HISTORY OF
VARIAN CAPILLARY INJECTORS

by

Randall Bramston-Cook
Lotus Consulting
5781 Campo Walk
Long Beach, Ca 90803
310/569-0128
714/898-7461 – Fax

and

Herb Neumann
Varian, Inc.
2700 Mitchell Drive
Walnut Creek, Ca 94598
800/926-3000

Just after the capillary patent expired in the late 1970's, the market for gas chromatography was flooded with many new products related to capillary chromatography, and Varian was very much a part of the stampede. The Varian 3700 had been introduced already in 1976, but was originally designed to handle the demands of the new injectors for capillary columns when the commercialization was open to all. Over the ensuing years, Varian has made significant offerings to optimum performance, ease of use and full automations with capillaries – helping to establish the widespread acceptance of capillary chromatography today.

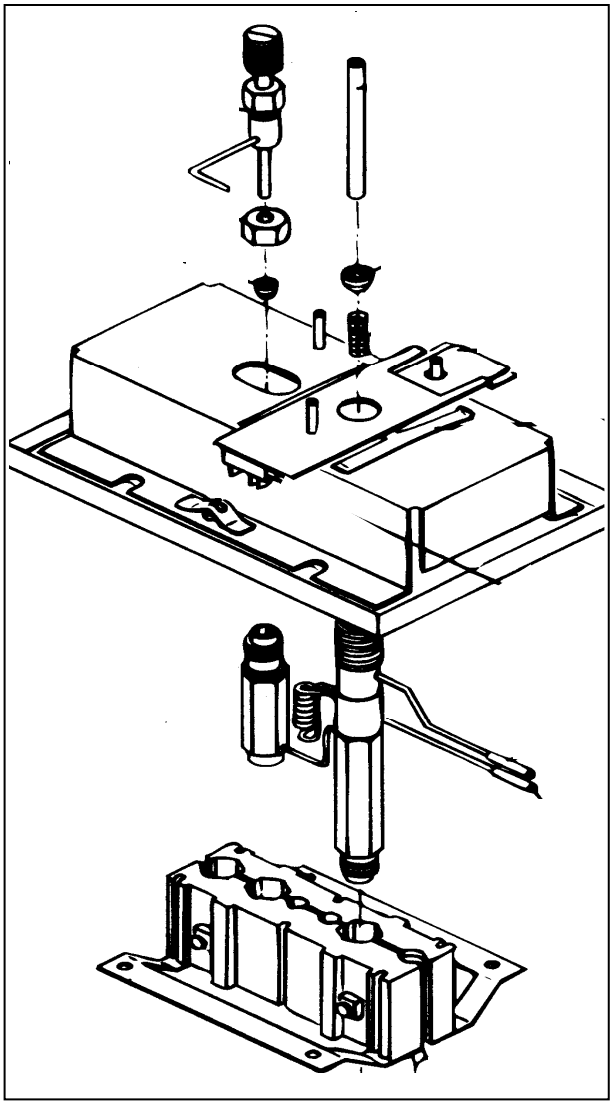
The first capillary columns were made from glass and were very fragile. Most early injectors required the ends of the columns to be straightened by gently heating the ends to convert the coiled ends to soften enough to form roughly straight sections to insert into the injector and detector. This became a major obstacle for many operators and the prime reason that many regulatory agencies did not accept the use of capillary columns at first. Varian's first capillary injector, the Model 1070 [1980], utilized novel injector and detector inserts that were glass-lined and allowed the column to be attached as a butt joint. This simplified installation by not mandating the column be straightened. This was the first of many innovations contributed by Varian.

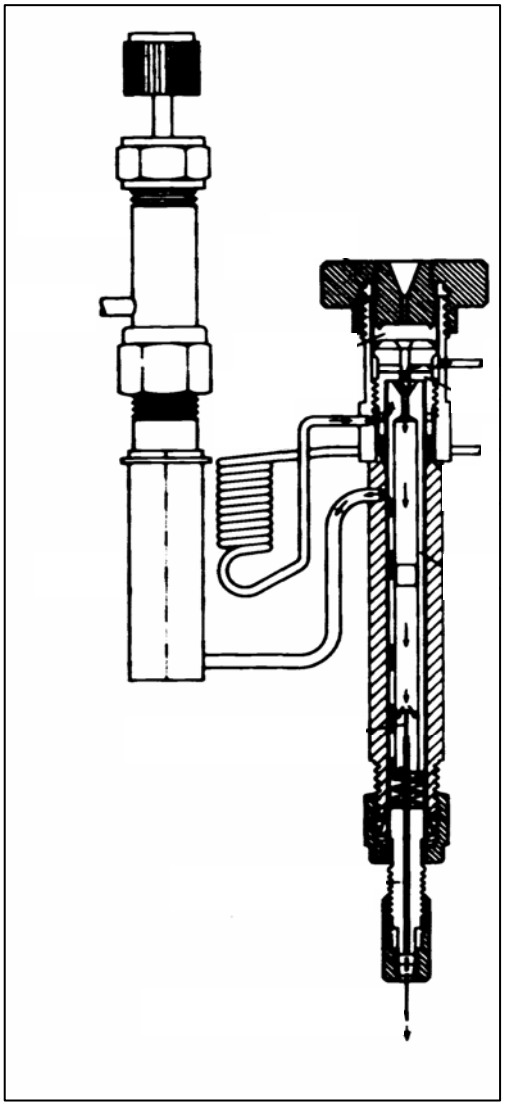
Varian's development efforts continued with 14 more injectors designed to simplify operations, improve inertness, and dramatically advance productivity in the laboratory. The following list of injectors provides an insight into the progressive steps made toward making capillary chromatography the routine operation it is today. Each one is listed with features and advantages. To help differentiate the various injectors, a distinctive feature for each is listed to help identify the injector.

1070 Split/Splitless Capillary Injector [Introduced in 1980]

Distinctive external feature – **Black knob on splitter valve jutting up just in front of injector**.

- First Varian capillary injector.
- Full split/splitless operation, readily interchanges between modes by swapping injector inserts and altering program operations.
- Buffer volume ties in after the injector body to accommodate rapid thermal expansion of liquid injection and to eliminate flow rate changes caused by viscosity differences between carrier and sample
- Both injector and detector inserts are glass-lined and column connections are made at bottom of inserts
- Variety of capillary injector inserts (glass) allows full optimization for various injector modes.
- Pressure regulated pneumatics, but can be plumbed with flow controller plumbed in parallel with pressure regulator for maintenance of true constant flow with temperature programming.*
- Manual adjustment of split ratio with black knob on top.





* Constant “flow” modes on many chromatographic systems are computed flows based on column length, column diameter, carrier gas type and column temperature. Significant errors are introduced into the actual flow from inaccuracies in the variables.

- All capillary pneumatics are thermostatically controlled to ensure great retention time reproducibilities independent of changes in ambient temperature.
- Carrier pre-heater coil heats carrier gas to the injector temperature, eliminating sample condensation effects from a cold carrier.
- True septum purge is featured to prevent sample adsorption onto the septum and eliminates tailing and ghost peaks caused by septum bleed.
- Standard Varian injector oven allows easy field installation of injector kit.
- A solenoid valve opens and closes the exit split flow, under system control, allowing high reproducibility in the splitless mode.
- Injector septum size – 7/16" (11.5 mm)
- **COMPETITIVE ADVANTAGES – No mandate to straighten ends of capillary columns; both injector and detector inserts are glass-lined and column connection is made at bottom end of inserts. Capillary pneumatics thermostatically controlled. Field upgrade kits available for existing Varian instruments.**

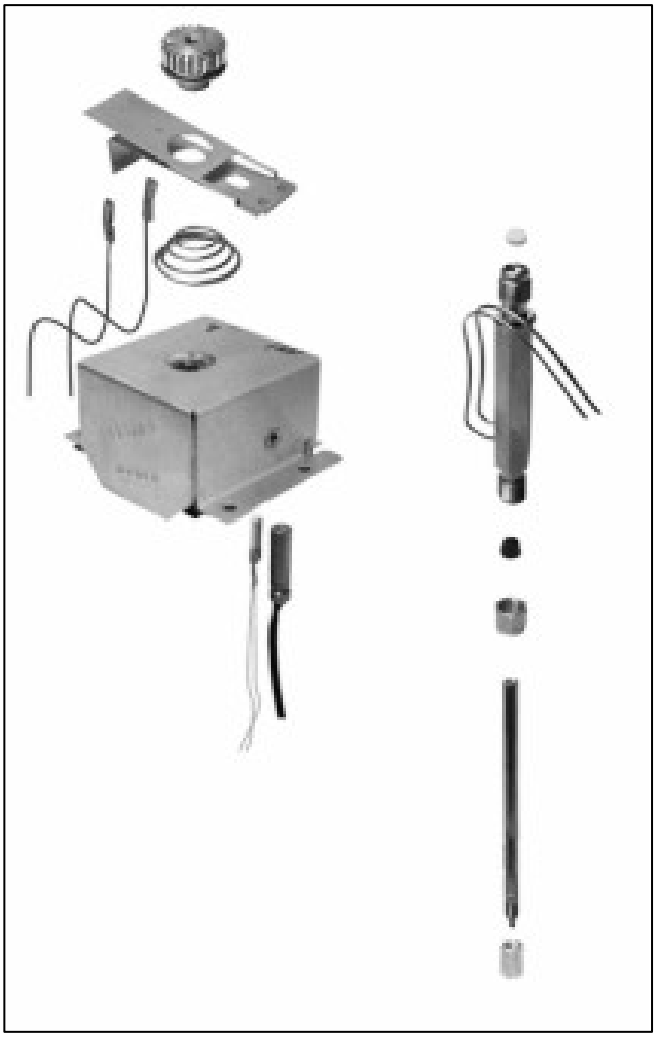
1075 Split/Splitless Capillary Injector [Introduced in 1983]

- Adaptation of 1070 to handle fused silica capillary columns.
- Column becomes split point to provide better inertness in injector.
- Column inserts up inside injector and all ionization detectors.
- Full split/splitless operation, readily interchanges between modes by swapping injector inserts and altering program operations.
- Buffer volume ties in after the injector body to accommodate rapid thermal expansion of liquid injection and to eliminate flow rate changes caused by viscosity differences between carrier and sample.
- Pressure regulated pneumatics, but can be plumbed with flow controller plumbed in parallel with pressure regulator for maintenance of true constant flow with temperature programming.

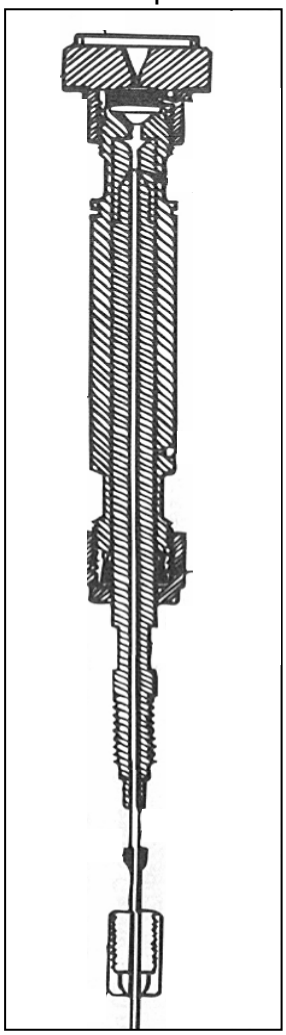
Distinctive external feature – **Looks like 1070, but capillary column can be inserted up inside both injector and detector**.

- Manual adjustment of split ratio with black knob on top.
- Variety of capillary injector inserts (glass) allows full optimization for various injector modes.
- All capillary pneumatics are thermostatically controlled to ensure great retention time reproducibilities independent of changes in ambient temperature.
- Carrier pre-heater coil heats carrier gas to the injector temperature, eliminating sample condensation effects from a cold carrier.
- True septum purge is featured to prevent sample adsorption onto the septum and eliminates tailing and ghost peaks caused by septum bleed.
- Septum support nut seals on graphite ferrule to seal around glass inserts.
- A solenoid valve opens and closes the exit split flow, under system control, allowing high reproducibility in the splitless mode.
- Injector septum size – 7/16" (11.5 mm).
- **COMPETITIVE ADVANTAGES – Capillary pneumatics thermostatically controlled.**

1041 Universal On-Column Injector for 530 Micron Columns [Introduced in 1984]



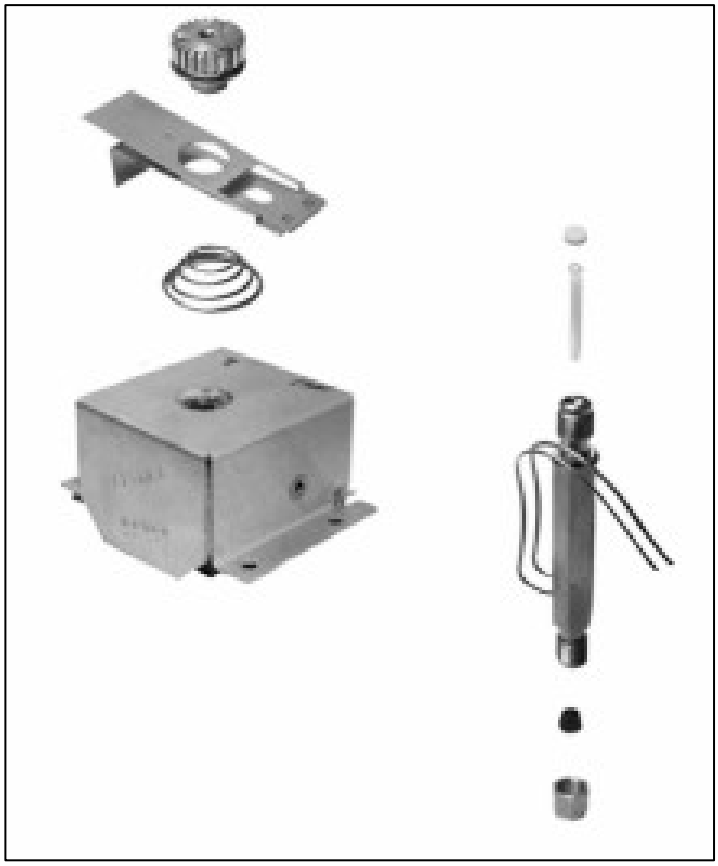
- Adaptation of 1040 Packed Column Injector for megabore capillary columns (0.53 mm ID).
- Special injector insert allows easy field conversion of existing 1040 injector.
- Column inserts to stop at top of adapter.
- Injections made directly on-column for complete elimination of active sites in injection process.
- Flow controlled pneumatics for constant flow, even with temperature programming.
- Sample capacity of megabore columns allows direct injection without splitting.
- All pneumatics are thermostatically controlled to ensure great retention time reproducibilities independent of changes in ambient temperature.



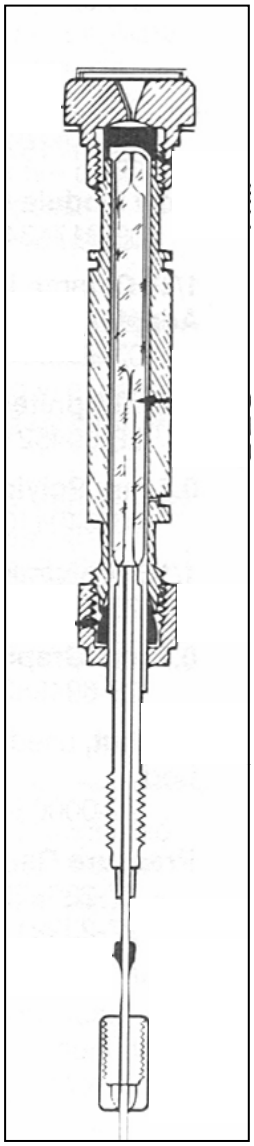
- Carrier pre-heater coil heats carrier gas to the injector temperature, eliminating sample condensation effects from a cold carrier.
- Injector septum size – 3/8” (9.5 mm).
- **COMPETITIVE ADVANTAGES – Easy, inexpensive field upgrade to megabore direct injection.**

Distinctive external feature – **Looks like 1040 Packed Column Injector, but protrusion into column oven has capillary ferrule nut.**

1061 Universal Flash Injector for 530 Micron Columns [Introduced in 1984]



- Adaptation of 1060 Packed Column Flash Injector for megabore capillary columns (0.53 mm ID).
- Special injector insert allows easy field conversion of existing 1060 injector.
- Column seals in taper of insert.
- Sample is flashed in chamber above column insert.
- Flow controlled pneumatics for constant flow, even with temperature programming.
- Sample capacity of megabore columns allows direct injection without splitting.



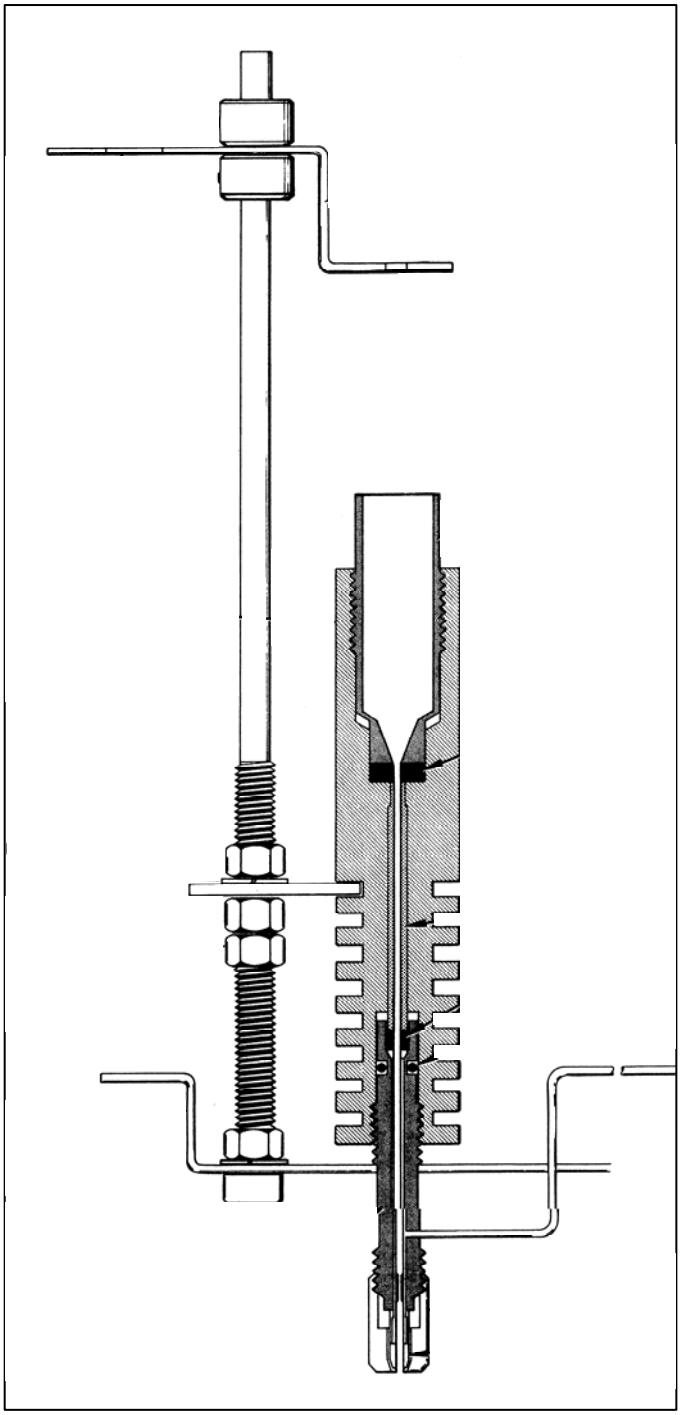
- All pneumatics are thermostatically controlled to ensure great retention time reproducibilities independent of changes in ambient temperature.
- Carrier pre-heater coil heats carrier gas to the injector temperature, eliminating sample condensation effects from a cold carrier.
- Injector septum size – 3/8” (9.5 mm).
- **COMPETITIVE ADVANTAGES – Easy, inexpensive field upgrade to megabore flash injection.**

Distinctive external feature – **Looks like 1060 Packed Column Flash Injector, but protrusion into column oven has capillary ferrule nut.**

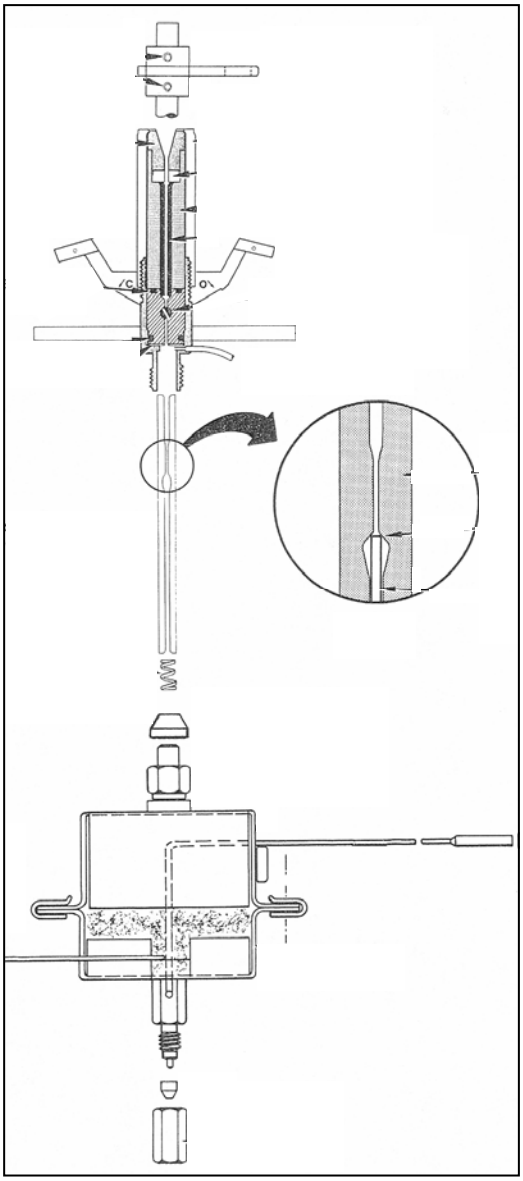
1090 Compact Low Thermal Mass On-Column Septumless Capillary Injector [Introduced in 1985]

Distinctive external feature – **Unusual syringe guide alignment assembly on top of injector and no heater connections.**

- First introduced with Varian 3500 Dedicated Capillary Gas Chromatograph
- **NO SEPTUM!!** Syringe needle seals with operator twist of injector body.
- **NO HEATER!!** Sample is injected on-column inside column oven.
- **NO SPLITTER!!** Direct on-column injection.
- Flow controlled pneumatics for constant flow, even with temperature programming.
- All capillary pneumatics are thermostatically controlled to ensure great retention time reproducibilities independent of changes in ambient temperature.
- **COMPETITIVE ADVANTAGES – Low cost septumless injector.**



1095/1097 Temperature Programmable On-Column Septumless Capillary Injector (SPI) for Varian 3700/Vista 6000/Varian 3400/Varian 3500/ Varian 3600 – LCO_2 Coolant [Introduced in 1985]



Distinctive external feature – **Notable needle guide arrangement with rocker arm; no septum.**

- First introduced with Varian 3500 Dedicated Capillary Gas Chromatograph.
- Sample injects directly into narrow-bore capillary columns through a special "rocker" valve arm to not interrupt column flow.
- Complete elimination of active sites in injection process.
- Programmable temperature range -60 ^{o}C to +420 ^{o}C.
- Flow controlled pneumatics for constant flow, even with temperature programming.
- All pneumatics are thermostatically controlled to ensure great retention time reproducibilities independent of changes in ambient temperature.
- **NO SEPTUM!!** Syringe needle seals with special "rocker" valve.
- Inlet purge provided to sweep sample introduction volume.
- 8035 AutoSampler^{TM} * automates injection with full control of special rocker valve arm.
- **COMPETITIVE ADVANTAGES – First subambient capillary injector with direct on-column narrow-bore capillary injection. Capillary pneumatics thermostatically controlled.**

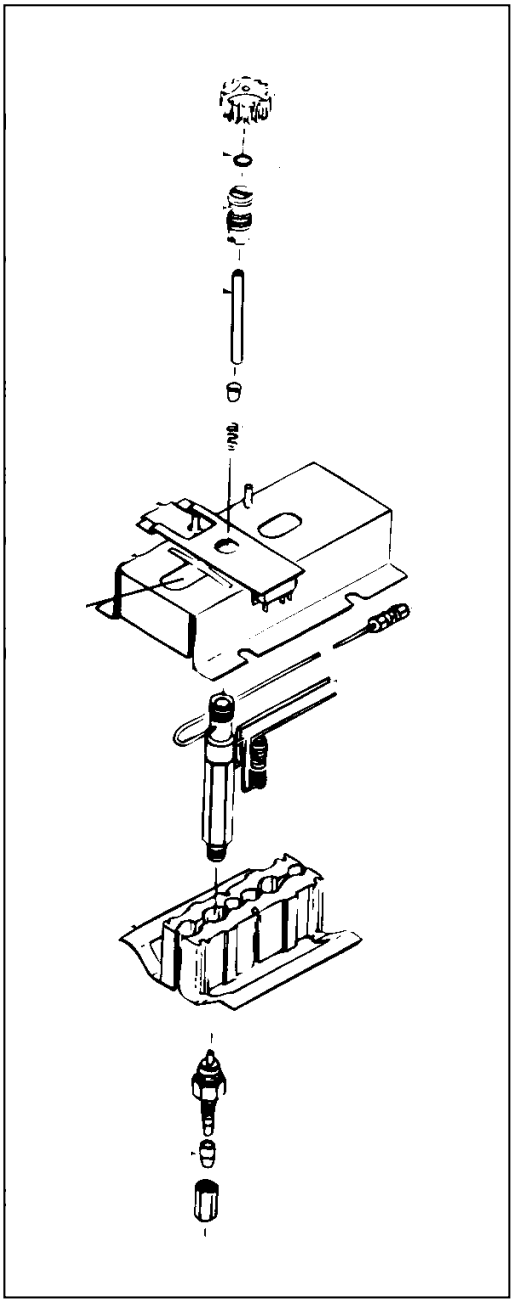
1096/1098 Temperature Programmable On-Column Septumless Capillary Injector for Varian 3700/Vista 6000/Varian 3400/ Varian 3500/Varian 3600 – LN_2 Coolant [Introduced in 1985]

- Similar to 1095. with temperature range from -99 ^{o}C to +420 ^{o}C.

---

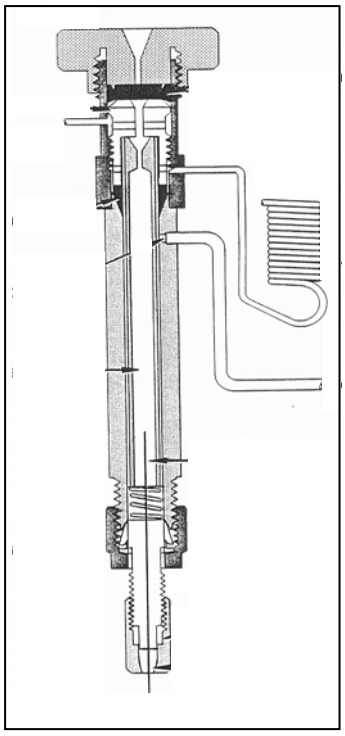
* AutoSampler is a registered trademark of Varian, Inc.

1077 Split/Splitless Capillary Injector for Varian 3400/Varian 3500/Varian 3600 [Introduced in 1985]



Distinctive external feature – **Similar in appearance to 1075, but without black split flow knob on top.**

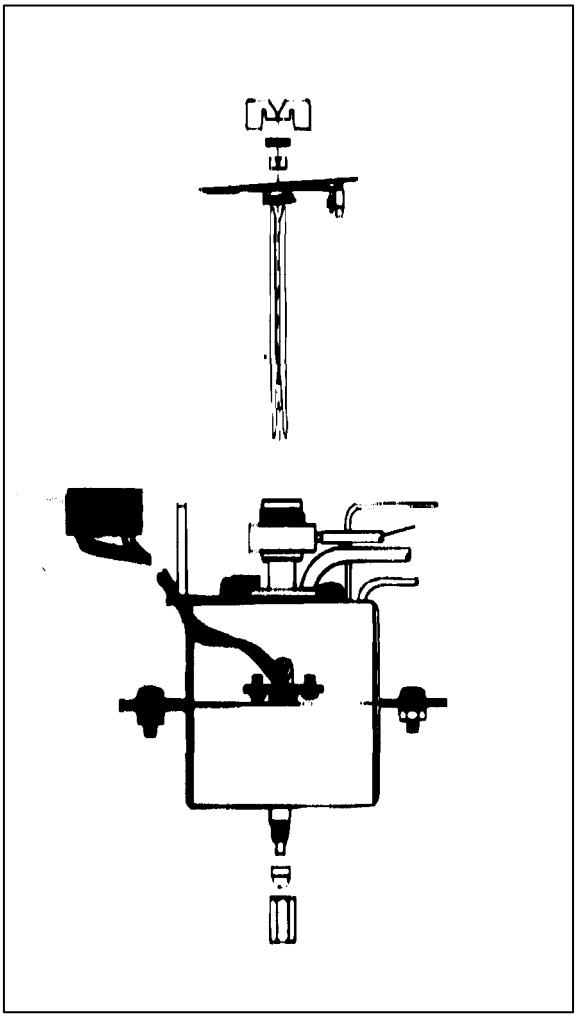
- Adaptation of 1076 with back pressure regulated split/splitless column flow and flow controlled split ratio.
- Full split/splitless operation, readily interchanged between modes by swapping injector inserts and altering program operations.
- Backpressure regulated pneumatics.
- Variety of capillary injector inserts (glass) allows full optimization for various injector modes.
- All capillary pneumatics are thermostatically controlled to ensure great retention time reproducibilities independent of changes in ambient temperature.
- Carrier pre-heater coil heats carrier gas to the injector temperature, eliminating sample condensation effects from a cold carrier.
- True septum purge is featured to prevent sample adsorption onto the septum and eliminates tailing and ghost peaks caused by septum bleed.



- A solenoid valve changes split state between split and splitless, under system control, allowing high reproducibility in the splitless mode.
- Injector septum size – 7/16” (11.5 mm) mm.
- **COMPETITIVE ADVANTAGES – Capillary pneumatics thermostatically controlled.**

1093 Septum Equipped Temperature Programmable Capillary Injector (SPI) for Varian 3400/3600 – LCO_2 Coolant [Introduced in 1988]

Distinctive external feature – **Separate injector oven. Injector has large coolant exhaust tube.**



- Temperature programmable injector, from -60 ^{o}C to +420 ^{o}C, at rates up to 200 ^{o}C/min. Optimum performance for nonvaporizing "cold" injection into conventional fused silica capillary columns.
- Cold injection reduces or eliminates many problems with conventional vaporizing split/splitless injection:
  - Minimizing molecular weight discrimination or loss of both high and low boiling substances
  - Reducing thermal decomposition of labile analytes.
- Can be automated for improved quantitation, especially for labile and high molecular weight analytes.
- Variety of injector inserts available to optimize for sample type.
- Easily replaceable inserts.
- Carrier pneumatics can be either flow controlled or pressure regulated.
- All capillary pneumatics are thermostatically controlled to ensure great retention time reproducibilities independent of changes in ambient temperature.
- True septum purge is featured to prevent sample adsorption onto the septum and eliminates tailing and ghost peaks caused by septum bleed.
- Injector septum size – 7/16" (11.5 mm).
- **COMPETITIVE ADVANTAGES – Subambient temperature programmable on-column injector.**

1094 Septum Equipped Temperature Programmable Capillary Injector (SPI) for Varian 3400/3600 – LN_2 Coolant [Introduced in 1988]

- Same as 1093, but with temperature range from -99 ^{o}C to +420 ^{o}C.

1078 Temperature Programmable Split/Splitless Capillary Injector for Varian 3400/3600 [Introduced in 1995]

Distinctive external feature –.**Unusual bracket and thermal insulation around injector.**

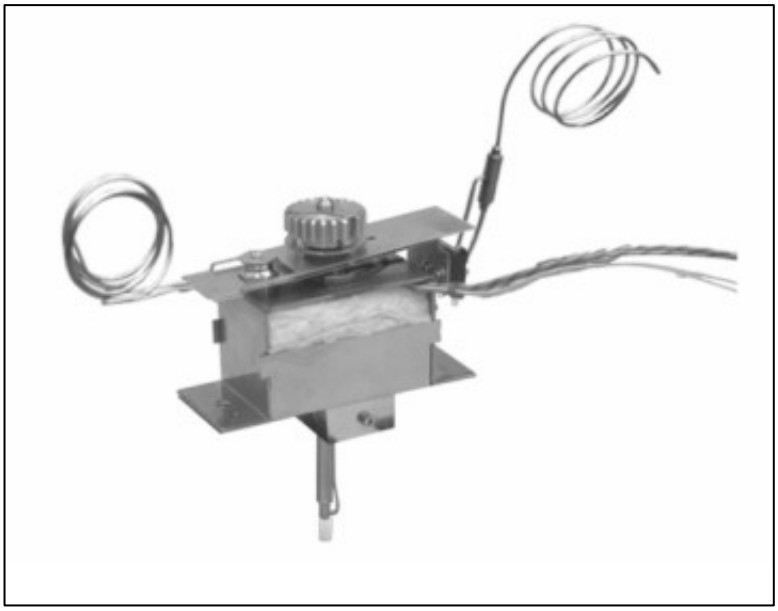
Shown without heater block, coolant tubing and insulation.

- Temperature programmable injector, from -99 ^{o}C to +420 ^{o}C. Splitless temperature ramp mode preferred for analytes altered by higher injector temperatures. Split ramp mode employed with high boiling range mixtures.
- Injector temperature profile keeps septum cool while maintaining the point of injection closer to the temperature setpoint.
- Full split/splitless operation, readily interchanged between modes by swapping injector inserts and altering program operations.
- Improved low split ratio control.
- Easily replaceable inserts and graphite sealing ferrule.
- Backpressure regulated pneumatics.
- Variety of capillary injector inserts (glass) allows full optimization for various injector modes.
- Septum support nut seals on graphite ferrule to seal around glass inserts.
- All capillary pneumatics are thermostatically controlled to ensure great retention time reproducibilities independent of changes in ambient temperature.
- True septum purge is featured to prevent sample adsorption onto the septum and eliminates tailing and ghost peaks caused by septum bleed.
- A solenoid valve changes state between split and splitless, under system control, allowing high reproducibility in the splitless mode.
- Injector septum size – 7/16” (11.5 mm).
- **COMPETITIVE ADVANTAGES – Subambient temperature programmable injector for improved splitless operations.**

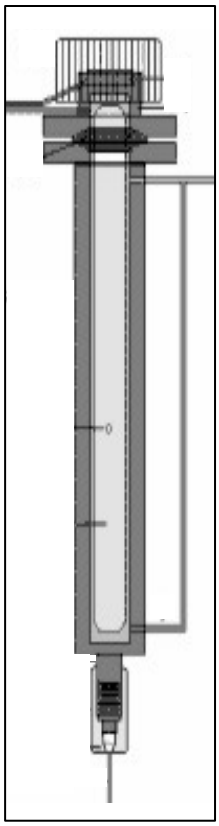
1079 Temperature Programmable Split/Splitless Capillary Injector for Varian 3800 [Introduced in 1997]

- Same as 1078, but with temperature range from -99 ^{o}C to **+450** ^{o}C.

1177 Split/Splitless Capillary Injector for Varian CP 3800 [Introduced in 2000]



- Isothermal split/splitless injector.
- Large volume injector inserts minimize sample backflash during injection process.
- Dual position split vents allow more complete sweep of injector body for more reproducible results.
- Adjustable septum purge allows constant sweep of septum at any head pressure.
- Easily removable purge head allows quick and easy access to injector inserts.



- Can properly accommodate both liquid injection and purge and trap attachment.
- Variety of capillary injector inserts (glass), up to 4 mm ID, allows full optimization for various injector modes.
- Insert seals with Viton o-ring at top.
- Capillary pneumatics with Electronic Flow Controller is thermostatically controlled
- Injector septum size – 9 mm.
- **COMPETITIVE ADVANTAGES – Large volume inserts and easier sealing of liners.**

Distinctive external feature – **Visible special tee for dual split vents. Column insertion is 3.7 cm.**

Lotus Consulting
310/569-0128 Fax 714/898-7461
email ebramstoncook@msn.com

5781 Campo Walk
Long Beach, California 90803