Fluorescent Lamp Circuits

By G8MNY (Correction Mar 08)

HOW TUBES WORK.
The tubes are coated with some fluorescent powders on the inside that glow to make up the colour balance for that type of tube (Warm White, White, Daylight). The low pressure gas (mercury vapour) is ionised. The ionised gas glows in the ultra violet range. The ultra violet light causes the material sprayed on the inside of the glass tube to fluoresce. (correction from G4IJL)

To make the gas ions (Hg) a high voltage is applied after first heating the tube with the end heaters. This heating encourages the low pressure gas to strike an arc (plasma) when a high voltage is applied across the tube. The heaters stay hot with the very high gas temperature of the arc, but due to the low pressure there is little heat transference to the glass.

As the tube ages the heaters eventually burn out leaving tungsten blackening on the glass, & an arc can no longer be initiated or maintained. To increase the heater lifetime heater guard plates reduce the ion velocity near the heaters.

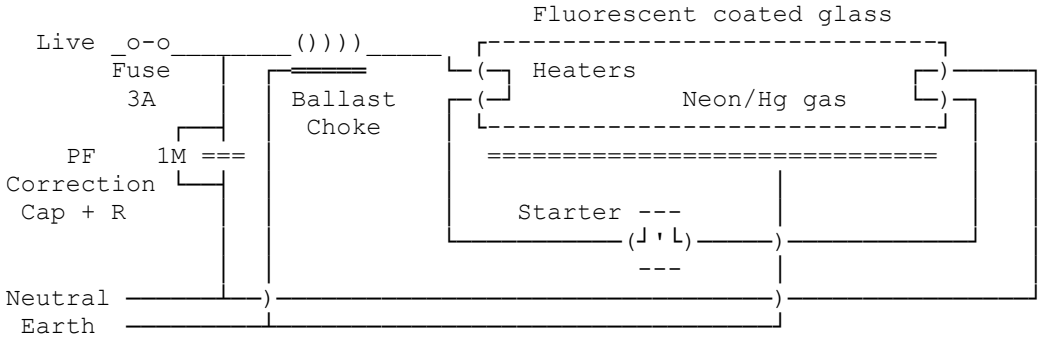
To encourage the arc striking it is important that the fitting be earthed as this helps propagate the initial arc down the tube. To aid this some makers put a metal strip down the outside of the tubes that is connected to the end caps. With the right type of matching holder these are earthed, otherwise just the nearby body of the lamp fitting has to do.

There are 2 mains iron ballast types other than electronic ballast types. For rotary workshop work, 3 tubes are normally used one per mains phase so that strobe effects do not occur with synchronous motors.

12V DC types are all electronic, high voltage DC types used to be used with resistive ballast & needed the tubes regularly tuned around as the burned out one end.

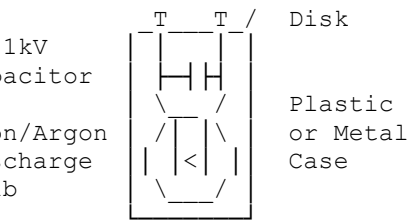
STARTER TYPE (including the older heavy energy saver lamps)
Advantages..
1) 3-5 times more efficient than normal tungsten lamps once warmed up

Disadvantages.
2) The light is difficult to focus with reflectors than tungsten lamps.
3) 100Hz flicker is more pronounced that tungsten Lamps.



The ballast choke is designed to give the correct heater current (1A) when the starter shorts & also give the correct arc current (lamp rating) when running. The capacitor is optional depending if the mains power factor (due to inductive ballast) needs to be corrected, & even then usually only to a PF of 0.85-0.9.

The starter is a small neon/argon tube that immediately strikes & passes a small current when mains is applied to it. It has a normally open bi-metal contact inside starter that form the electrodes, these quickly heat up from the gas plasma. When it is hot after a few mains cycles the contacts close for 1-2 seconds, this puts high current from the choke through the heaters, which should cause them to glow. Often a small capacitor is included to reduce spark QRM & contact pitting.



When the starter contacts cool down, the contact breaks & if there is still mains current flowing (not at the wrong part of the mains cycle) high back EMF from the choke is applied via the mains across the tube. If the tube fails to strike the start cycle repeats.

COMMON FAULTS

a) Burnt out heaters causes no start cycle. Blackened ends confirm age.
b) Old tubes with blackened ends need higher than normal strike voltage & can fail to start with a starter of too lower strike a voltage (wattage).
c) Fail to start when cold. Try earths, touching tube with finger, & warming!
d) Welded starter contacts cause permanent glowing & no start cycle.
e) Burnt out choke due to shorted starter & silly fuse rating. Also a DC component from old tubes can saturate the choke & lead to overheating failure.

For b) & d) change/swap/remove starter. For a) & b) change tube.

ELECTRINIC STARTERS

In recent years new non mechanical starter has been available. It should give longer starter live & some claim to give longer tube live as well.

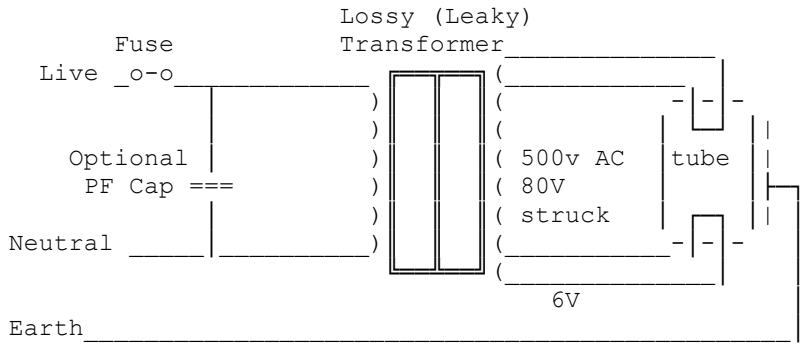
INSTANT START TYPES

Advantages..

1) 3-5 times more efficient than normal tungsten lamps once warmed up.
2) No flashing starter, gentler on tubes.
3) May be able to run tubes when the heaters are burned out to give really long useful tube lifetime & lower maintenance.

Disadvantages..

4) The light is difficult to focus with reflectors than tungsten.
5) 100Hz flicker is more pronounced than tungsten Lamps.
6) They are often more expensive than starter types.
7) They are often heavier than starter types.



These use either a non resonant lossy transformer with a magnetic shut that allows the flux to bypass the secondary. (An isolating one is shown here but auto-transformer types are common). A resonant transformer with a series tuning capacitor, this can cut down the size of the transformer while also correcting the PF.

When powered a high voltage (>500VAC) appears across the tube & the heaters are energised (approx 6VAC @1A). When the tube strikes the 500V falls to about 80V @ the current rated for that tube's power. The heater voltage also falls dramatically.

COMMON FAULTS

a) Burnt out Transformers, due mainly to uneven tube striking (50Hz flicker) on old tubes can causes DC through transformer & shorten transformer life due to over heating. A sensible slow blow fuse rating or thermal cut out would stop this!

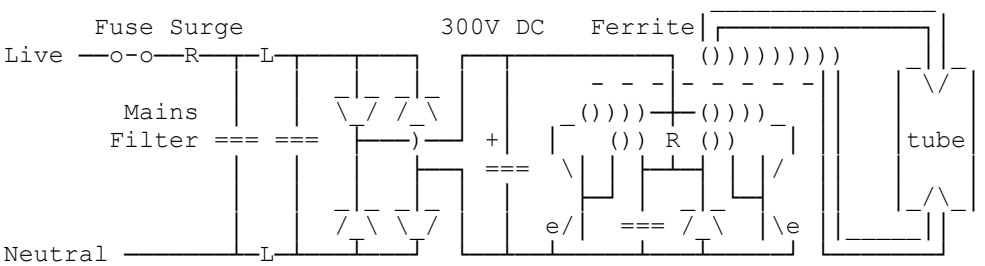
b) The Heaters are not needed if in warm environment, so tubes can often be run until they "drop", but fail in the cold.

ELECTRONIC BALLAST TYPE (including most Saver lamps)
Advantages..

1) Slightly brighter & more efficient lamp than normal ballasted types, as HF excitation gives more light!
2) 4-6 times more efficient than normal tungsten lamps once warmed up
3) No Mains 100Hz flicker, the fast pulsing is merged by the tube persistence.
4) AC/DC operation.
5) Lightweight.

Disadvantages..

6) The light is difficult to focus with reflectors than tungsten lamps.
7) Radio QRM radiated down mains.
8) Direct QRM from tube acting as an aerial.
9) Cross modulation (Mixing) of nearby RF fields in the tube.
10) Interference to IR remote controls sensors from pulsing IR arcs at the heater ends.



The mains is protected from the large HF inverter QRM by the mains filter. The Surge R has to handle turn on surges (>340V peak). The always live 300V DC is roughly filtered by the electrolytic cap & the supplies the high frequency current path needed by the inverter. Here I have shown a simple push-pull high power inverter, some use driver control ICs & MOSFETS etc.
Push-pull positive feedback drive the 2 output hard, initially biased by a pull up R from +300V (sometimes from the mains side to reduce R wattage), then they self bias from the diode once oscillation starts. Frequency of oscillation is usually 15-30kHz & changes on depending on the tube status, mains voltage etc. The tube drive may have heater taps as shown or not, of the ferrite output transformer secondary produces over 1000V AC before the tube strikes.

It may not be safe to run the unit without a tube!

COMMON FAULTS
i/ Not working, mains spike killed bridge/inverter, surge R blown up.
ii/ Loud singing, cause .. ferrite core chattering glue dried out.

Why Don't U send an interesting bul?

73 De John, G8MNY @ GB7CIP