SUMMARY

Typical applications of NIXIE tubes are discussed. Specific methods of operating NIXIE tubes are described, including electro-mechanical switches, transistors and BEAM-X® switches. Typical power supply circuits and specialized circuit techniques such as dimming and blanking are discussed. Suggested methods of mounting and environmental data are given.

NIXIE TUBE APPLICATIONS

NIXIE tubes have found application in literally every type of equipment from elevators to electronic instruments, from process control flowmeters to missile count-down displays. The following is a brief listing of some typical applications which indicate the scope, versatility and capabilities of these unique readout devices.

- Digital Clocks
- Aircraft Channel Indicators
- Computer Console Readouts
- Airline Displays
- Frequency Counters
- Direct Readout Oscilloscopes
- Digital Tachometers
- Flight Simulators
- Teaching Machines
- Stock Quotation Displays
- Digital Voltmeters
- Flowmeters
- Tank Level Indicators

In each of these applications, a particular set of conditions exists which dictates the manner in which the tubes will be operated. In some cases, occurrences are to be counted and displayed using either electronic or electro-mechanical circuits; in others, coded information must be converted to decimal form and displayed visually. In still other applications, a simple ten-position switch can select the desired characters without need for elaborate circuitry. On the following pages, various methods of NIXIE tube operation are described in detail to assist the design engineer in incorporating the tubes into his equipment.

DRIVER CIRCUITS

BEAM-X SWITCH CIRCUITS

Since the NIXIE indicator tube is a current operated device, the ideal driver for the tube is a constant current source such as the BEAM-X Switch. Thus, the NIXIE tube and the BEAM-X Switch are inherently compatible devices. Having been designed as companion units, their operating voltages and currents are such that optimum performance of the NIXIE tube readout is assured.

The BEAM-X Switch is a high-speed, ten-position, electronic switching device. Within the device are ten arrays of independent elements positioned around a centrally located cathode. See cross section Figure 16.

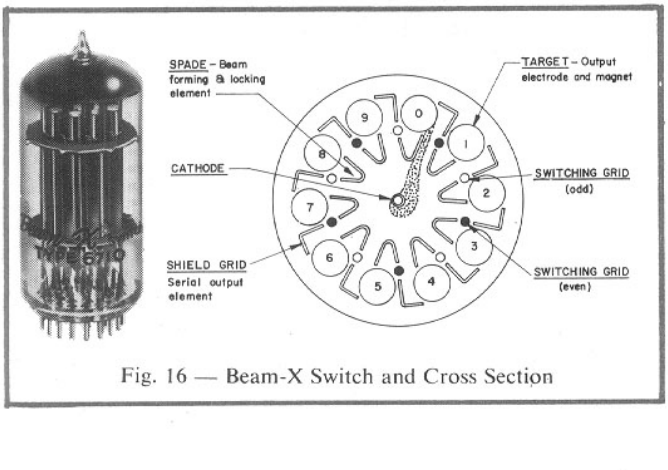

Fig. 16 — Beam-X Switch and Cross Section

An electron beam can be formed from the cathode to any one position and then can be switched sequentially or at random by use of the elements in each array to any of the other nine positions of the tube. When the beam is formed at a given position, the output current available at that position can be used to operate NIXIE tubes, printers, and to perform gating or presetting functions.

The versatile design of the BEAM-X Switch allows it to perform the two most common functions in a readout system. The BEAM-X Switch can count pulses reliably at both low and high frequencies, and it can decode binary coded decimal information to decimal form.

DECADE COUNTING WITH THE BEAM-X SWITCH.

A number of different techniques can be utilized to operate the BEAM-X Switch as a counting device. Typical are 100 KC and 1 MC flip-flop circuits which use transistors, vacuum tubes or Nuvistors to drive the switching grids of the BEAM-X Switch and advance the electron beam through the ten positions of the device. A cascade output pulse from the ninth or tenth position of the BEAM-X Switch is normally used to drive succeeding decades. At lower frequencies (below 10 KC), flip-flop drive circuits can be eliminated and the switching grids can be pulsed directly. In either case, the ten constant current outputs of the BEAM-X Switch operate remote or local NIXIE tube readouts directly without need for decoder, buffer or amplifier circuits. BEAM-X Switch/NIXIE tube circuit design criteria is discussed in detail in the BEAM-X Switch brochure (BX-535-A). In the following sections, typical BEAM-X Switch circuits are shown.

TRANSISTOR BEAM-X COUNTER CIRCUITS

Figure 17 shows the schematic diagram of a 1 MC Transistorized BEAM-X Counter. A total of only eleven active components (three silicon transistors, seven diodes and one BEAM-X Switch) are required to perform the counting function. In addition to operating the NIXIE tube directly, ten electrical outputs are available to drive gates and printers.

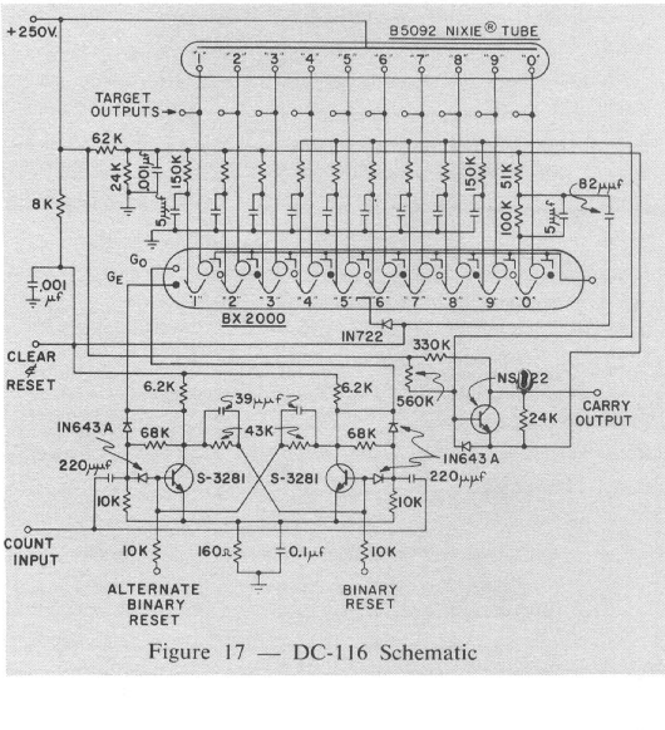

Figure 17 — DC-116 Schematic

This circuit is commercially available as a plug-in module which is designed for front panel mounting in direct readout counting systems (see Figure 18). For counting applications requiring 110 KC maximum pulse resolution, a germanium transistor circuit is available. This circuit is electrically compatible with the 1 MC circuit shown above so that complete high-speed systems can be designed using the two units together.

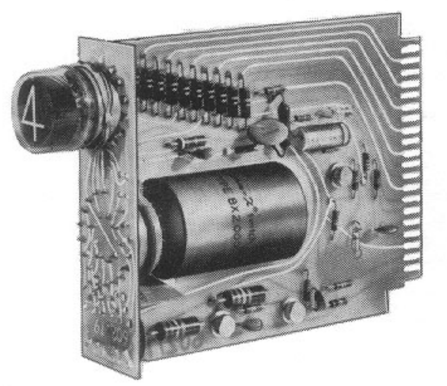

Fig. 18 — DC-116 Module

Each unit contains an integral NIXIE tube (standard long life Type B5092) and a magnetically shielded BEAM-X Switch to facilitate side-by-side mounting. In addition, a 110 KC unit is available without integral NIXIE tube for those applications in which remote readout is desired. Complete specifications for the units can be found in the BEAM-X Modules Brochure #405.

VACUUM TUBE BEAM-X COUNTER CIRCUITS

BEAM-X Switches can be driven at all frequencies with suitable vacuum tube flip-flop circuits. A typical 110 KC circuit is shown in Figure 19. Here a transistor amplifier is used to couple succeeding stages.

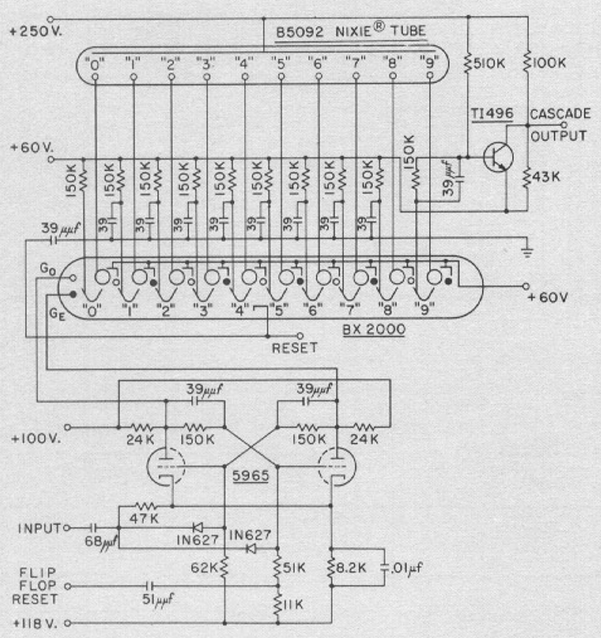

Fig. 19 — 110 KC Vacuum Tube Counter Circuit

A unique vacuum tube-BEAM-X Switch combination is that of the Burroughs BEAM-X module, Type DC-112. This unit utilizes a high gain screen grid pentode to provide the cascade output to drive the next succeeding decade. This unit is insensitive to large noise pulses. For this reason, the counter is ideal for use in industrial counting systems where electrical noise can cause difficulties with flip-flop circuits which are relatively noise sensitive.

The circuit for the DC-112 module is shown in Figure 20 below.

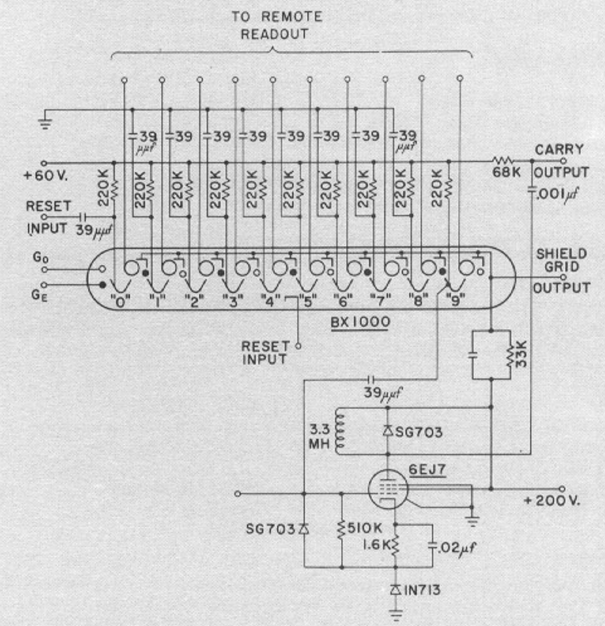

Fig. 20 — Beam-X Switch Counter Circuit.

A remote NIXIE tube can be operated from the target output terminals directly. Figure 21 is a photograph of the unit.

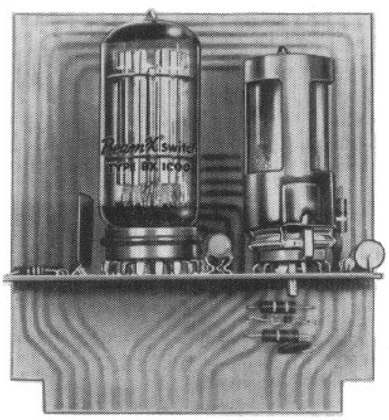

Fig. 21 — DC-112 Module

NUVISTOR BEAM-X COUNTER CIRCUITS

Figure 22 is supplied to show the compatibility of the BEAM-X Switch with Nuvistor tubes for decade counting. Here, a two Nuvistor tetrode flip-flop and a Nuvistor triode output amplifier are used. This circuit is capable of 1 MC operation.

This circuit shows the ability of a high current BEAM-X Switch to operate multiple remote NIXIE tubes of miniature, standard or

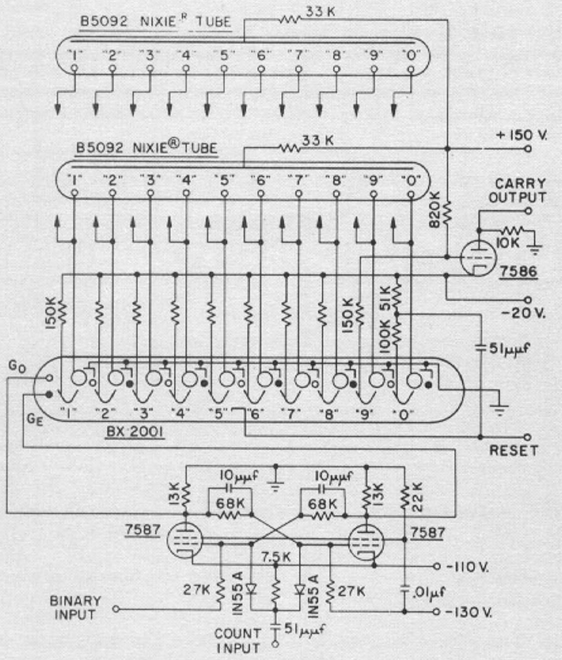

Fig. 22 — I MC Nuvistor-Beam-X Switch Counter Circuit

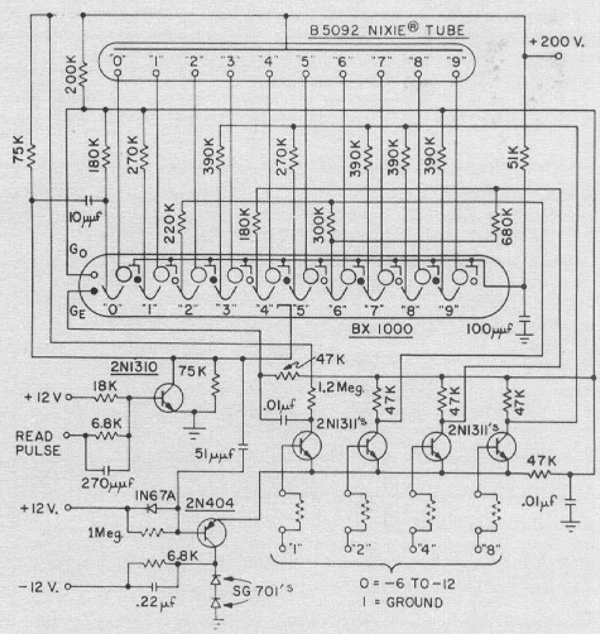

Fig. 23 — Transistorized Beam-X Switch Decoder

super sizes. In Figure 22, 2 type B5092 standard tubes are being operated remotely. The BEAM-X Switch, Type BX-2001 used, provides a minimum of 4.0 ma of constant current output which is sufficient to light 4 miniature NIXIE tubes or 2 standard size tubes. Transistor and standard vacuum tube circuits can also be combined with high-current BEAM-X Switches to perform the same function.

DECODING WITH THE BEAM-X SWITCH

One of the most common circuit requirements in readout systems is the need for conversions of binary coded data to decimal form. In almost every case, the information is available for only a short period of time so that a decoding device which has both data storage and high speed operation capabilities is required. A typical example is the activation of computer console displays from binary coded decimal information.

The BEAM-X Switch is a device which satisfies all of the basic requirements of a decoding system. It has high access speed (ten microseconds or less) and provides electronic storage in decimal form for the data. It can be combined with transistors in a circuit such as that shown in Figure 23. This circuit is designed to decode 8-4-2-1 BCD to decimal form with four-line access and single line read gate control.

In performing the decoding function, the ten-position BEAM-X Switch operates as a homing switch. A read gate pulse, amplified by a transistor, clears the previously stored information from the BEAM-X Switch and then resets the switch to the "zero" position. As the BEAM-X Switch resets, a second transistor generates an information access gate pulse which turns on four binary information input transistors. Depending upon the binary information at the input to these transistors during the access gate time, voltage levels are established within the BEAM-X Switch so that the beam switches to the decimal output position corresponding to the binary input. Upon termination of the information access gate, the four binary input transistors are turned off. The BEAM-X Switch retains the information stored in it until the next conversion cycle begins.

This type of decoder operation is commercially available in a series of BEAM-X decoder modules (Types DC-115-A, DC-115-B, DC-115-C, etc). The modules are designed to decode various BCD codes to decimal form.

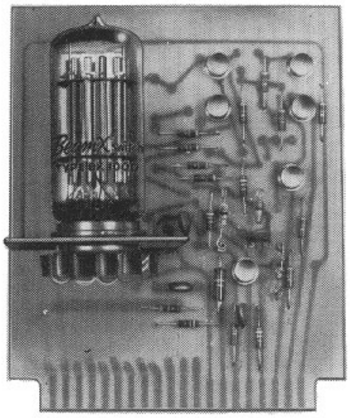

Fig. 24 — DC-115 Module

A photograph of a typical DC-115 module is shown in Figure 24. Each unit is designed to operate remotely located NIXIE tubes directly. The table below lists the various modules and the data which they convert. Detailed technical specifications can be obtained by referring to the BEAM-X Modules Brochure #405. Other codes can also be converted and modules can be prepared to your specifications.

Decoder Type #	*Code Converted*
DC-115-A	8-4-2-1
DC-115-B	8-4-2-1 (constant current read gate)
DC-115-C	4-2-2-1
DC-115-D	2-4-2-1
DC-115-F	5-3-1-1

In the preceding sections, typical circuits have been supplied as a guide to the operation of NIXIE tubes in electronic counting and decoding systems by means of the BEAM-X Switch. The BEAM-X Switch holds a definite advantage over other electronic techniques in these areas since the device replaces as many as eighteen transistors, and forty diodes or resistors which would be required to perform the same function in an all-solid state design. This can be seen by comparing the all-transistor decoding circuit shown in Figure 25A with the transistor-BEAM-X decoder shown in Figure 25B.

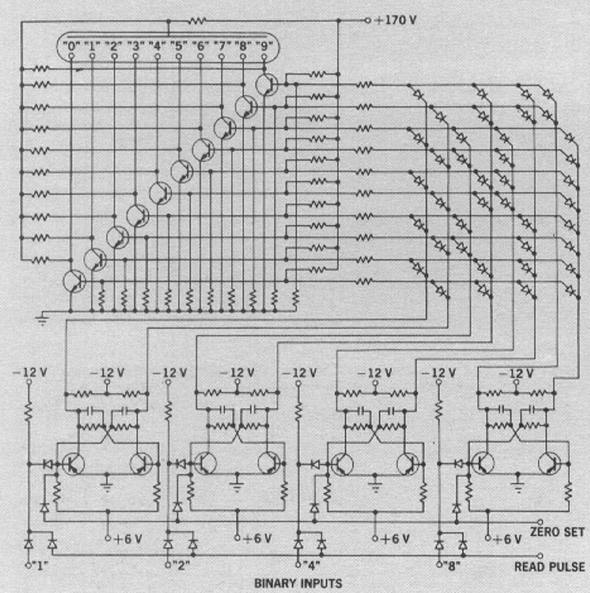

Fig. 25A — Typical All-Transistor Decoder Circuit

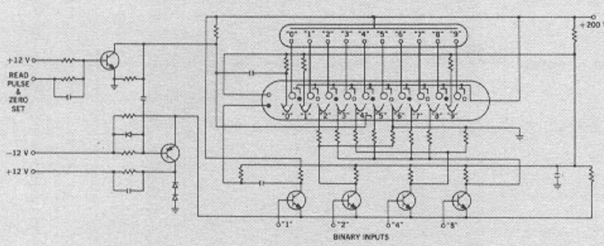

Fig. 25B — Beam-X Switch Decoder Circuit

TRANSISTOR CIRCUITS

Low cost NPN transistors suitable for driving NIXIE tubes have been developed by leading semi-conductor manufacturers. When the NIXIE tube was originally introduced to the market, there was some difficulty in obtaining NPN transistors which would drive the NIXIE tube conveniently. Being a neon device, the NIXIE tube requires a relatively high voltage and low current. The total power involved is quite small since the neon glow is an efficient light emitter and very little heat is generated. Transistors are typically low voltage, high current devices, and a problem of compatibility existed.

Originally, it was felt that the transistors used with the NIXIE tubes would have to be able to switch voltages approaching 100 volts. Later experience showed that the pre-bias voltage which must be switched to operate the NIXIE tube reliably is approximately 33% (usually about 50 V) of the sustaining voltage for the NIXIE tube being used. It was further determined that relatively inexpensive and low voltage transistors can be used with the NIXIE tube by employing the TRIXIE® driver technique. (Packaged TRIXIE modules are described on Pages 15, 22 and 24 of this brochure).

In the TRIXIE driver technique, transistors used to select the number desired to be "on" are operated as saturated switches.

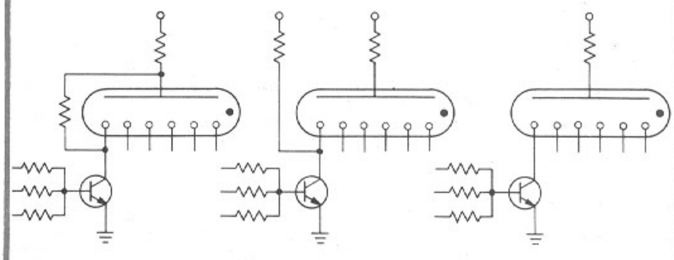

Fig. 26 — Typical TRIXIE Circuit Configuration

The "off" transistors are usually operated in a back bias BCVEX condition with a base resistor or a combination of base resistors. The electrical characteristics of the NIXIE tube's "off" cathodes are important because they help determine the operating point of the transistor associated with the "off" cathode. The "off" cathode looks like a current source to the transistor associated with this cathode. The source current is a function of the leakage currents between the NIXIE tube "off" cathode and the anode, and the "off" cathode and the "on" cathode. This current is dependent upon the physical position within the tube of the "off" cathode with respect to the "on" number. The following graph shows a typical V-I plot of this characteristic. This curve is similar to that shown as Figure 14 in the discussion of pre-bias (page 10).

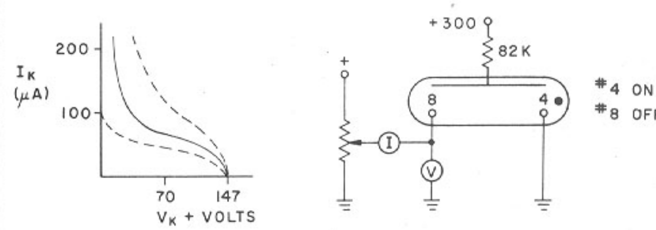

Fig. 27 — Characteristics of NIXIE tube "off" cathodes

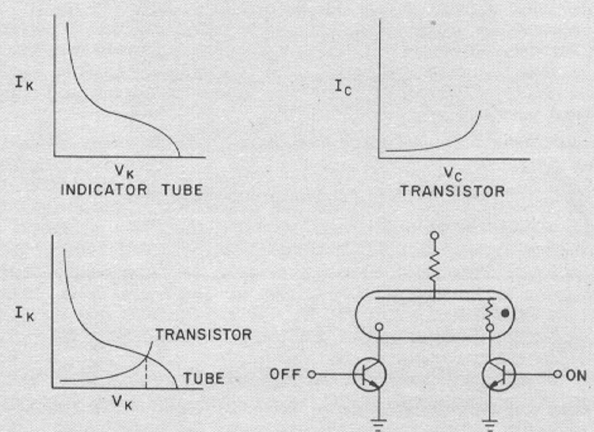

Fig. 28 — Combination of NIXIE tube and Transistor Curves