10.4: Flat Panel Multi-Digit Fluorescent Display

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Introduction

The requirement for digital display to be used in electronic calculators, measuring instruments, and in other industrial purposes are emphasized in the reduction of size and power consumption as well as in the flat panel configuration.

The vacuum tube type fluorescent alpha-numerical display, which we call the "ITRON" or rather the GREEN TUBE as is widely known in U.S., was initially developed in 1967 at Ise Electronics Corp. It is used popularly in electronic calculators due to its legibility, low voltage and low power consumption.

The "Flat Panel Itron", which will be described here, is a new outgrowth from the tubular concept to a thin panel construction with several outstanding improvements in manufacturing technology, namely the application of Thick Film Screen Printing on glass plate which constitutes a part of the display device enclosure. It is also featured by its improvement in power consumption resulting from the improvement in the alignment and configuration of the electrodes.

Flat Type Multi-Digit Numeric Display

Heretofore, multi-digit display devices were developed along a few paths, such as the tubular glass envelope type within which a multiple digits were enclosed, the metal envelope with window type, and the ceramic envelope with window type.

The basic process of the new flat multi-digit display is in the application of thick film screen printing technology in making the luminous anode. Formerly, a flat ceramic was used as the substrate glass envelope. This was improved and simplified so that the anode was made of a flat glass substrate which was made to serve a part of the vacuum envelope.

(1) Glass plate

A remarkable point of glass flat type, Multi-digit display is the glass plate that constitutes a part of the vacuum sealed package.

Figure 1 illustrates a brief construction of the glass plate.

(2) Processing of glass flat multi-digit numeric display

Figure 2 explains the fabrication process of flat glass type multi-digit numeric display.

(3) Characteristic of glass flat nine digit display

Application of this particular display is mainly in the hand-held electronic calculator. Therefore power consumption among other characteristics is always the major subject to be discussed.

Since the battery operated hand held calculator was dominated by nine digit displays, there was predominant requirment for the nine multi-digit display device to have the least power consumption.

To achieve this requirement it is necessary to reduce the filament power (Wf) and grid power (Wc).

In reducing the filament power (Wf), although it may be conceivable to use a thinner filament wire, it proves to be not economical from the point of productivity and reliability.

The conventional tubes have two filament wire, and apparently the removal of one filament should result in half the filament power.

Nevertheless, this causes the electron distribution upon the anode to be extremely poor, hence non uniform brightness on the segments.

To overcome this defect, the number of filament was reduced without affecting its length while the anode dimmension was reduced to secure uniform electron distribution on all the segments. The character size was thus reduced to 3.7 x 1.7 mm. The configuration of the grid was also improved in consideration to achieve uniform brightness. Thus the total power consumption was bright down to 39.6 mmW.

Figure 3 shows a comparison of the characteristic between the present and new nine digit display.

(4) Characteristic data of a new nine digit display device

Figure 4: Filament voltage (Ef) vs filament current (if), plate current (ib), grid current (ic) and brightness (Ft-L). Brightness is in Ft-L.

Figure 5: Plate voltage (eb) and grid voltage (ec) vs plate current (ib), grid current (ic), and brightness (Ft-L).

Figure 6: Duty factor vs brightness.

Conclusion

Since the development of the vacuum fluorescent display by Ise Electronics Corp. in 1967, this display became to be a major readout for use in various electronic calculators in Japan. It is also applied in various fields of digital instruments such as measuring and weighing equipments, clock computer terminals, taxi meters etc. The display to be made smaller and compact in size and diminished in power consumption so as to prolong the operating life for a given battery is still a continued demand. The flat panel display therefore, should be the solution to this requirment.

Acknowledgments

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References

(1) Electronics May 29, 1967 pp212 - 213
(2) Electronics April, 1969 pp 220

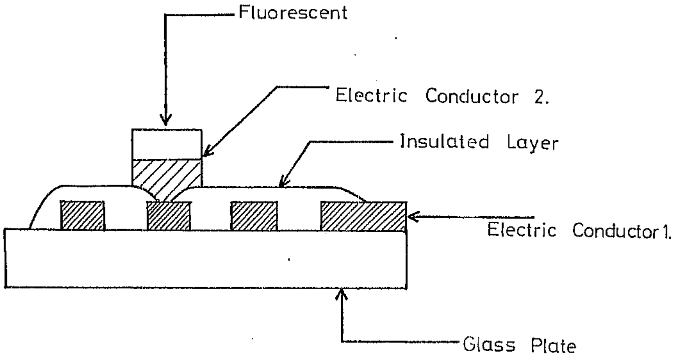

Fig. 1. Construction of Glass Plate

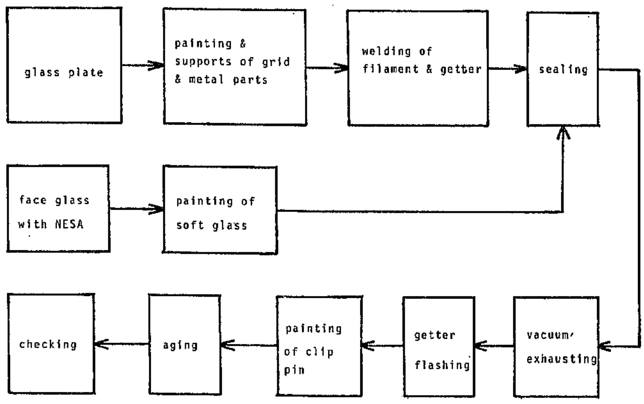

Fig. 2. Fabrication Process of Flat Tube.
Block Diagram

	oss WxHxT (mm)	cs HxW (mm)	Ef (V)	If (mA)	Wf (mW)	eb (V)	ib(mA)		ec V	ic(mA)		Ecco (Vdc)	L	D.F	P.W (us)	Wb.c (mW)	Wt (mW)	Wd (mW)
							TYP	MAX		TYP	MAX							
normal type	65x 22x7.2	5x2.4	3.0	22	66	24	1.0	2.0	24	1.5	3.0	-3.0	200	1/12	40	60	126	12.3
new type	56.5x 20.2 x7.2	3.7x 1.7	2.7	12	32.4	24	0.4	0.8	24	0.5	0.9	-2.0	200	1/12	40	21.6	54	5.4

NOTE:
- OSS : out side scale
- CS : character scale
- Ef : filament voltage
- If : filament current
- Wf : filament power
- eb : anode voltage
- ib : anode current
- ec : grid voltage
- ic : grid current
- Ecco : grid cut off voltage
- L : brightness (fL)
- D.F : duty factor
- P.W : pulse width
- Wb.c : anode power + grid power
- WT : total power
- Wd : Watt / digit

Fig. 3. Charasteristic of Flat Tube

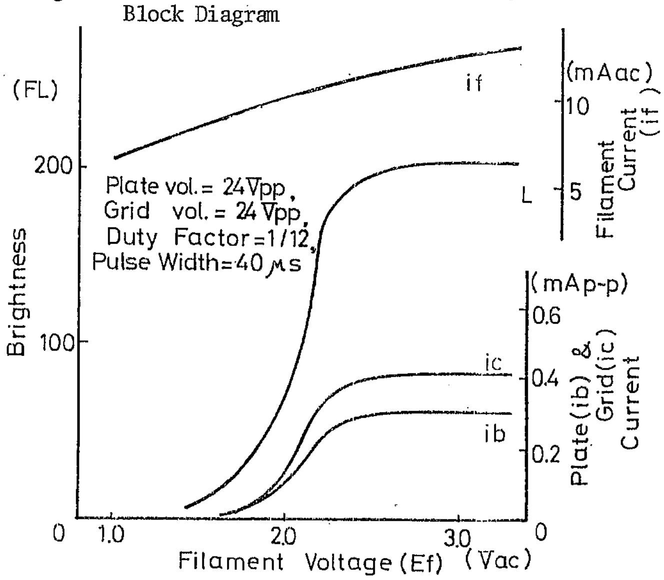

Fig. 4. Brightness, Plate, Grid & Filament Current
v.s. Filament Voltage

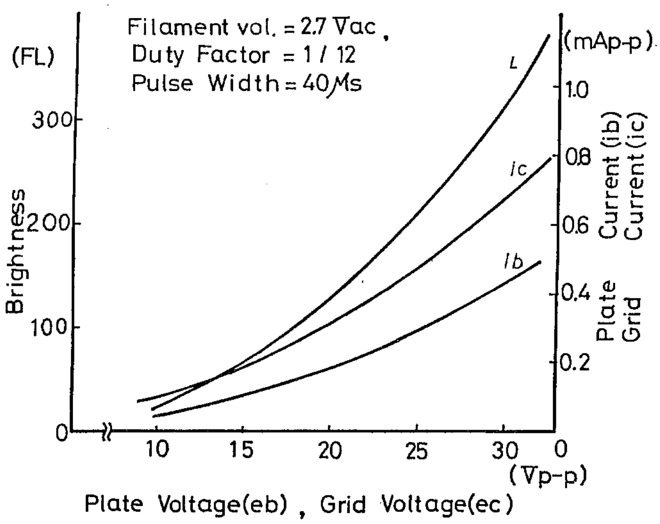

Fig. 5. Brightness, Plate & Grid Current
v.s. Plate & Grid Voltage

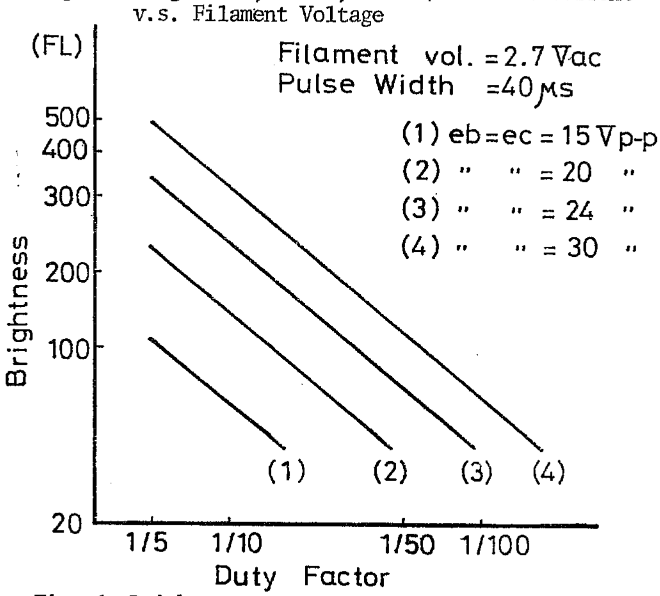

Fig. 6. Brightness v.s. Duty Factor