pan head screws

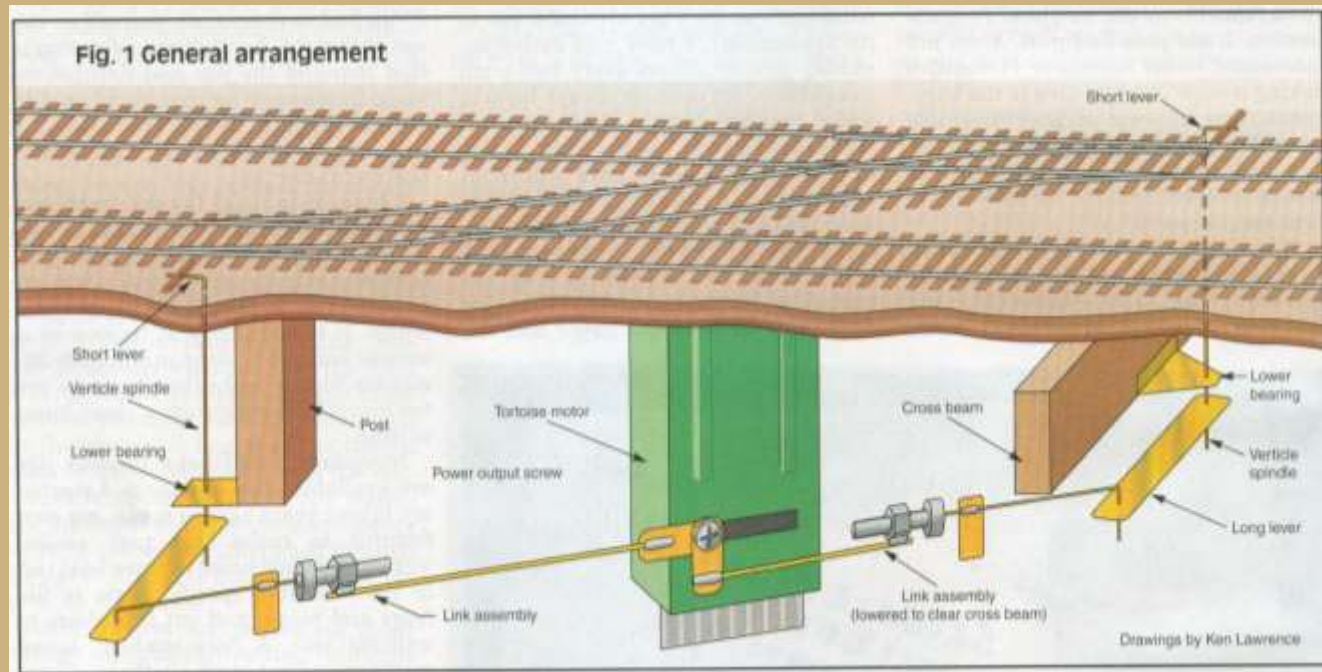


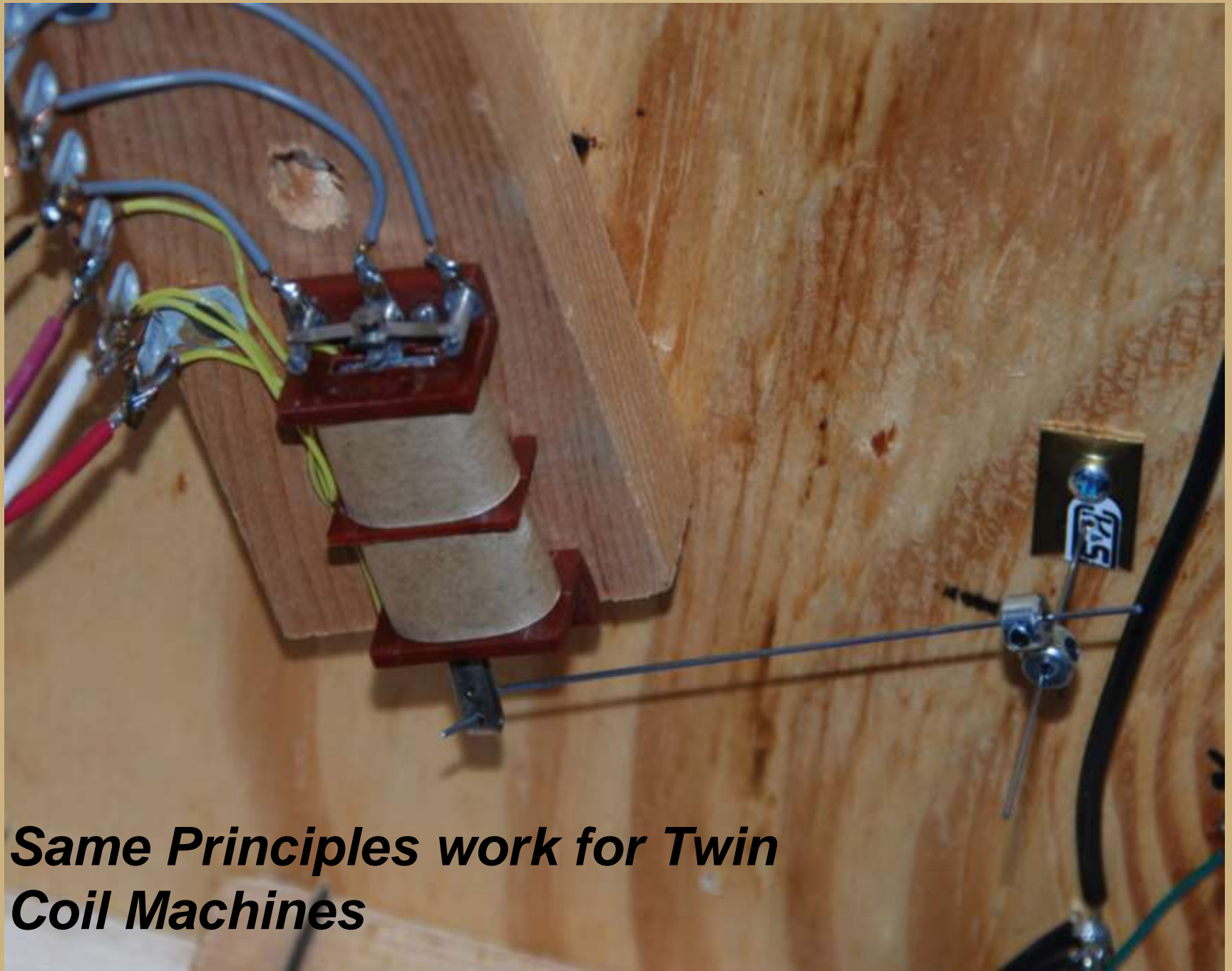


A Tortoise can be mounted in almost any position, along as the motion is approximately at right angles to the track

Possible alternative linkage

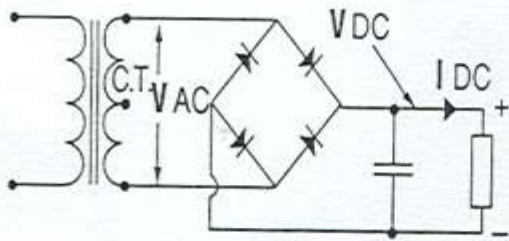
***If no hole under turnout:
From Feb 2010 RMC
Consider 0.032" wire for
Lower arm, spring action***





Same Principles work for Twin Coil Machines

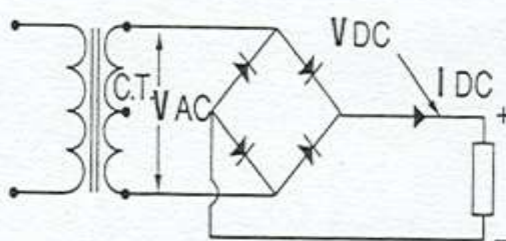
Full-wave bridge
Capacitive input filter



$$V_{DC} = 1.41 \times V_{AC}$$

$$I_{DC} = 0.62 \times I_{AC}$$

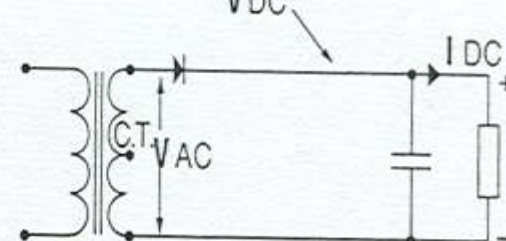
Full-wave bridge
Resistive load



$$V_{DC} = 0.90 \times V_{AC}$$

$$I_{DC} = 0.90 \times I_{AC}$$

Half-wave
Capacitive input filter



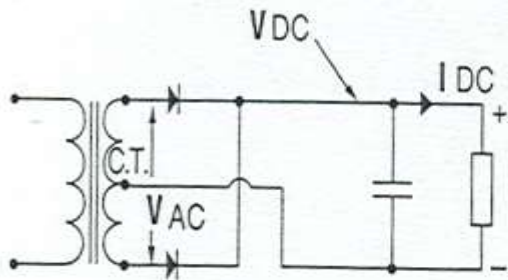
$$V_{DC} = 1.41 \times V_{AC}$$

$$I_{DC} = 0.28 \times I_{AC}$$

12 volts in, 16.9 out

12 volts in, 10.8 out

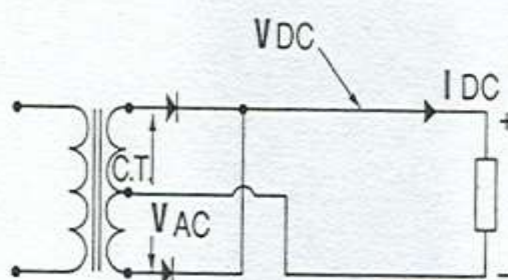
Full-wave
Capacitive input filter



$$V_{DC} = 0.71 \times V_{AC}$$

$$I_{DC} = 1.0 \times I_{AC}$$

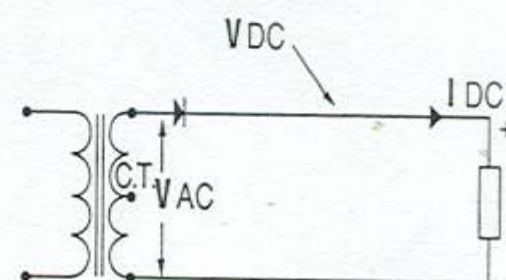
Full-wave
Resistive load



$$V_{DC} = 0.45 \times V_{AC}$$

$$I_{DC} = 1.27 \times I_{AC}$$

Half-wave
Resistive load



$$V_{DC} = 0.45 \times V_{AC}$$

$$I_{DC} = 0.64 \times I_{AC}$$

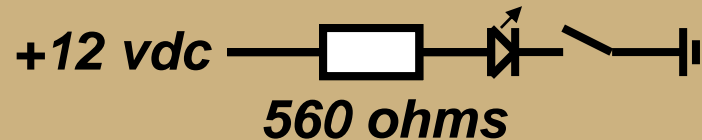
Be aware: If you wire your own power supply, you might not get the output voltage you expect!

LED's on panel to show turnout position

- ✓ **The position of a single turnout can be shown with two LED's in parallel in a wire to the Tortoise.**
 - **The lighted LED will be dim until the Tortoise motor stalls, then go bright.**
 - **You can also indicate a single turnout by grounding the LED through a Tortoise contact. Wiring LED's in line is usually simpler.**
- ✓ **This can also be used for a route if you wish to show the position of every turnout.**
- ✓ **To show the route selected with a single LED, the LED is powered at the panel and grounded through contacts on the Tortoise machines.**
 - **This gives a CTC “feel” to the panel. Push the button, hear the switch machines operate, and the LED lights only after all turnouts are aligned to the desired route.**

Wiring - Suggestions

- ✓ Use PCB edge connectors to wire Tortoise
 - No risk of damage to circuit board, can make layout connections more accessible
- ✓ Use two power supplies and common ground
- ✓ Wire LEDs for position indication in this order:



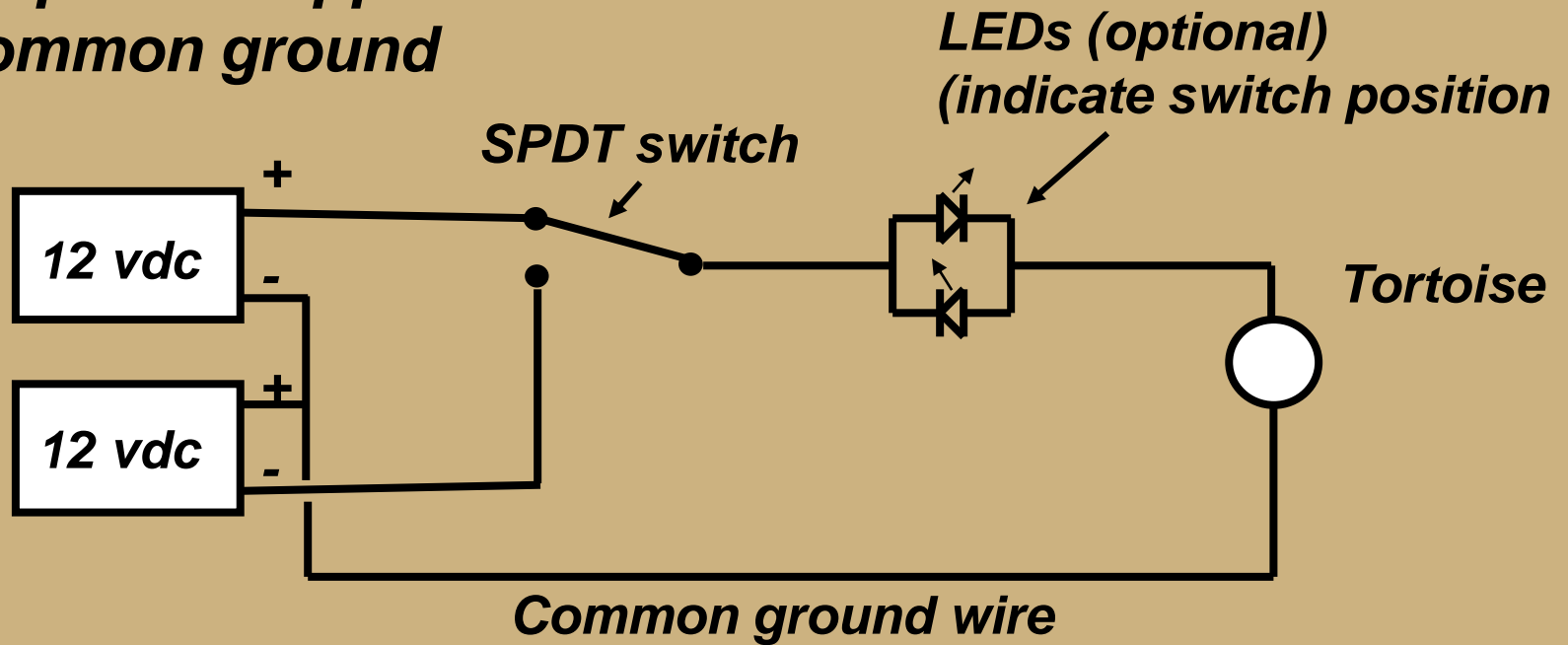
- (LED life 30,000 hours @ 25 ma, about 1/2 sec @ 12 volts!)
- ✓ Make 9 volt battery/330 ohm resistor/LED “tester”
- ✓ Get a “multimeter” (reads volts, ohms, ma, more)
 - Magic words are “digital” and “autoranging”
 - About \$25 and up (way up!) at Radio Shack or Lowes

Add PCB Edge Connector

- ✓ ***Allows remote (and accessible) layout connections***
 - ✓ ***10 Position Connectors were \$0.50 at All Electronics***
 - ✓ ***Easy removal w/o risk of board damage***
-
- ✓ ***Layout connections at more accessible location***

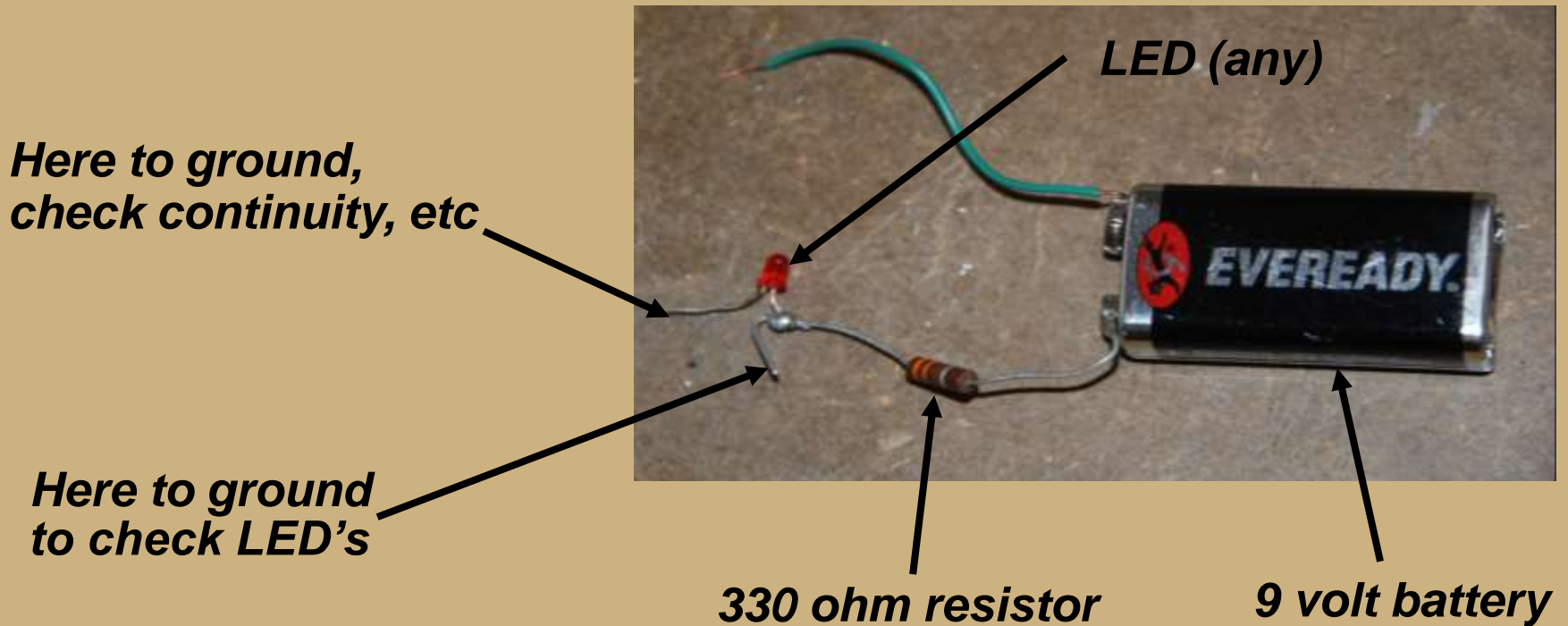


***Use two power supplies w/
Common ground***



- ✓ ***Makes wiring much simpler, only one wire to each Tortoise***
 - ***Common ground not for DCC, but helpful for accessory wiring***
 - ***Common ground wire not shown in wiring diagrams***
- ✓ ***Switch can be toggle, rotary, slide, or relay***
 - ***Beware of “make before break” switches!***

Simple Electrical Tester



Check which contacts are closed on Tortoise, relays, etc

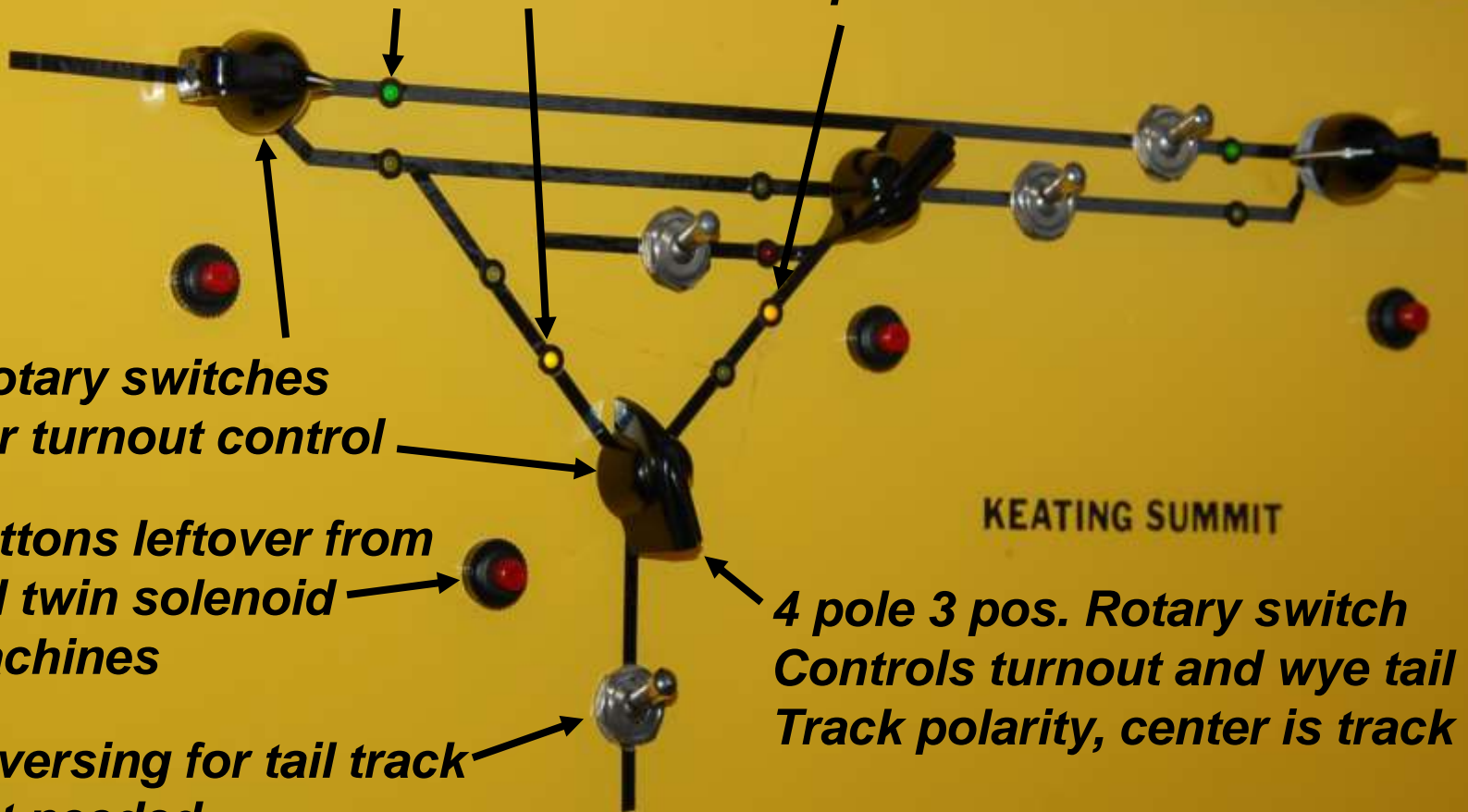
Can also test transistors, on PNP, P to N (emitter and collector to base) should conduct, N to P should not.

NOTE: 3 volt battery, 100 ohm resistor safer, LED's not rated for 9 volts in reverse



My layouts used rotary switches for twin coil switch machines. Turn knob then push button, knob showed turnout position. This technique worked well for years before changing to Tortoise machines.

LEDs indicate turnout position



**Rotary switches
for turnout control**

**Buttons leftover from
old twin solenoid
machines**

**Reversing for tail track
Not needed**

KEATING SUMMIT

**4 pole 3 pos. Rotary switch
Controls turnout and wye tail
Track polarity, center is track off**

Control Panel for Hidden Staging Yard

**Occupancy
(Entrance Section)**

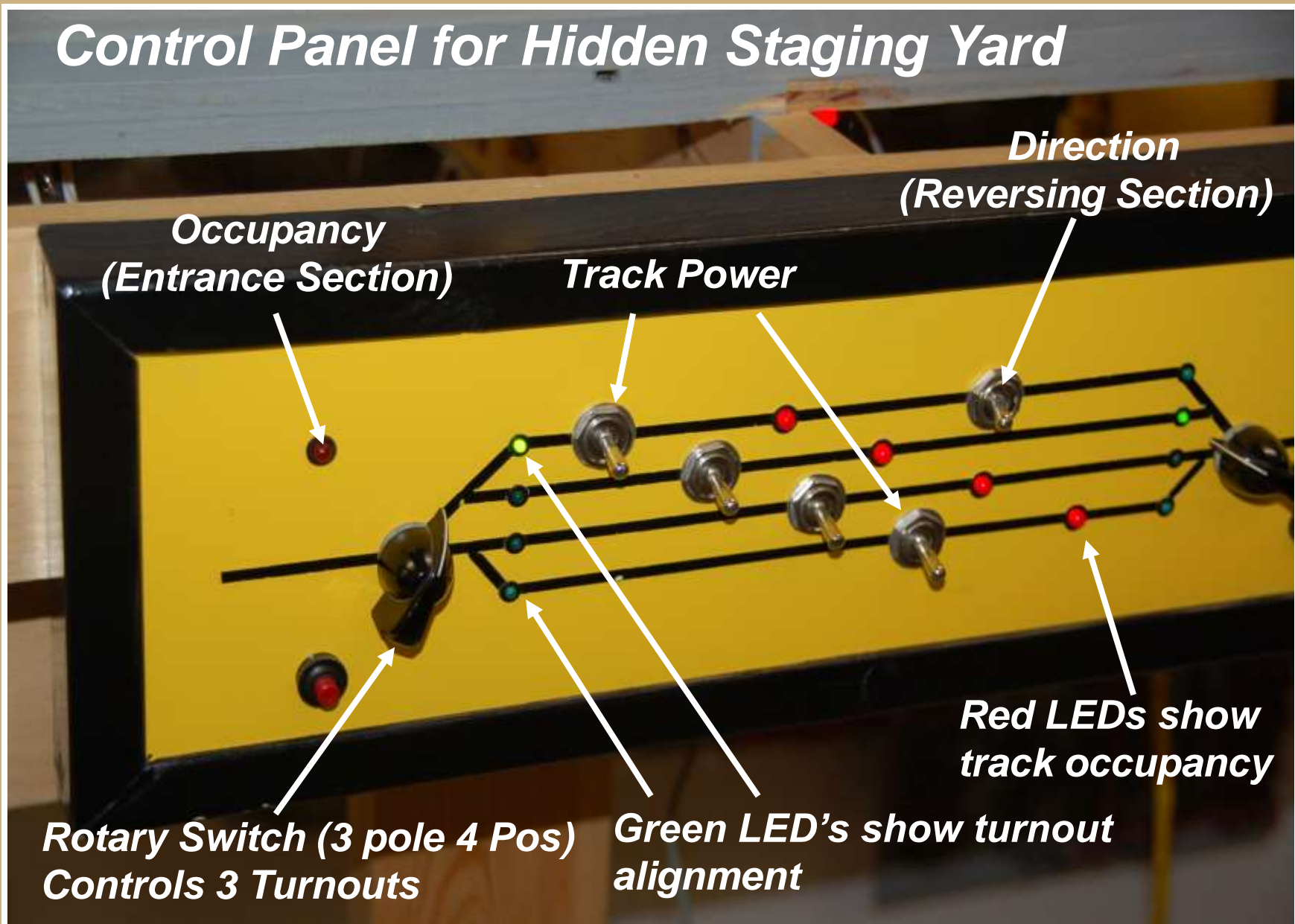
Track Power

**Direction
(Reversing Section)**

**Rotary Switch (3 pole 4 Pos)
Controls 3 Turnouts**

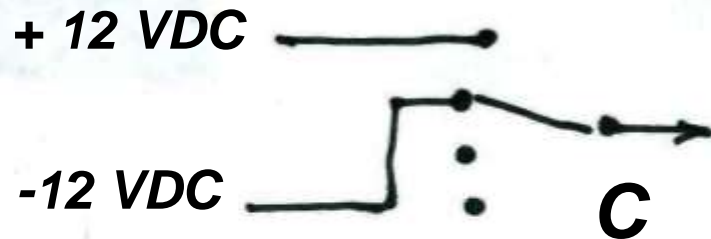
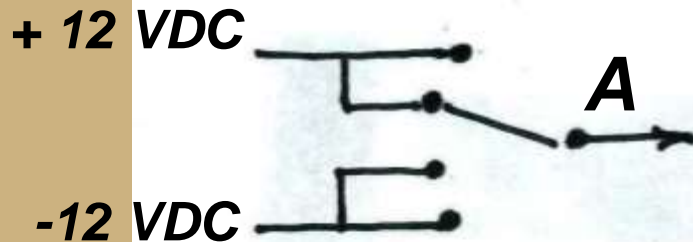
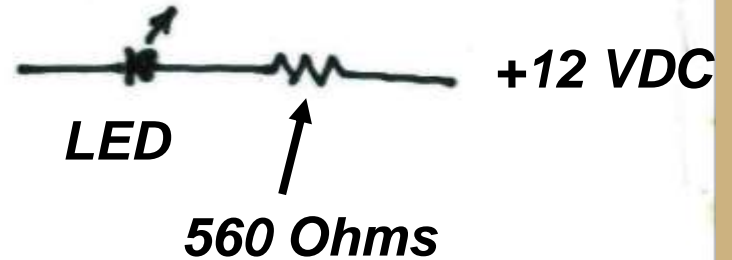
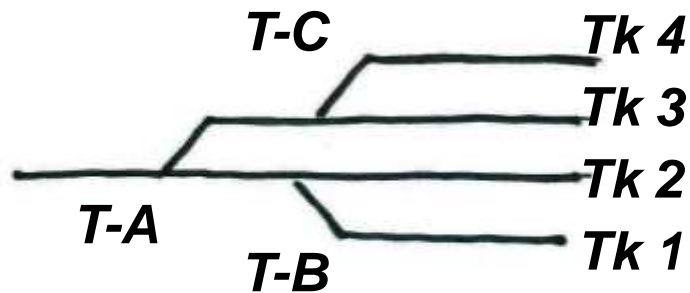
**Green LED's show turnout
alignment**

**Red LEDs show
track occupancy**

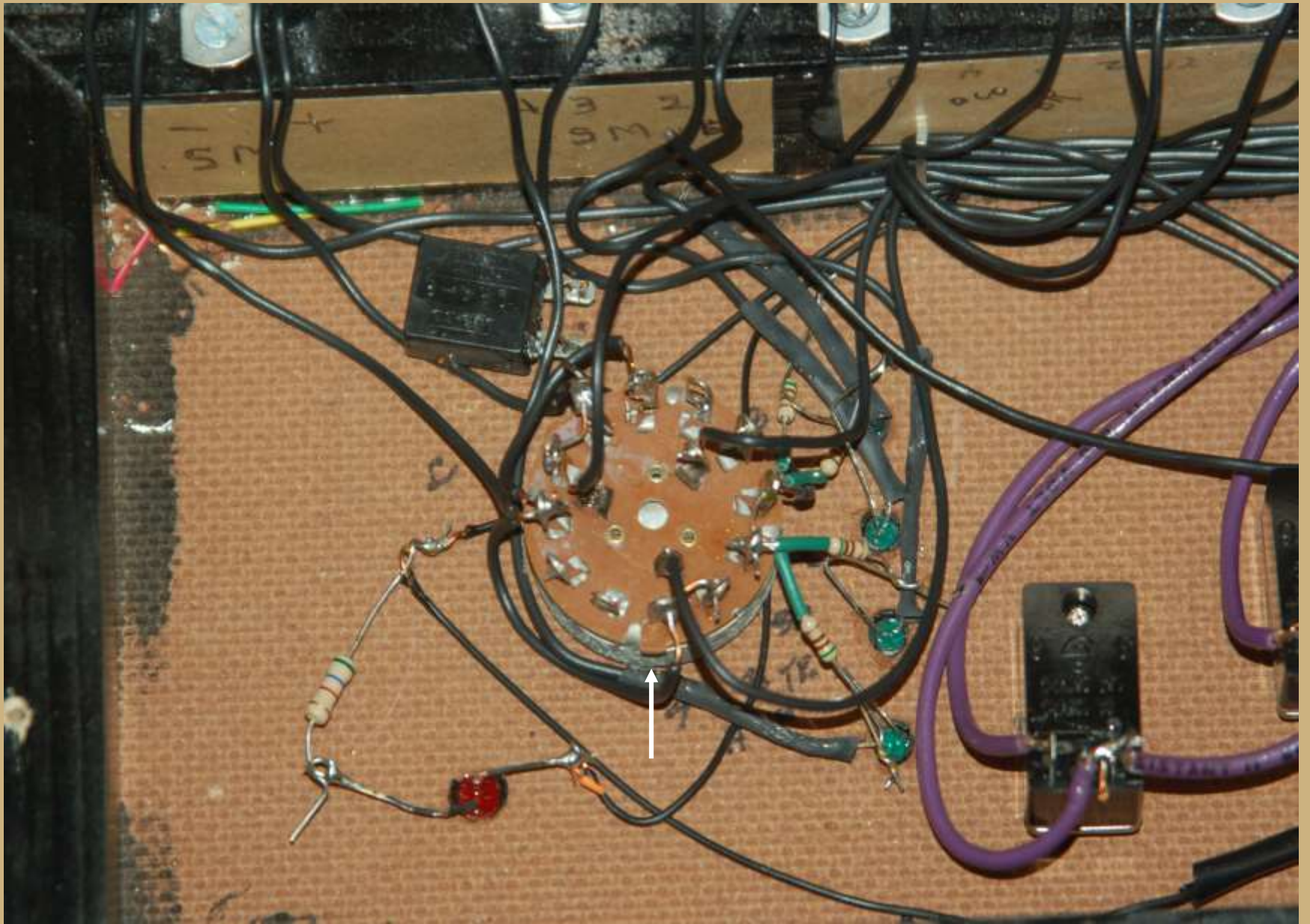


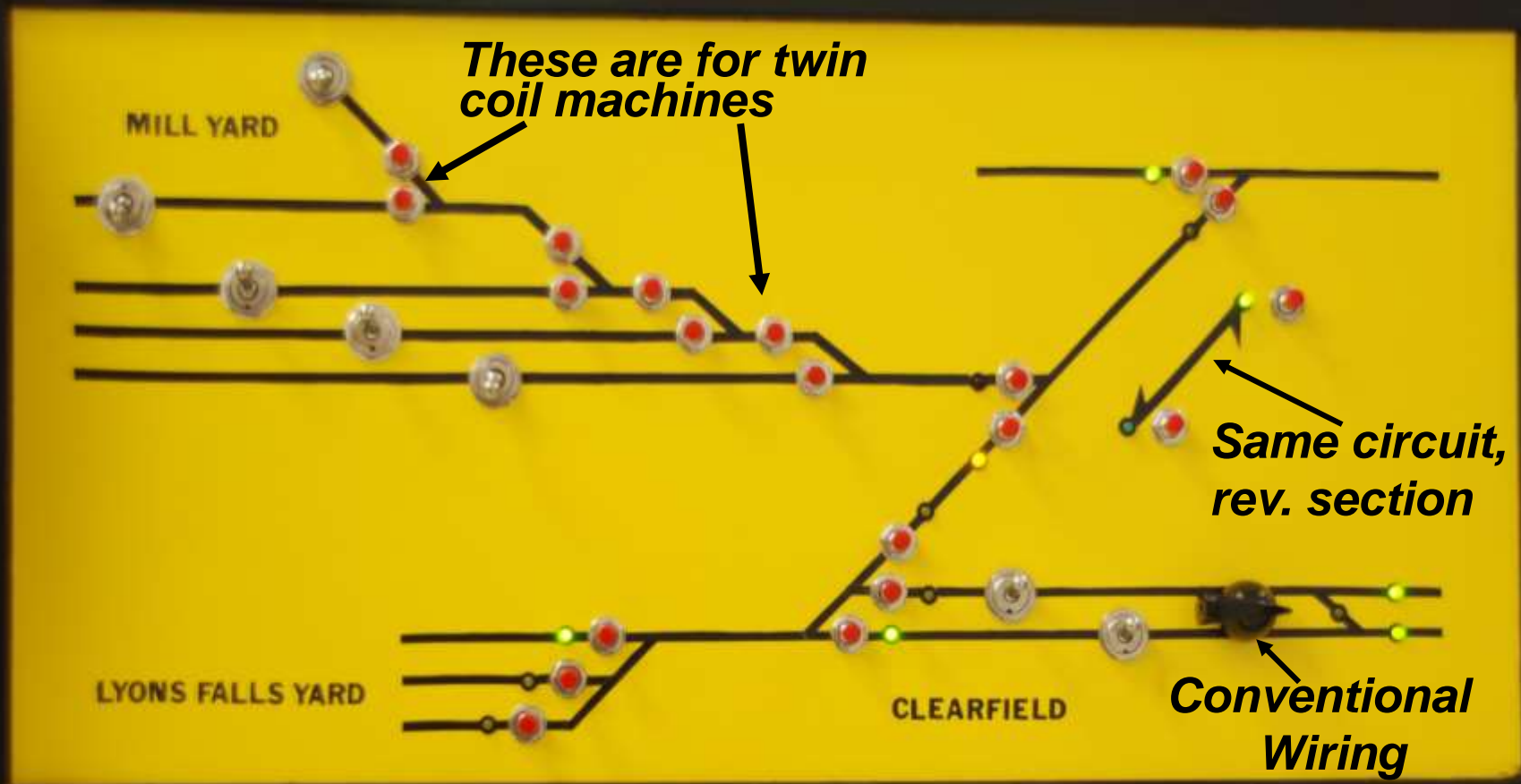
Staging Yard Tortoise Wiring

Track Layout



**3 Pole 4 Pos Rotary Switch
Each Pole shown separately**





Simple transistor/relay circuits operated by push buttons on this panel permit controlling Tortoises from several locations and via a diode matrix, route selection. The LED's show turnout position and/or route selected.

Turnout Control from Multiple Locations and Route Selection

- ✓ ***On following circuits, while one button is shown, any number of buttons can be wired in parallel to control the relay (and Tortoise) from several locations.***
- ✓ ***The first three circuits default to the “relay off” turnout position when layout power is turned off or interrupted.***
- ✓ ***All Circuits can be used for anything that requires operating a relay from several locations***
- ✓ ***PC relays require care in soldering connections to avoid overheating and damaging relay***

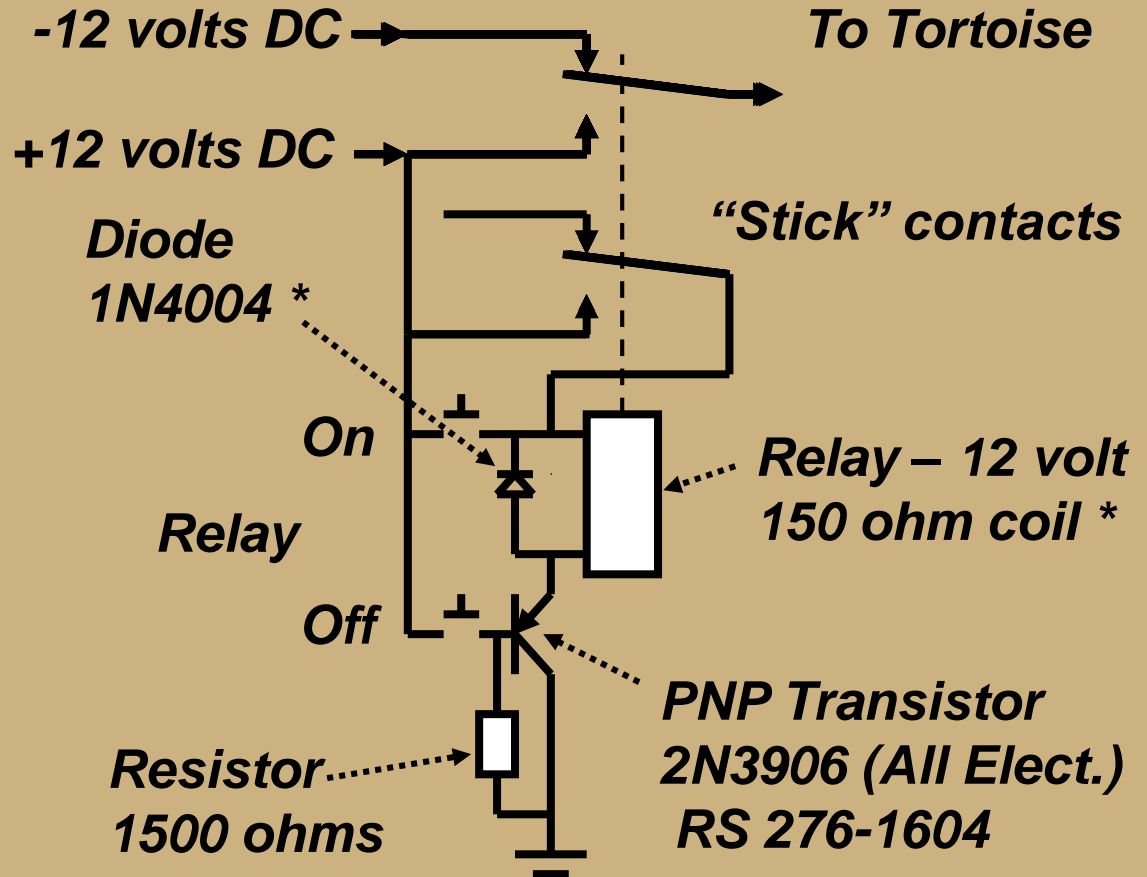
Simple Transistor Circuit

✓ Resistor allows transistor to conduct

▪ Per Transistor specs,
Up to 5000 ohms OK

✓ “On” button powers relay, stick contacts hold it on

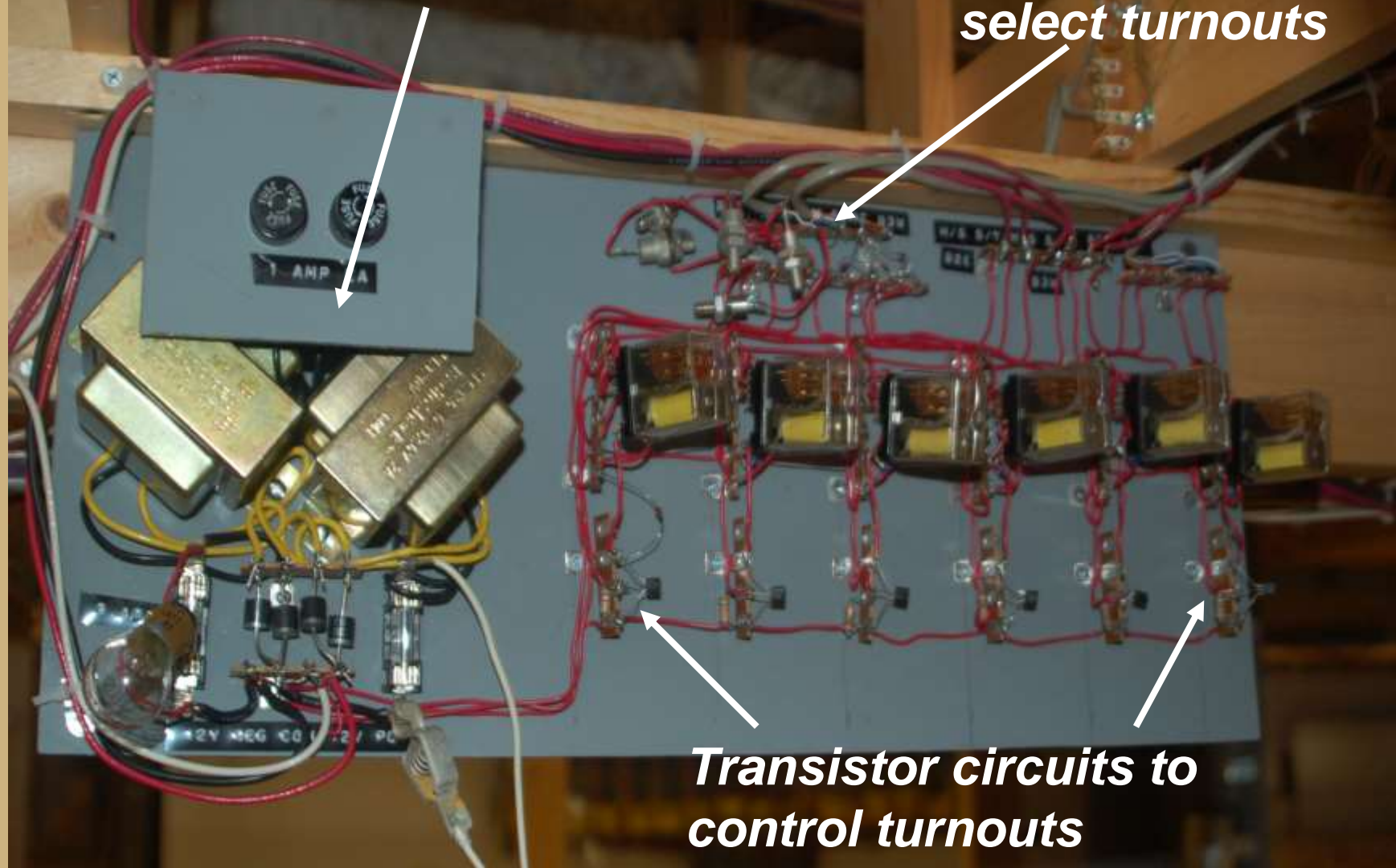
✓ “Off” button “shorts” relay coil, so it drops out



* not critical

Two 3 amp Power Supplies

Diode Matrix to select turnouts



Transistor circuits to control turnouts

Control Tortoise with 5 volt Relay

(No personal experience)

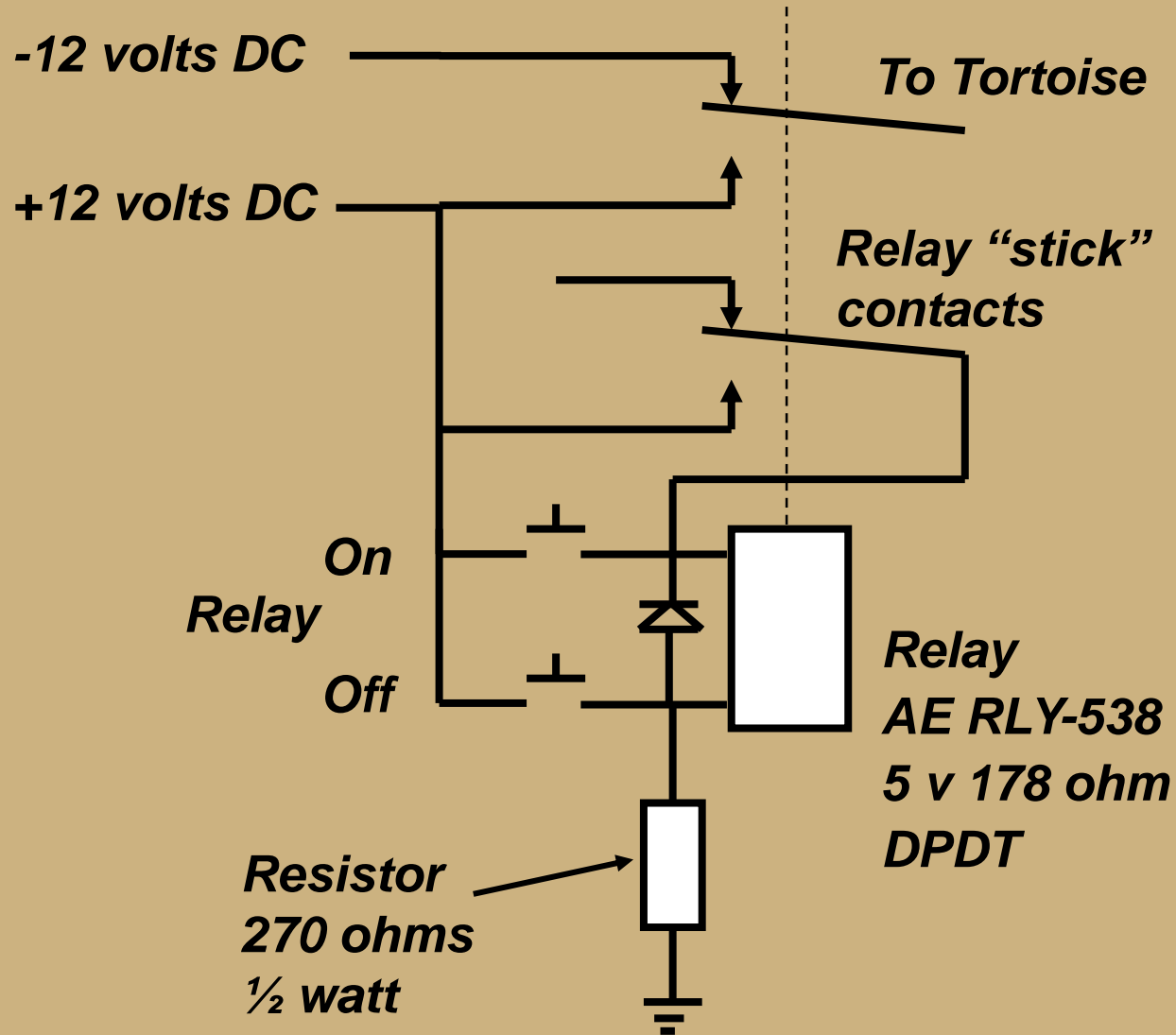
✓ “On” Button powers relay, “stick” contact holds it on

✓ “Off” button bypasses relay coil so it drops out

✓ Can have any no. of on & off buttons in parallel

✓ Resistor matched to relay coil so about 7 volt drop, ½ watt at 12 volts

✓ Relays \$1 to \$1.50 ea. at All Electronics



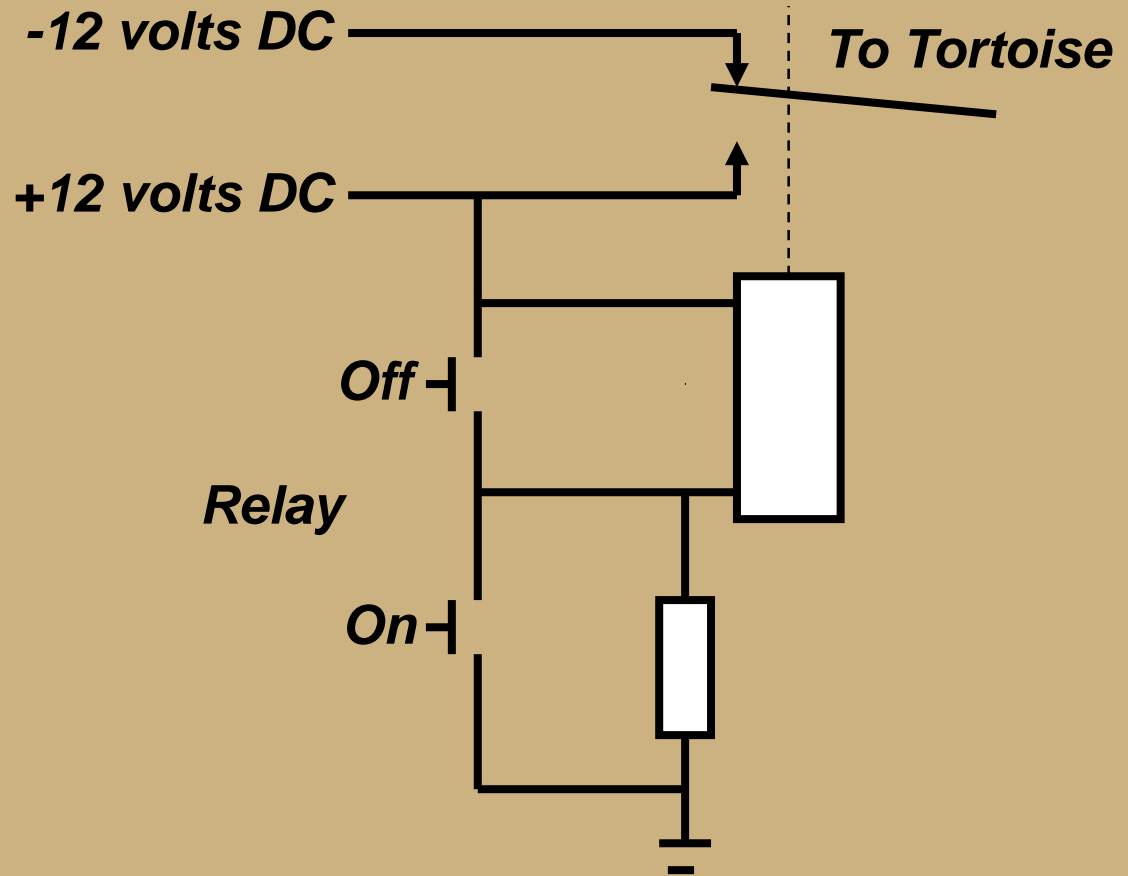
Hysteresis Circuit

(no personal experience)

✓ *This relay pulls in at 6 volts, drops out at 3 volts*

✓ *300 ohm resistor selected so 4.5 volts on relay coil*

✓ *Resistor must be matched to relay coil*



Beware that if both buttons are pushed at once, a short will result. There should be some sort of current limiter in circuit (eg, an auto taillight bulb.

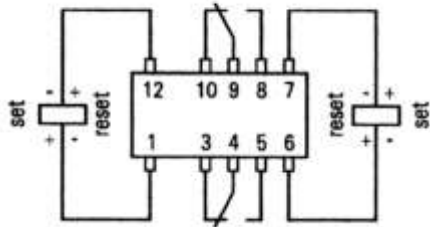
- ***Latching Relays***

- ***A relay an electromechanical switch. It is used to control a large current with a small current. Most relays require a small continuous control current to stay on. A latching relay is different. It uses a voltage pulse to cycle the relay, then stays in this position until the opposite control voltage is applied.***
- ***The latching relay has a small metal strip which can pivot between two terminals. The switch is magnetized, or attached to a small magnet. On either side of that magnet are small coils of wire.***
- ***The two coils are used to control the relay. When electric current flows into one coil, it generates a magnetic field, which moves the switch from one side to the other. When the power is removed from the coil, the strip stays there until it receives a magnetic pulse in the opposite direction. This may come either from the other coil or from a current with the opposite polarity in the original coil, pushing the switch back to the other terminal.***

Latching Relay - Typical

\$2.71 ea.

reset condition

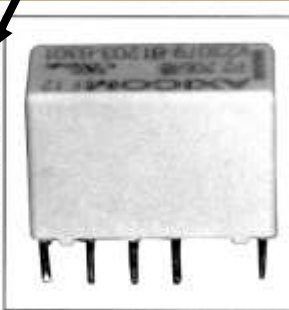


ECR0813-K

Contacts in reset position. Both coils can be used either as set or reset coils.

Digi-Key Part Number	PB1085-ND	Price Break	Unit Price	Extended Price
Quantity Available	362	1	2.71000	2.71
Manufacturer	Tyce Electronics	25	2.37320	59.33
Manufacturer Part Number	V23079B1203B301	50	2.14700	107.35
		100	1.69500	169.50
Description	RELAY MINI DPDT 2A 12VDC	250	1.52552	381.38
		500	1.44078	720.38
Lead Free Status / RoHS Status	Lead free / RoHS Compliant	1,000	1.38425	1,384.25

All prices are in US dollars.

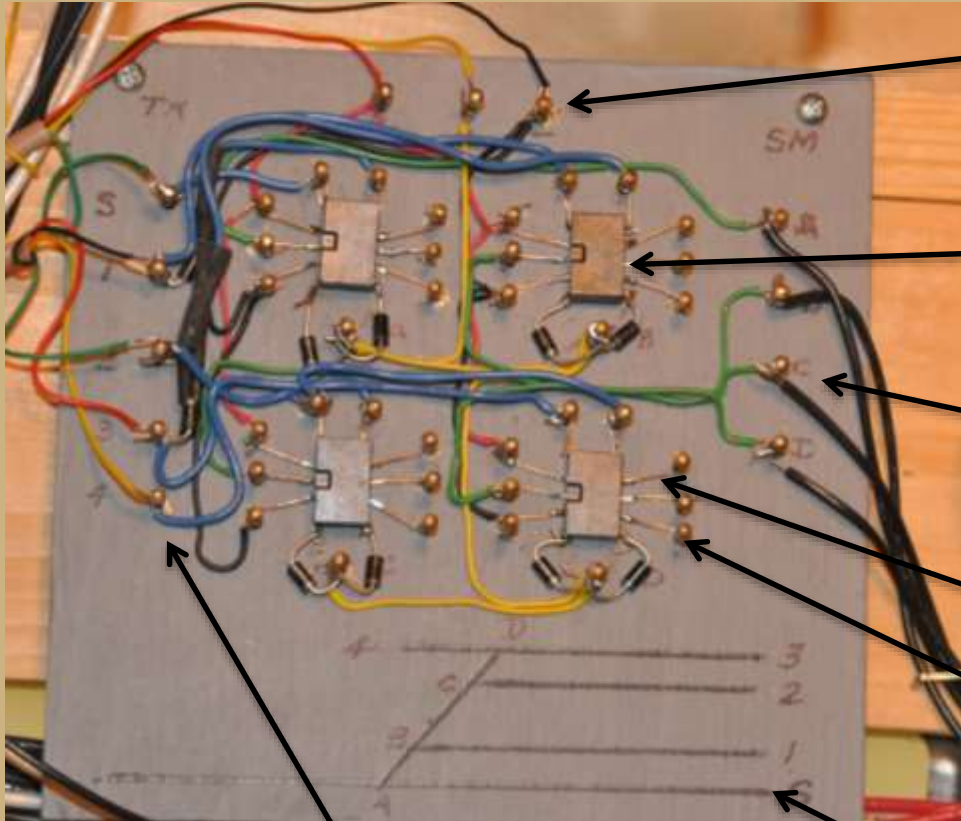


Quantity Item Number Customer Reference

- ✓ Sample from Digikey Catalog
- ✓ Use “set” & “reset” coils to reverse
- ✓ Permits multiple control locations &
- ✓ Route control w/diode matrix
- ✓ IE very simple, versatile
- ✓ But 10 terminals on 9/16” x 5/16” base

Datasheets	V23079 Relay V23079 Series
Product Photos	V23079B1203B301
Catalog Drawings	V23079 Series V23079 Series Circuit V23079 Series Footprint
Standard Package	2,000
Category	Relays
Family	Signal, Up to 2 Amps @ 30 VDC
Series	V23079, AXICOM
Relay Type	General Purpose
Circuit	DPDT (2 Form C)
Contact Rating @ Voltage	2A @ 30VDC
Coil Type	Latching, Dual Coil
Coil Current	11.7mA
Coil Voltage	12VDC
Control On Voltage (Max)	9 VDC
Control Off Voltage (Min)	-
Mounting Type	Through Hole
Termination Style	PC Pin
Catalog Page	2312 (US2010 Interactive) 2312 (US2010 PDF)
Other Names	3-1393788-6 PB1085

Panel for Latching Relays



Power, +, gnd, - 12 vdc

Relay

To Switch Machines

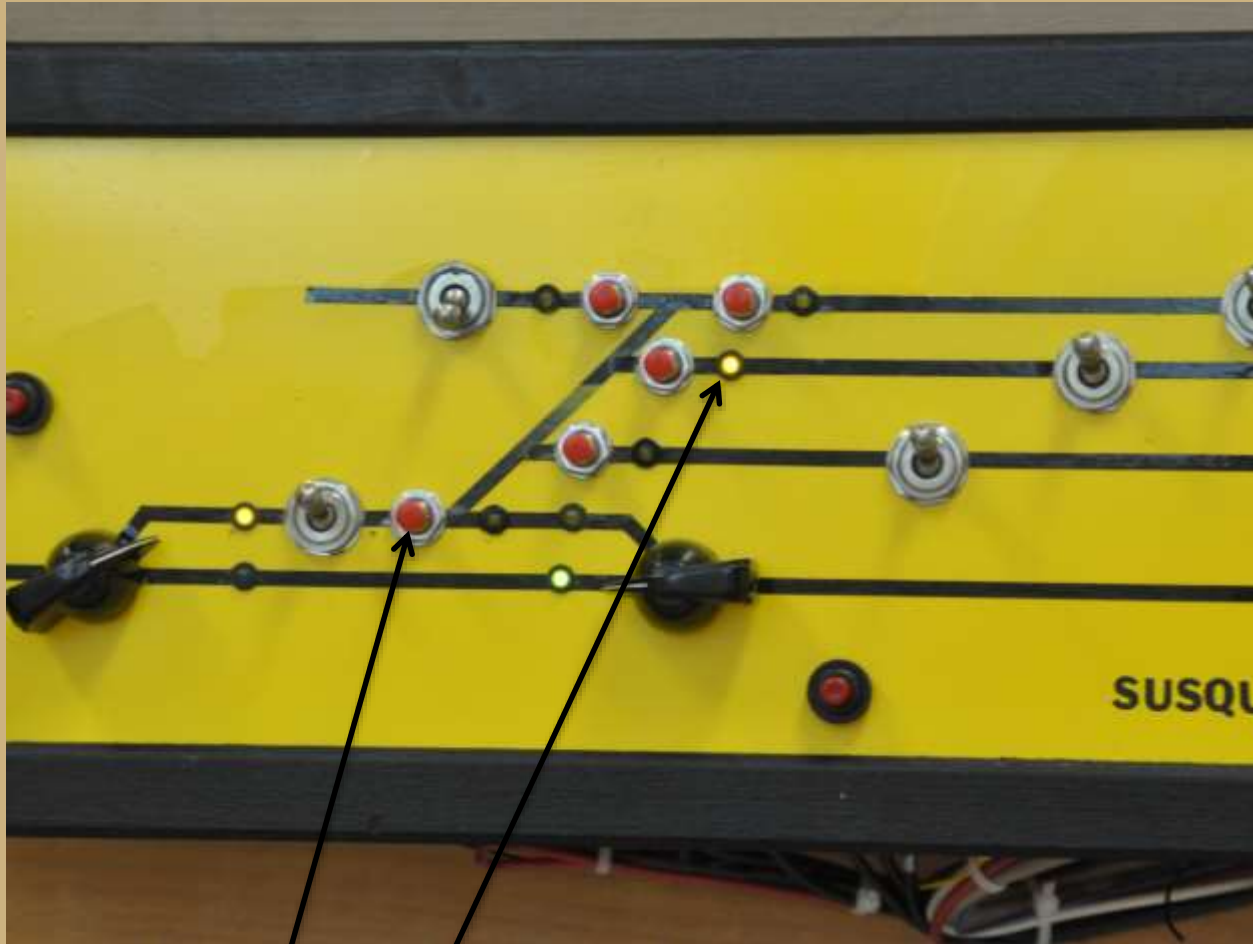
#24 wire relay to pin

Escutcheon Pins
Handy as terminals

Track Schematic

Input from Panel Buttons
(Diode matrix under HS tubing)

***Susquehanna Panel
(Modified since earlier slide)***



***Buttons select track,
LED's show current turnout positions***

***Further information is available
(or comments, criticism, etc)
Phone, email, or visit Hendersonville***

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