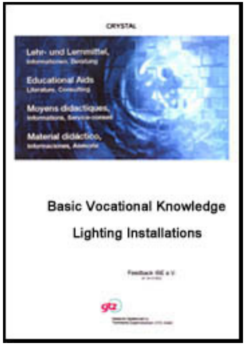

Lighting Installation - Basic vocational knowledge (Institut fr Berufliche Entwicklung, 164 p.)

6. Operating Components for Discharge Lamps

6.1. Ballast

With discharge lamps, the appropriately dimensioned ballast is an important precondition for the achievement of the lamp life. If a ballast is used which does not correspond to the respective lamp, the lamp parameters may not be achieved and the service life of the lamp may be reduced.

The ballast must have sufficient temperature conditions for the case of use they are meant for. These are printed on the ballast. For example: 105/55/140.

The meaning of these numbers is in succession: Winding limiting temperature in degree

centigrade, winding overtemperature in degree Kelvin in normal and anomalous operation.

In normal operating conditions, ballasts in permanent operation with the winding limiting temperature have a service life of 10 years. If the ballasts are operated in anomalous conditions, at the limit of the then occurring winding overtemperature, their service life expires after 20 days. Towards the end of the service life, the ballasts fail due to break, interturn short-circuits or body contact. With this, very high temperatures may occur on the contact surfaces.

In the case of anomalous operation - for instance with preheating of the lamp electrodes - and with 110 % of the rated voltage for ballasts for lamps up to 400 W, the maximally occurring current is limited to the 2.1-fold value of the rated lamp current with lamps of greater power to the 2.2-fold value of the rated lamp current.

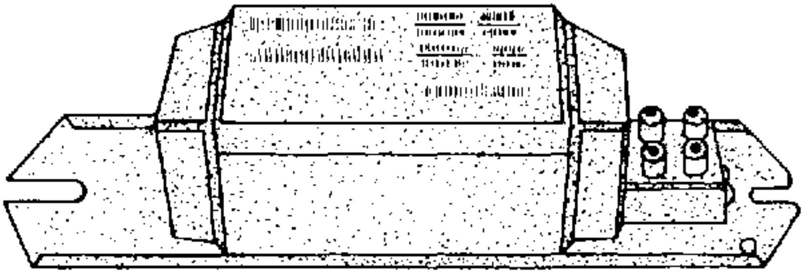

Figure 37. Series reactor for fluorescent lamps

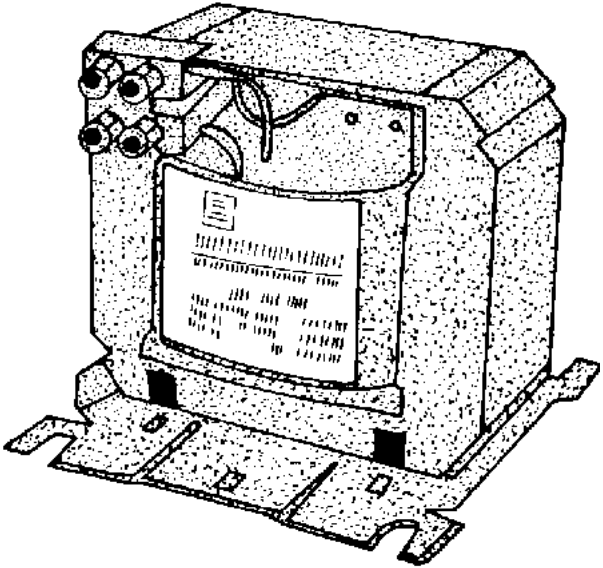

Figure 38. Series reactor for high-pressure mercury vapour lamps and halogen metal vapour lamps

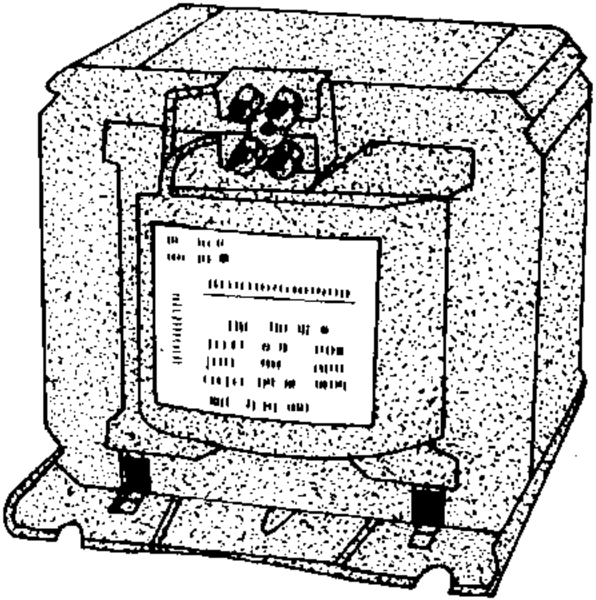

Figure 39. Series reactor for high-pressure sodium vapour lamps

6.2. Starter Switches

Starters consisting of the major components of glow starter and capacitor are in important operating means of fluorescent lamps and recently in special designs have also been used as starters for ignition sets.

The prolonged first make time for instance of the St l glow starter for fluorescent lamps is within the range of 0.45 to 2 s; with most starters it is 1 s on an average. The maximum voltage produced is more than 400 V, the test service life 6000 (number of switchings).

For tandem operation of fluorescent lamps of 20 W special starter switches are required.

For starter ignition sets of high-pressure discharge lamps a special glow starter without capacitor is used.

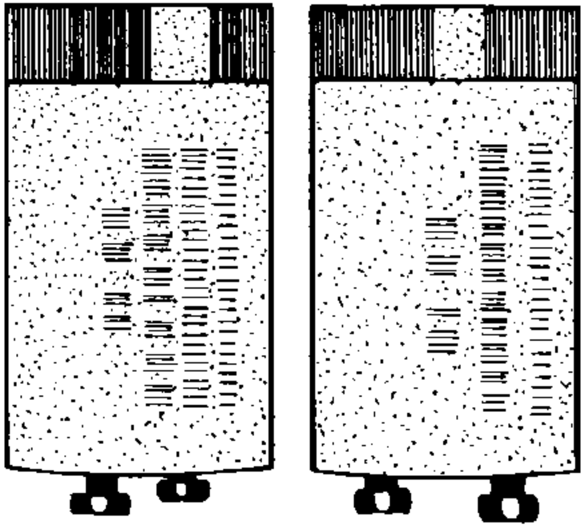

Figure 40. Starter for fluorescent lamps

6.3. Ignition Sets

Halogen metal vapour lamps and high-pressure sodium vapour lamps need ignition sets for starting the discharge. Two different types of sets are available for the user - the starter ignition sets and the thyristor ignition sets.

Starter ignition sets, in their essence, consist of a special glow starter with a current-

limiting capacitor and, perhaps, a protective resistor connected in series, by which - including the inductivity of the ballast - the required glitches from 1.5 to 2.5 kV are generated in the form of irregular pulses.

Starter ignition sets are very economical as to the price; they meet the requirements of the IP54 protective system and can be placed at a distance from the lamp.

After ignition of the lamp there is no internal consumption. As a wearing part the starter is considered as disadvantageous its replacement requiring much maintenance work.

The thyristor ignition set is an electronic heterodyne ignition set and consists of various semiconductor elements as well as of a pulse transformer. The primary voltage of the pulse transformer is switched by a thyristor controled by a diac.

The high-voltage pulses of approximately 4.5 kV and a natural frequency of 100 kHz which develop at the secondary winding of this transformer are superimposed on the network voltage near the maximum of the positive half-wave. Ballast and secondary winding of the pulse transformer are connected in series with the lamp, i.e. the lamp current flows over the secondary winding which is designed for a continuous current load of 4.4. A. From this results the power loss of the ignition set of maximally 4 W with the lamp burning. The high tension is led out by an ignition wire which has to be connected with the contact plate of the socket. The short ignition wire conditional on the set requires the ignition set to be arranged near the socket of the lamp. After having ignited the lamp the ignition set gives no further high-voltage pulses; however, it continues to work if and when the lamp is defective or the lighting outlet is unoccupied (continuous ignition).

6.4. Compensating Capacitors

The current limitation by inductive ballasts with discharge lamps causes a power factor of 0.4 to 0.7 according to the type of lamp; the average is 0.5 approximately. The use of

suitable capacitors enables an improvement in the power factor - about 0.85. MP-compensating capacitors (parallel capacitors) of 2 to 40 microfarad as well as motor and power capacitors are used.

Furthermore, it is distinguished between single power-factor compensation, group power-factor compensation in alternating current installations and three-phase current installations and central power-factor compensation. The last mentioned kind of compensation considers all inductive consumers of the entire generating plant by a battery of capacitors based on an automatic control by connecting and disconnecting individual capacitors depending on the power factor measured. The capacity values of single compensation are to be found in the respective tables.

Compensation capacitors are connected in parallel to the network and must be disconnectable together with the entire installation. If a number of single capacitors are used in order to achieve the total capacity, these must be connected in parallel.

6.5. Intensity Control of Lamps

With all-purpose lamps intensity control can easily be realized.

By a voltage dip of only 30 %, a luminous flux value of 1 % can be achieved. This is done by using series resistors or - more economically - by adjustable transformers. Modern electronical small devices on thyristor basis are known as dimmers.

With fluorescent lamps, due to the falling characteristic of the current-voltage-dependence and the required high reignition voltage, an intensity control by reducing the voltage (amplitude control) is not possible.

Here, the principle of phase-shifting control is applied, i.e. the lamp current and thus the luminous flux are changed in a wide range both half-waves being used. The best control

behaviour is shown by rod-shaped fluorescent lamps of 40 W, which must be equipped with an ignition aid in the form of an earthed starting strip or a closely spaced ignition grid. In addition to the ballast, each lamp needs a heating transformer with two separate secondary windings for preheating the lamp electrodes. The heating transformer, for instance 220 V/2 x 6.3 V, 10 VA and the device for the phase-shifting control must always be connected to the same external conductor. Because of the low preheating voltage of about 6 V, attention has to be paid that the lamp sockets give faultless contacts. In order to improve the quality of control, an ohmic base load has to be connected to the load exit of the device according to the instructions of the manufacturer (e.g. filament lamps 25 W).

To one light-controlling device, several lamps can be connected according to the design of the device.

The regulating proportion that can be achieved is in the range of 1:20 to 1:30; in favourable conditions a ratio of 1:100 is possible. Before using fluorescent lamps for intensity control the entire lot of lamps of one charge should be burnt in for approximately 20 hours.

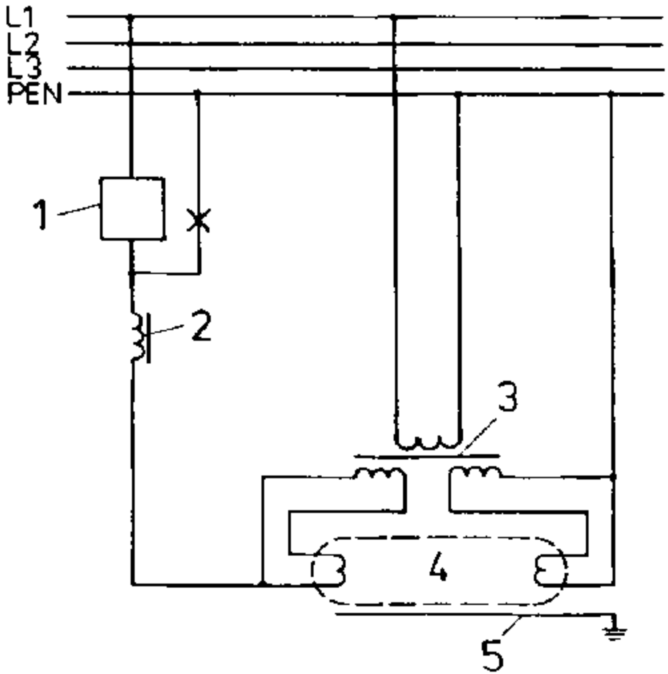

Figure 41. Intensity control of fluorescent lamps

1 control unit
2 series reactor
3 filament transformer
4 lamp
5 ignition strip

To high-pressure mercury vapour lamps the above mentioned methods cannot be applied, because a voltage dip of more than 15 % already leads to the extinction of the lamp or to unstable operation.

Questions for repetition and knowledge tests

1. What are the distinguishing characteristics of ballasts of fluorescent lamps compared with ballasts of high-pressure mercury vapour lamps?

2. Why are compensation capacitors required for discharge lamps?

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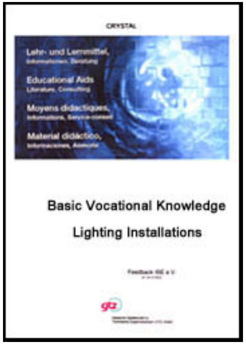
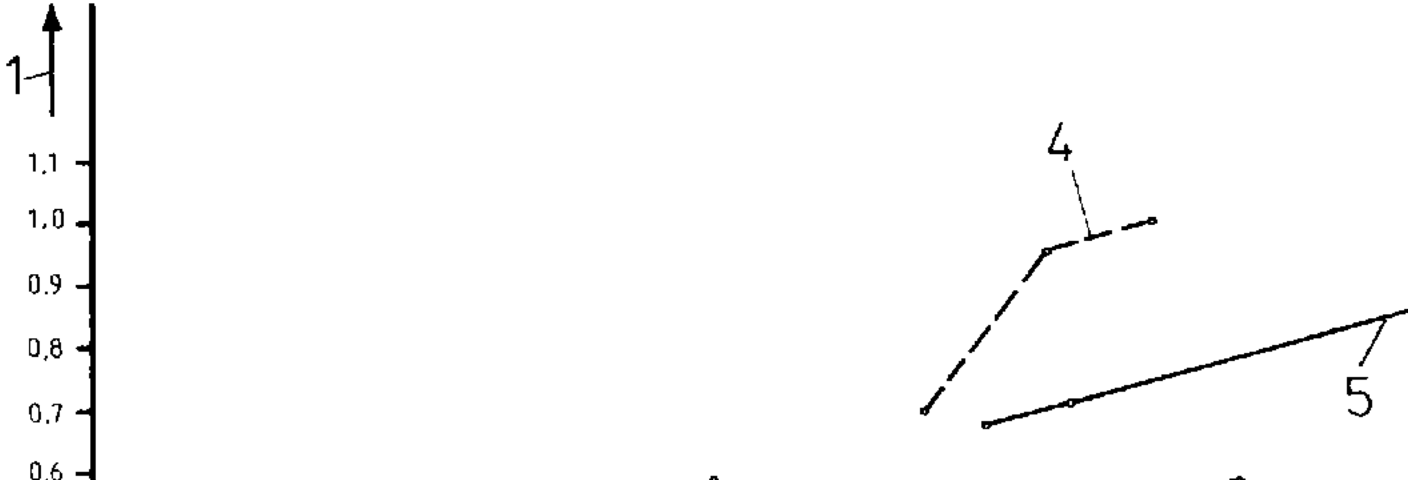


7. Comparative Tabulations of the Properties and Energy Consumption of Lamps

Lamps are not only radiation sources but also heat sources. The increasing importance of integrated illuminating installations - included in the air-conditioning and noise control measures - requires also knowledge of the energy balance of lamps. The energy balance represents the division of performance into heat of conduction and convection heat as well as the entire radiant flux (radiation power). In this context, it is of special importance how the total radiant flux splits up into the individual wavelength ranges.



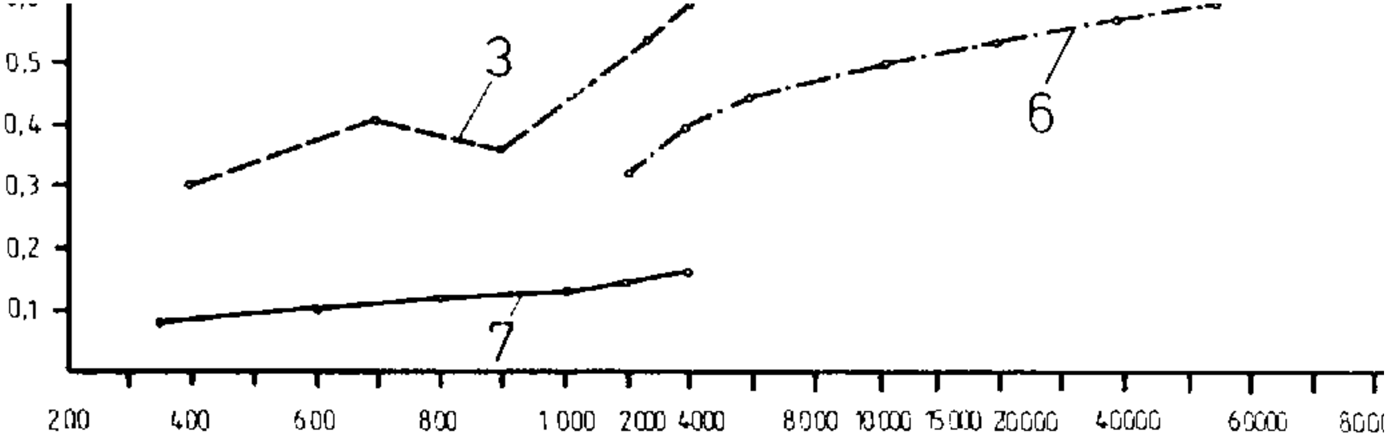


Figure 42. Comparison of light yields of discharge lamps

1 light yield (Phi(L)) divided by (Phi(total)), 2 lamp lumens in lm, 3 fluorescent lamps, 4 sodium vapour lamps, 5 metal vapour lamps and halogen lamps, 6 high-pressure mercury vapour lamps, 7 filament lamps of standard rating

Table 21. Comparison of light source parameters

Qualities	General service lamp	Halogen filament lamp	Fluorescent lamp	High Press. mercury vapour lamp	Halogen metal vapour lamp	High-press. sodium vapour lamp
Rated power - W	25...1000	1000..2000	8...65	50...2000	140...2000	175...400

Luminous flux - lm	220...11900	22000...44000	350...4300	1900...120000	12000...180000	17500...43000
Light yield with ballast - lm/W	8.8...19	20...22	27...56	31.5...58	62...86.5	72.5...98.8
Light colour	ww	ww	ww, nw, dw	nw	ww, nw, dw	ww
Colour rendering steps	1	1	1; 2; 3	2; 4	2; 3	3
Service life - h	1000	1200	4000...1000	5000...12000	1000...6000	8000
Rated voltage - V	225; 240	225	220	220; 380	220	220
Tolerance of rated voltage - %	-	-	+-10	+-10	+-5	+-5
Ballast	-	-	choke	choke	choke	choke
Ignition set	-	-	starter	-	ignition set	ignition set
Starting time - min	app. 0	app. 0	>0.035	4...5	2...3	4...5
Restarting	app. 0	app. 0	app. 0.016	4...5	10...15	app.

Restarting time - min	app. 0	app. 0	app. 0.016	1...5	10...15	app.

(ww warm white; nw neutral white; dw daylight white)

Table 22. Energy balance in % of a number of lamps

Lamp	Circuit convection heat	Total radiant flux	Radiant flux in various wavelength					
			ranges (mean values)					
			UV-B-	UV-A-	visible	IR-		
			range					
			300	350	580	1090	2050	2700
General servics lamp								
100 W	7	93	-	0.03	9.0	36.0	32.0	16.0
1000 W	5	95	0.005	0.06	11.9	38.2	29.2	15.6
Halogen filament lamp for floodlight								
2000 W	6	94	0.01	0.1	13.3	38.9	31.1	10.6
Fluorescent lamp								
LS40, nw20	40, approx.	60, app.	0.05	0.5	18.8	0.5	0.15	40, app.
LS65, nw20	40, approx.	60, app.	0.06	0.5	18.0	0.6	0.12	41, app.
High-pressure mercury vapour lamp with luminescent material								

400 W	25	75	0.12	2.0	14.8	5.5	6.1	47, app.
Halogen metal vapour lamp								
400 W	20	80	0.02	2.3	20.5	8.5	6.8	42, app.
High-pressure sodium vapour lamp								
400 W	22.5	77.5	0.003	0.3	30.0	16.2	8.0	23, app.