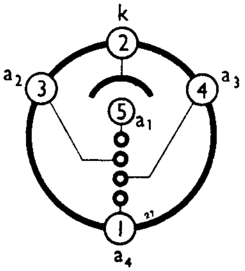
# STABILOVOLTS

## FOUR GAP

# STV280/40
# STV280/80

**APRIL, 1952**

## BASE CONNECTIONS AND TUBE DIMENSIONS



View from underside of base.

Base : British 5 pin
Bulb : Tubular

| | STV280/40 | STV280/80 | |
|---|---|---|---|
| Overall length : | 142 | 142 | mm. |
| Seated length : | 127 | 127 | mm. |
| Max. diameter : | 41 | 62 | mm. |

## RATING

| | STV280/40 | STV280/80 | |
|---|---|---|---|
| $V_{b\ \text{min.}\ a4\text{-}k}$ (approx) | 420 | 420 | V |
| $V_{b\ \text{min.}\ a3\text{-}k}$ (approx) | 320 | 320 | V |
| $V_{b\ \text{min.}\ a2\text{-}k}$ (approx) | 210 | 210 | V |
| $V_{b\ \text{min.}\ a1\text{-}k}$ (approx) | 110 | 110 | V |
| $V_{stab}$ a4-k | 280 | 280 | V |
| $V_{stab}$ a3-k | 210 | 210 | V |
| $V_{stab}$ a2-k | 140 | 140 | V |
| $V_{stab}$ a1-k | 70 | 70 | V |
| $I_{a4}$ (max) | 35 | 70 | mA |
| $I_{a3}$ (max) | 40 | 70 | mA |
| $I_{a2}$ (max) | 60 | 90 | mA |
| $I_{a1}$ (max) | 60 | 100 | mA |
| $I_{tube}$ (min) | 5 | 10 | mA |
| z (per gap) | 60 | 40 | Ω |

## OPERATION

The stabilisers require an ignition voltage greater than the stabilised voltage, and the supply should be not less than one and a half times the voltage developed across the gap, or gaps employed. The ignition voltage must be applied to the tube through a series resistor to absorb the excess voltage after ignition and prevent a heavy discharge current through the tube, as the D.C. resistance of the latter can be regarded as negligible. The series resistance also becomes an important factor in the ultimate stability of the supply to the load.

In addition to the series resistor it is essential that resistors of the order of 0·25 MΩ be connected between a supply line and each anode of the tube. They may be connected to either supply line, and as their effect is to apply the full available voltage to each gap in turn, the tube is ignited by a voltage much less than that required to ignite all the gaps simultaneously in series. Thus, if four gaps are used, the ignition voltage required $= 4V + v$ and not $4V + 4v$ where $V$ is the stabilised voltage per gap, and $v$ is the extra ignition voltage required per gap. As the ignition currents are of the order of 0·1 mA, the resistors may be of small power rating.

The extra ignition voltage is of the order of 50 volts per gap, and thus, for the STV 280/40 the ignition voltage is theoretically 280+50 volts. It should be noted, however, that this figure is the minimum value for the tube, and in practice it is calculated as one and a half times the overall stabilised voltage (i.e. 420V for the STV280/40). The ignition voltage will necessitate a higher value of series resistor, but this is an advantage as the variation of stabilised voltage is inversely proportional to the value of series resistance.

# STV280/40
# STV280/80

The following examples illustrate typical stabiliser applications and the method of calculating performance. The calculations are based on the following approximate formulae :

$$\delta\, V_{stab}\ (b) = \frac{\delta\, V_b \times z}{R}$$

$$\delta\, V_{stab}\ (L) = \delta I_L \times z$$

Where $\delta\, V_{stab}$ (b) = Variation of stabilised voltage due to supply fluctuation.
$\delta\, V_{stab}$ (L) = Variation of stabilised voltage due to load variation.
$\delta\, V_b$ = Variation of supply voltage.
$\delta\, I_L$ = Variation of load current through tube.
z = Tube impedance (i.e. number of gaps in use multiplied by impedance per gap).
R = Series resistance in circuit.

**Example 1**

To obtain a stabilised supply of 280 volts, 40 mA with no variation in load.
Consider the use of STV280/80 in the circuit of fig. 1.
Allow 20 mA ionisation current, then supply current = 60 mA.

Minimum supply voltage required = $280 + \frac{280}{2} = 420$ volts.

Voltage drop across R = $420 - 280 = 140$ volts.

$\therefore R = \frac{140}{0{\cdot}06} = 2350\ \Omega$ approx.

Consider a ± 5% supply variation (i.e. ± 21 volts).

$$\delta\, V_{stab}\ (b) = \frac{\delta\, V_s \times z}{R} = \frac{21 \times 4 \times z}{2350} = \frac{21 \times 4 \times 40}{2350} = 1{\cdot}43 \text{ volts}$$

or 0·51% approx.

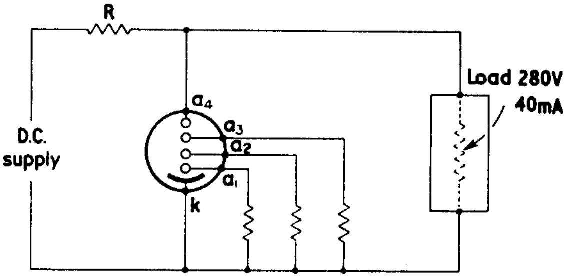


Fig. 1

**Example 2**

Assume that the load varies from 30 to 40 mA at 280 volts.

Then in addition to the variations due to supply fluctuation, as calculated in Example 1, there is also a voltage change in the tube due to its internal impedance.

$$\delta\, V_{stab}\ (L) = \frac{40-30}{1000} \times z = 0{\cdot}01 \times 4 \times 40 = 1{\cdot}6 \text{ volts or } 0{\cdot}57\% \text{ approx.}$$

Therefore the total load variation which may be anticipated under the above conditions is : ± 0·57% ± 0·51% = ± 1·08% max. approx.

When greater stability is required the value of the series resistor should be increased, or tubes operated in cascade.

**Example 3**

With a view to still greater reduction of output fluctuations due to supply variations, stabilisation can be applied twice in succession. The D.C. voltage from the first tube may be stabilised again by a second tube with the necessary series resistor.

The following example (see fig. 2), illustrates the cascade method of operation.

A stabilised supply of 140 volts, 40 mA is required.

Consider the use of the STV280/80.

Let $V_1 = 500$ volts, and $R_{source} + R_{filter} = 600\Omega$

Where $R_{source}$ is the internal resistance of the power supply and $R_{filter}$ is the resistance of the LC filter.

$I_L = 40$ mA.
allow 20 mA ionisation current per tube.
then $I_{R2} = 60$ mA.
and $I_{R1} = 80$ mA.

then $V_2 = V_1 - I_{R1}(R_{source} + R_{filter}) = 500 - \frac{(80 \times 600)}{1000} = 450$ volts approx.

and $R_1 = \frac{450 - 280}{0{\cdot}08} = 2125\,\Omega$ (280 volts is applied to $T_1$).

N.B.—The value of series resistance necessary to absorb the extra voltage after ionisation has occured, ($R_x$), may be calculated as $R_x = R_1 - (R_{source} + R_{filter})$.

Consider also a supply variation of $\pm 10\%$ (i.e. $\pm 50$ volts), then output variation from $T_1 = \frac{50 \times 40 \times 40}{2125} = 3{\cdot}77$ volts.

The starting voltage applied to $T_2$ is 280 volts, and the final output required is 140 volts, therefore the voltage to be absorbed by $R_2$ is 140 volts.

It will be appreciated that the voltage obtained from $T_1$ must be again one and a half times the output voltage required, as $\frac{2}{3} \times 280 = 187$ volts.

The nearest gap voltage below this is 140 (the second gap) and this is used.

From the above reasoning : $R_2 = \frac{140}{0{\cdot}06} = 2340\,\Omega$

Output variation from $T_2 = \frac{3{\cdot}77 \times 40 \times 2}{2340} = 0{\cdot}129$ volts.

representing a percentage of $0{\cdot}092\%$.

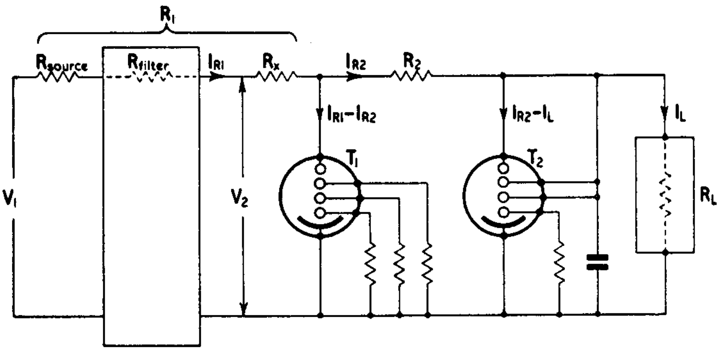


Fig. 2

## SERIES OPERATION

In order to obtain stabilised voltages in excess of 280, the tubes may be operated in series.

The series connection may be considered as one tube with an increased number of gaps or tapping points, e.g. two STV280/40 tubes series-connected will provide a stabilised voltage of 560 volts, with evenly spaced intermediate voltages.

This method of connection is particularly suitable for tubes operated in cascade as described above in order to obtain stabilised voltages in excess of 140.

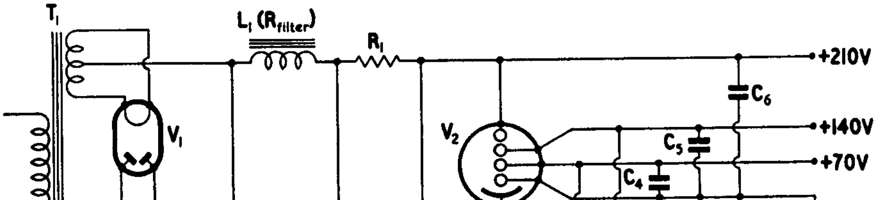


Fig. 3. A typical circuit of a stabilised supply unit for a power amplifier requiring various supply voltages.

Printed in England. C.