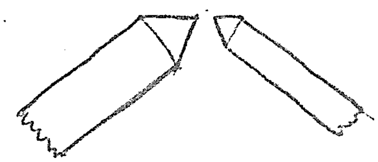
The arc

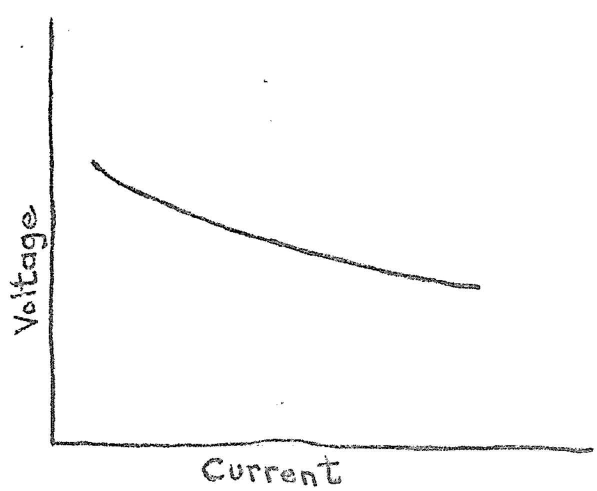
An arc is formed between two conical metal[1] (tungsten?) points surrounded by xenon gas in a fused-silica bulb. (See O.R. Norton, "Planetarium and Atmospherdum", page 75). We suspect that the pressure in the bulb with power off and arc cold is below atmospheric. Otherwise the Spitz glassblower would have difficulty in sealing the bulb after filling it with xenon.[1] Spitz describes the arc as "high pressure". Once in our experience the arc shattered while in operation and filled the star globe with fragments. The Spitz warning about operating the arc in the open is reasonable. Fingerprints on the bulb are undesirable because nonvolatile constituents of perspiration absorb radiation. Perhaps they absorb much radiation in the ultraviolet and thus raise the temperature of the bulb.



Star images near the horizon and near the plane of the electrodes tend to be faint. The "shadowed" areas (shadow of arc electrodes) on the dome are isosceles triangles several feet high. We have seen shadowing with every arc we have used and also in the Spitz A4 planetarium at Frostburg State College in Maryland.

In a new arc the spacing of the points is 0.009 inch (0.23 mm). Sometimes in our experience arcs have failed by bridging or shorting. Sometimes the spacing of the points has increased until the starter could not start the arc. In one case (October, 1969) a used arc with spacing 0.8 mm would barely start. The spacing of the points can be measured with a 20X microscope having a scale in the eyepiece.

The arc is nominally a "20-watt" arc. (1.8 amp)(12 volts) = 21.6 watts The slope of the current-voltage curve of an arc is usually negative. Data for an arc installed in November, 1969 are tabulated below.



† For more information on arcs, see M. Garbuny, Optical Physics (Academic Press, 1965), pp 61-2, also Hossain, Arc Physics. Spitz buys its arc tubes from PEK

The values of V are in volts and I in amperes.

New arc			After 10 hours operation		
I	1.9	0.7	I	1.8	0.6
V	14	15.4	V	14.7	18.5

Spitz claims arc lifetimes up to 1000 hours. A telephone survey among a few planetariums in our part of the country yielded hearsay values of 50 or 100 hours for the average lifetime of an arc. The lifetime of one arc which we mistakenly operated at 7 amperes was only 2 hours.

The starter and the starting process

Initially the points in the arc are cold. As soon as the power supply in the console supplies current to the starter, the starter supplies high voltage to the arc. The high voltage produces a spark between the points. This spark becomes an arc as the temperature of the points rises. After the arc is established, the starter connects the arc directly across the d-c line from the power supply.

If the arc does not start immediately, the sound of a spark inside the star globe can be heard by the operator at the console. Inside the starter chassis is a spark gap consisting of two wires in air. This gap can be adjusted by bending the wires.

The minimum current from the power supply is sometimes not enough to start the arc.

According to Spitz, the mean life to failure for the starter unit is about ten times the mean life to failure for the arc. If so, the arc needs replacement ten times as often as the starter unit.

Console power supply

In most arcs the voltage across the arc decreases as the current increases. An arc therefore needs some device or ballast to limit the current. The Spitz A3P uses a constant-current power supply. That is, the current output of the power supply is almost independent of the load, up to the open-circuit voltage of the power supply, which is 50 or 60 volts. Inside the power-supply chassis are two screwdriver potentiometers. One is marked H and the other L. The "stars" control partly controls the current. The normal range of current in a "20-watt" arc is 0.8 to 1.8 amperes. The H and L potentiometers should be adjusted until the output current falls roughly in this range. That is, a low setting of the "stars" control should give 0.8 amps and a high setting 1.8 amps. When making measurements and setting the H and L pots, one may remove the arc and starter and insert as a test load a power rheostat† of resistance 0-20 ohms. Using a rheostat as a dummy load reduces the danger of ruining a good arc by running excessive current through it.

† Use 10 to 20 ohms

The power supply has a 2:1 step-down transformer with a fuse in the primary of the transformer. With the H and L pots properly adjusted, the initial surge of current through the fuse when the power is turned on is 3 or 4 amperes. During operation the current in the fuse is 1.3 amperes for 1.8 amperes output and 0.6 amperes for 0.6 amperes output. (Some power, of course, is dissipated in the rectifier and regulator.) A $1\frac{1}{2}$ ampere slow-blow fuse blows immediately because of the initial surge. If the d-c output is in the normal range, a 2-ampere fuse may survive several starts. We usually use a 3.2-ampere or 4-ampere slow-blow fuse in the power-supply console. A fuse of this size may hold an hour or two and survive several starts with an output current of 7 amperes. A fuse heavy enough to survive the initial surge when the power is turned on does not necessarily blow when the arc current is excessive. It is therefore useful occasionally to insert an ammeter and measure the current to the arc.

The power supply uses semiconductor devices but no tubes. The catalogue numbers of the devices are not easy to find in handbooks and dealers' catalogues. The practice of Spitz is to exchange chassis rather than to send out a replacement semiconductor diode. This practice reduces the diagnostic effort required of the customer, but he must still recognize that a particular chassis needs replacement.

A new power supply and starter were introduced in fall of 1970. New power supply also has two pots.

ARC, STARTER, AND POWER SUPPLY

The "stars" control switches the 120-volt a-c on and off; it also varies the current output of the rectifier.