

Notes on Booster Vacuum

H. Halama

February 1986

Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No.DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

NOTES ON BOOSTER VACUUM

Booster Technical Note
No. 13

H. HALAMA

FEBRUARY 27, 1986

HIGH ENERGY FACILITIES
Brookhaven National Laboratory
Upton, N.Y. 11973

In order to satisfy the condition in Ref. 1 by a good safety margin, design pressure of $3-5 \times 10^{-11}$ Torr has been adopted for Booster vacuum system described in Ref. 2. (designed by Dick Hseuh) This all metal system bakable to 200°C is firmly based on the ISR and CBA 60m model experience³ which serve as existence proves,

Basically this system consists of vacuum chambers with 50 cm perimeter (A) pumped every 8.4m by a CBA pumping station, having a pumping speed (S) of 1600 l/s and 1000 l/s for H_2 and CO respectively³. In such a system the average pressure, P_{ave} ,

$$P_{\text{ave}} = P_0 + ALQ \frac{1}{S} + \frac{L}{12C} \quad 1$$

Where

P_0 = Pressure in the pumping station (1×10^{-11} Torr)

L = Distance between pumps 840 cm

Q = H_2 Outgassing rate taken as 3×10^{-13} Torr $\text{l cm}^{-2}\text{s}^{-1}$

(Q = 1×10^{-13} Torr. $\text{l.cm}^{-2} \text{s}^{-1}$ was achieved⁴. However, due to bellows, pick-up electrodes etc. the above more conservative value is used)

C = Conductance of chamber for H_2 (720001 cm s^{-1})

Since more than 90% of gas content in the system is hydrogen⁴, Q, S and C values for H_2 (hydrogen) are used in Eg. 1 which yields

$$P_{ave} = 3 \times 10^{-11} \text{ Torr}$$

Presence of other gasses such as CO and CH₄ increases P_{ave} only slightly.

$P \approx 4 \times 10^{-11}$ Torr would provide a safety factor of four even for stringent conditions in Ref. 1.

Care must be taken that all special equipment in straight sections, such as RF cavities, injection system, septum magnets and kickers are designed for VHV operation, operating in 10^{-11} Torr range.

References

1. G. R. Young, RHIC pg.16 (1983)
2. AGS Booster Conceptual Design Report, Vol. 1; BNL#34989R pg.47 (1985)3. H.
3. Halama, Proceedings of 8th Intern. Vac. Congress; Cannes, France; Vol. 2 pg.115 (1980)
4. H. J. Halama, J. Vac. Sci. Technol. 16(2) (1979)

H. Hatakeyama

III Injection from Linac and into AGS $\leq 1 \times 10^{-7}$ Torr ion pumps

IV Differential pumped area by getter/cryopumps $\leq 1 \times 10^{-8}$ Torr

HEBT $\leq 1 \times 10^{-7}$
AGS $\leq 1 \times 10^{-7}$

V Ring Vacuum $\leq 1 \times 10^{-10}$ Torr all metal system (4×10^{-11}) bakeable to 200°C

6 vacuum sectors
Ti sublimators + ion pumps

ACCUMULATOR / BOOSTER

II Transfer line from tandem $\leq 1 \times 10^{-9}$ Torr bakeable to 150°C non-evaporable getter ion pumps

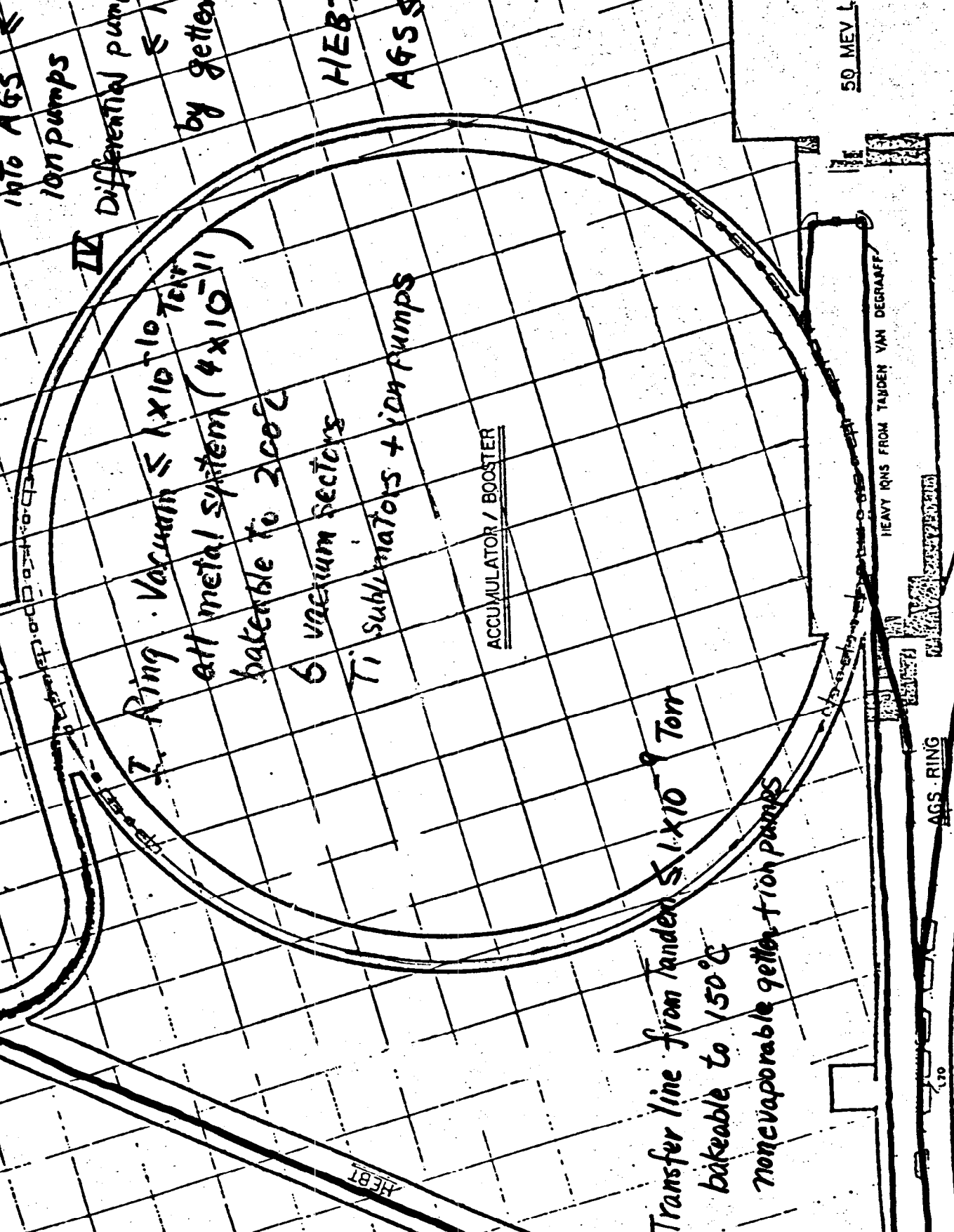
50 MEV LINAC BLDG

HEAVY IONS FROM TANDEN VAN DEGRAFF

AGS

AGS RING

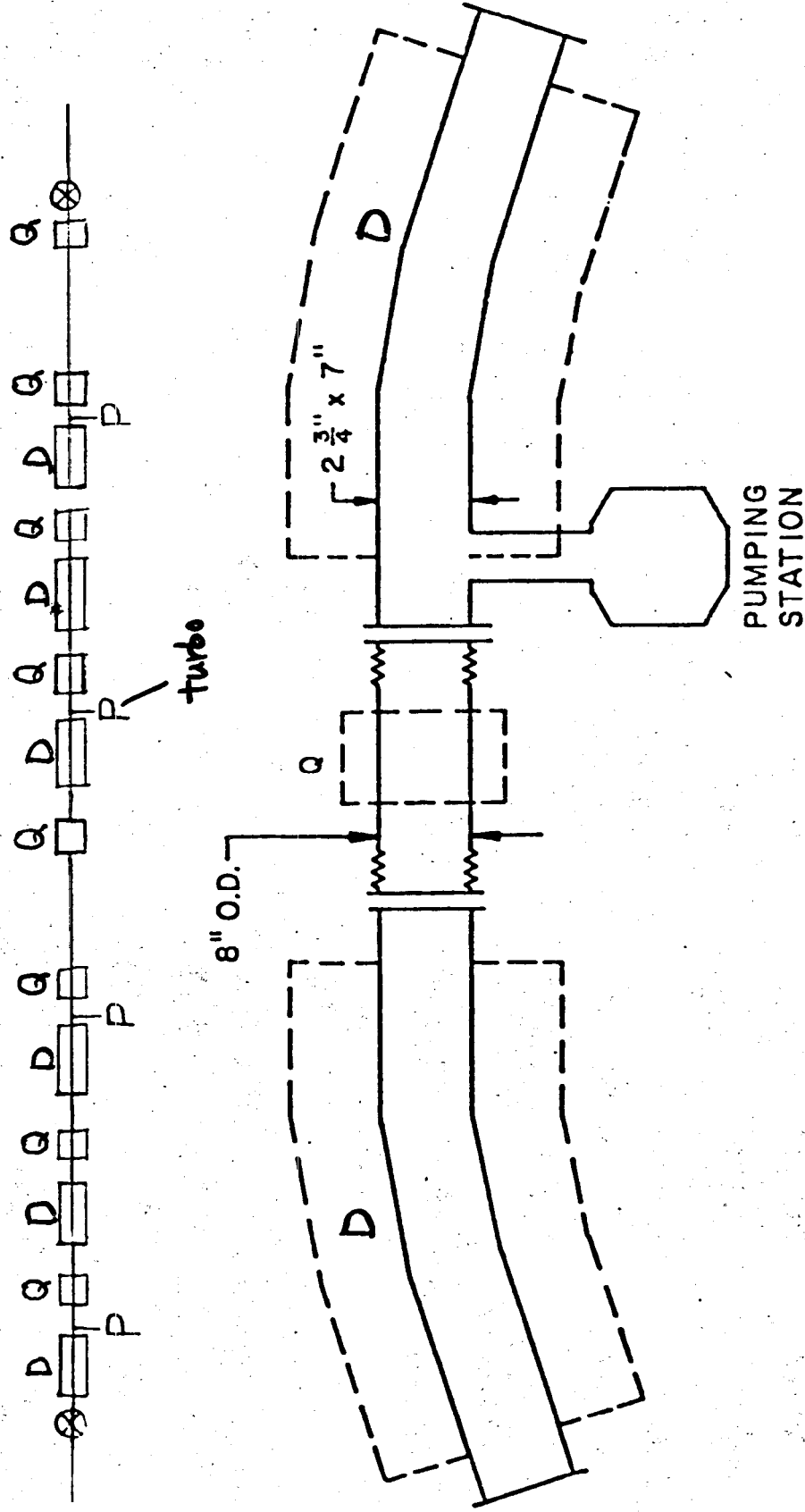
170

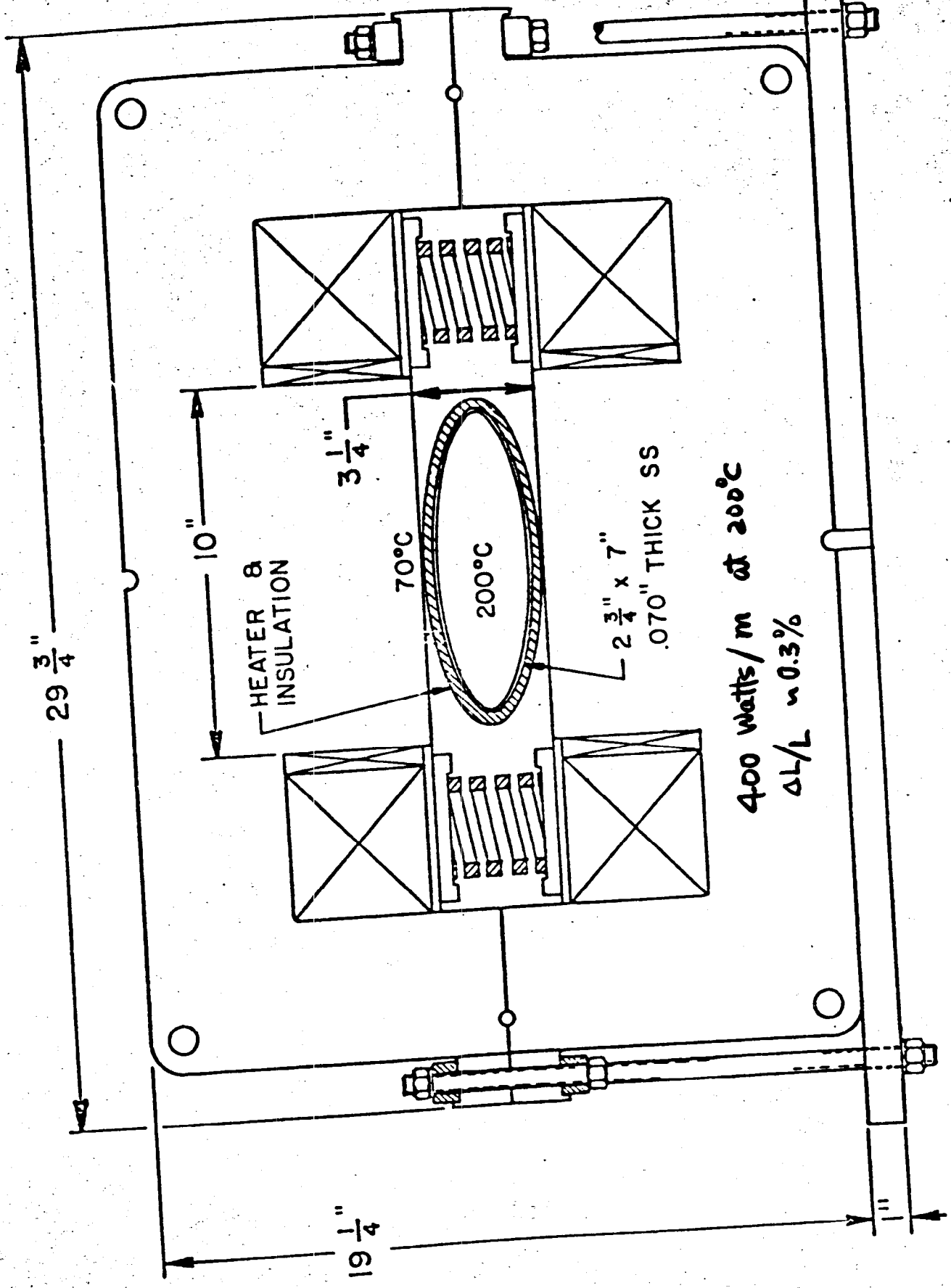


I Ring Vacuum System $\sim 4 \times 10^{-11}$ Torr

Vacuum sectors ~ 37 meter each

- 4 ultrahigh vacuum pumping stations (Ti, IP, IQ) 8.5 m between pumps
- 1 turbomolecular pumping station





Vacuum chamber in ring dipole magnet.

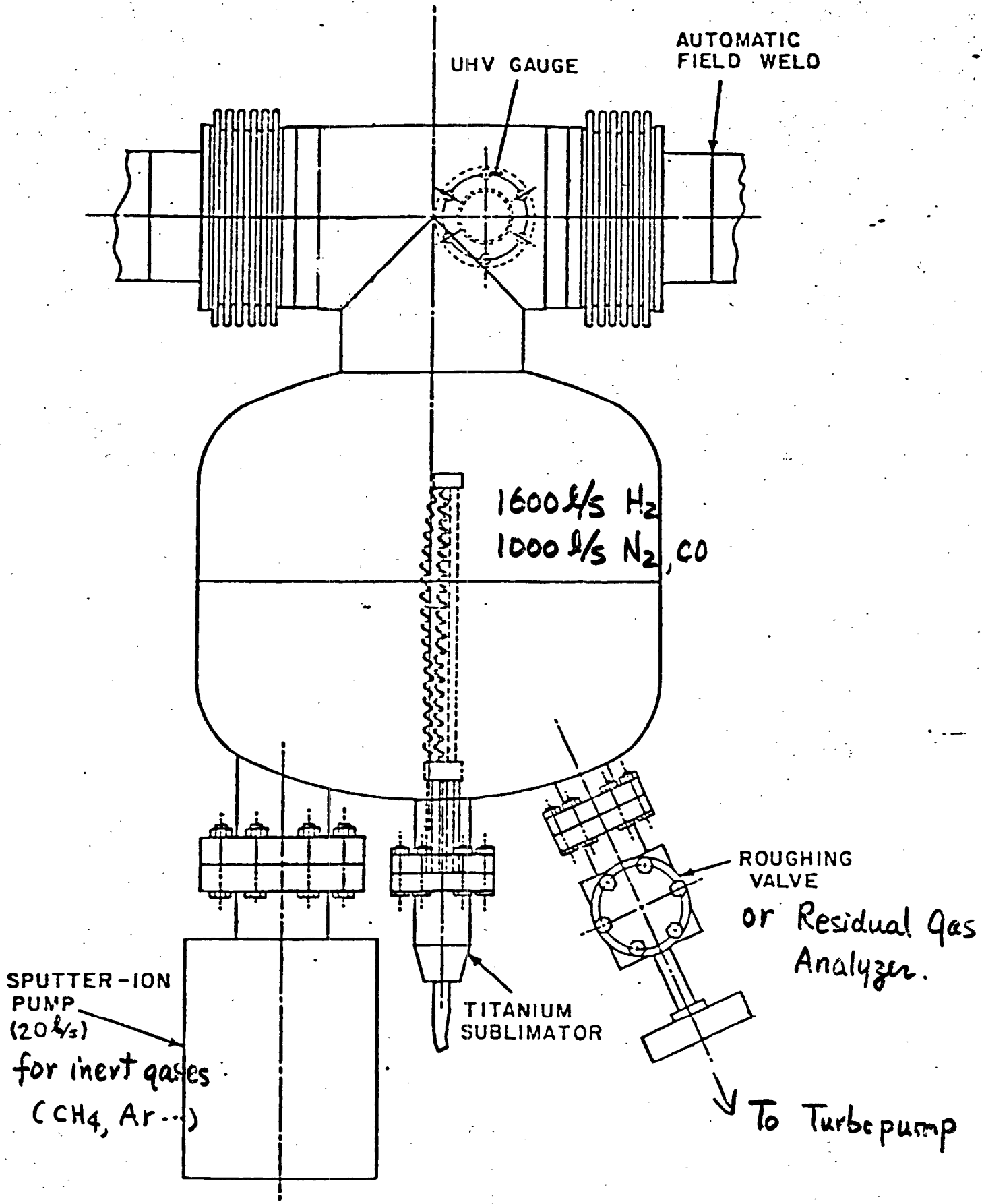


Figure 12 - Typical pumping station of accumulator/booster ring.

Vacuum Characteristics of Booster Ring

- all metal system
- vacuum fired at 900°C
- glow discharge cleaned before assembly
- insitu baked at 200°C x 24 hrs
 - \Rightarrow outgassing $3 \times 10^{-13} \text{ Torr} \cdot \text{l/s} \cdot \text{cm}^2$
 - $\sim 90\% \text{ H}_2$, $\sim 10\% \text{ CO}$, $< 1\% \text{ CH}_4, \text{ Ar} \dots$
- pumped by Ti sublimation pump
 - 1600 l/s for H_2
 - 1000 l/s for $\text{CO}, \text{ N}_2$
- 20 l/s ion pump
 - 10 l/s for CH_4

III Injection from Linac and
into AGS $\approx 1 \times 10^{-7}$ Torr
ion pumps

IV Differential pumped area
 $\approx 1 \times 10^{-8}$ Torr
by getter/cryopump

HEBT $\approx 1 \times 10^{-7}$
AGS $\approx 1 \times 10^{-7}$

V Ring Vacuum $\approx 1 \times 10^{-10}$ Torr
all metal system (4×10^{-11})
bakeable to 200°C

6 vacuum sectors
Ti sublimators + ion pumps

ACCUMULATOR / BOOSTER

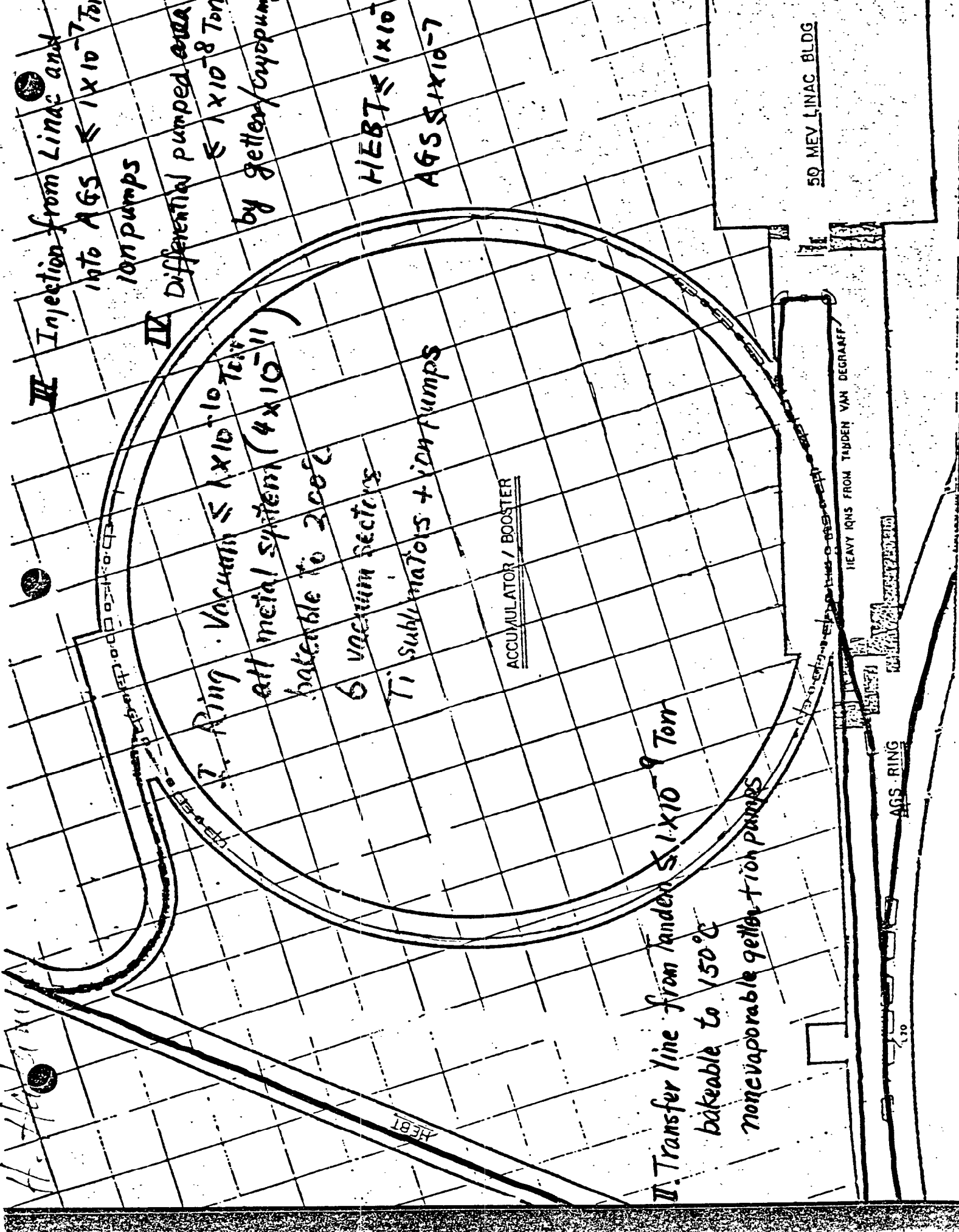
II Transfer line from tandem $\approx 1 \times 10^{-9}$ Torr
bakeable to 150°C
non-evaporable getter-ion pumps

50 MEV LINAC BLDG

HEAVY IONS FROM TRUBEN VAN DEGRAFF

AGS RING

1.70



I Ring Vacuum System $\sim 4 \times 10^{-11}$ Torr
 Vacuum Sectors ~ 37 meter each

4 ultrahigh vacuum pumping stations (Ti, IP, IQ) 8.5 m between pumps
 1 turbomolecular pumping station

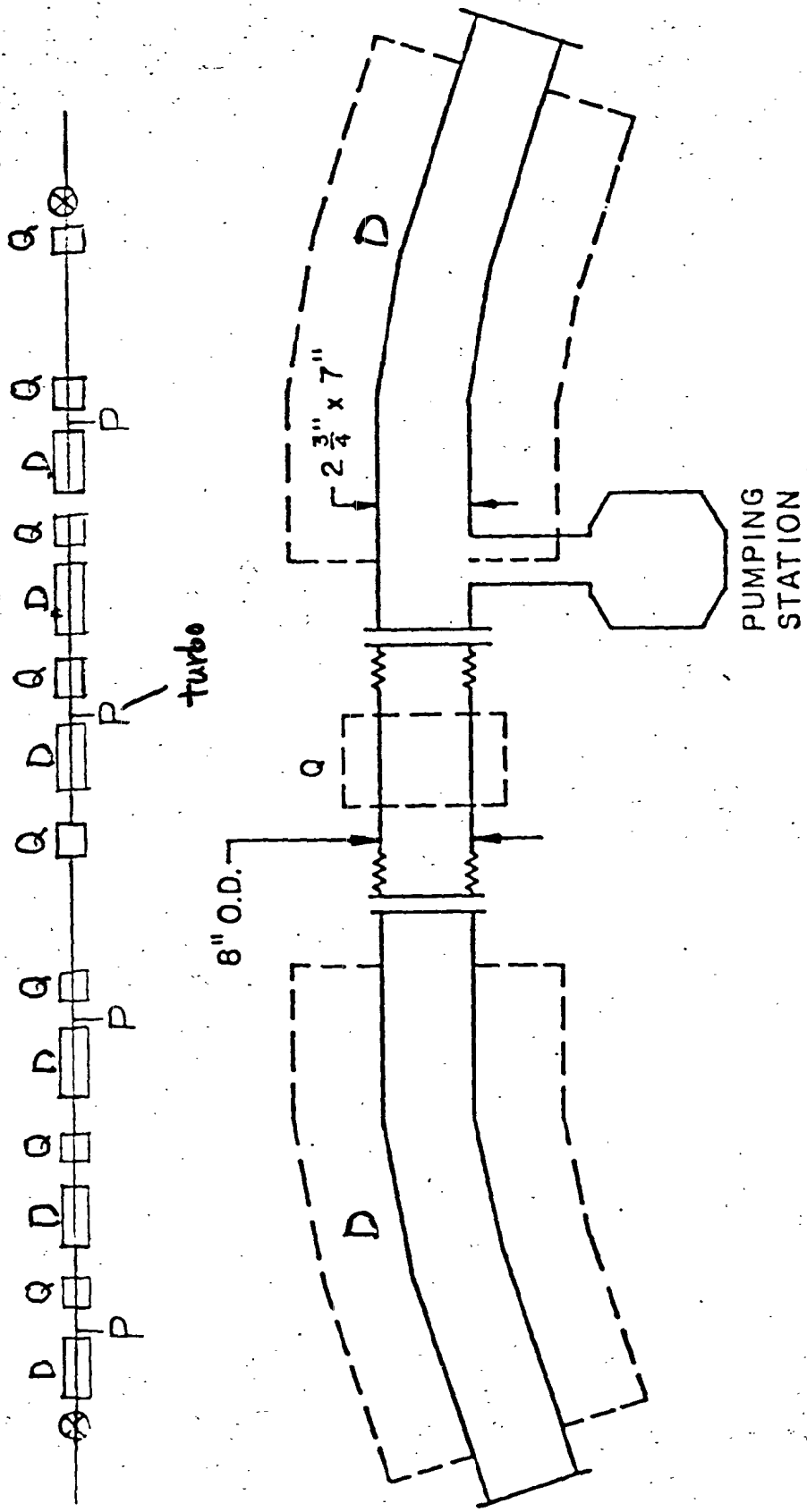


Figure 11 - Vacuum

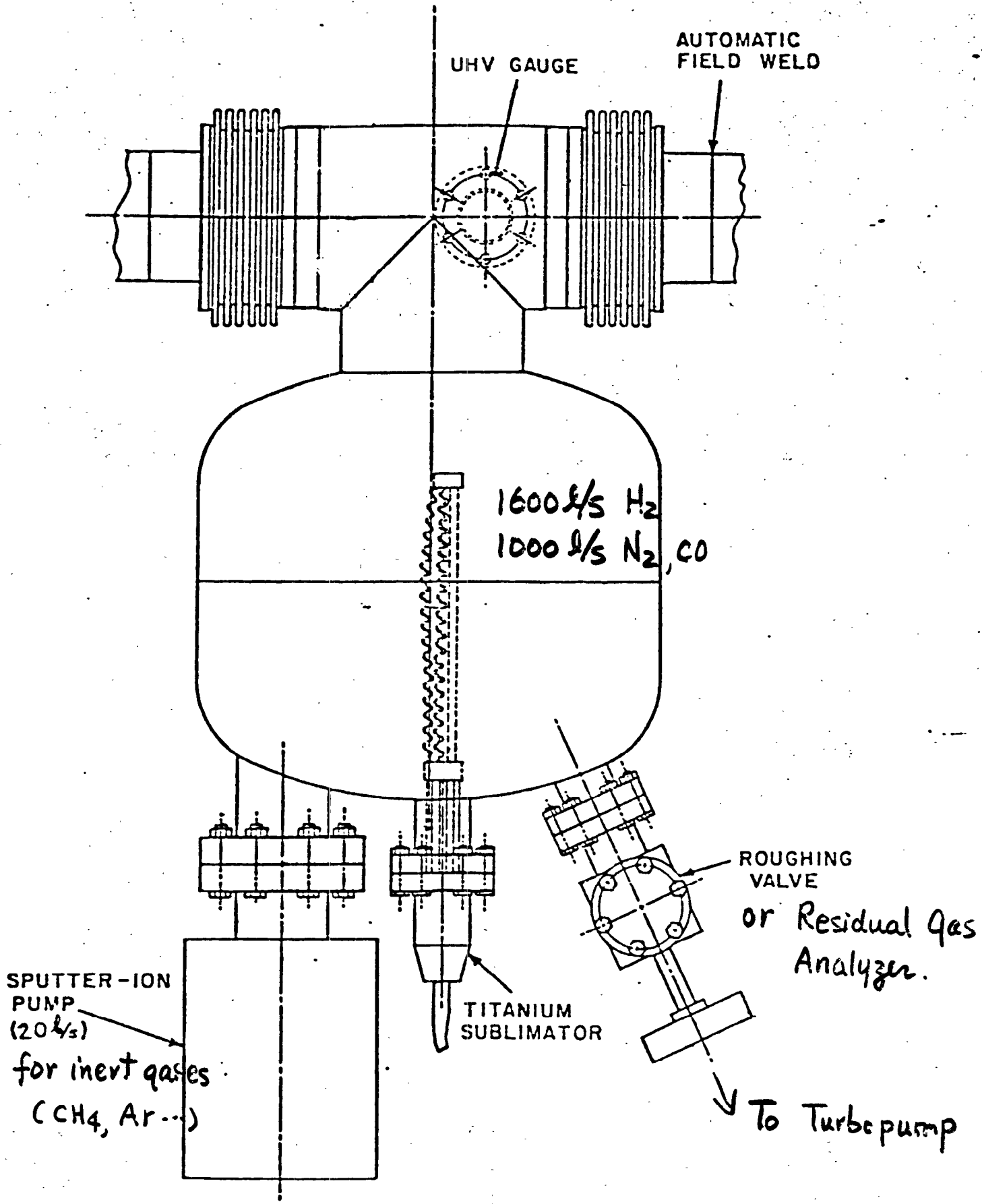


Figure 12 - Typical pumping station of accumulator/booster ring.

Vacuum Characteristics of Booster Ring

- all metal system
- vacuum fired at 900°C
- glow discharge cleaned before assembly
- insitu baked at 200°C x 24 hrs
 - \Rightarrow outgassing $3 \times 10^{-13} \text{ Torr} \cdot \text{l/s} \cdot \text{cm}^2$
 - $\sim 90\% \text{ H}_2$, $\sim 10\% \text{ CO}$, $< 1\% \text{ CH}_4, \text{ Ar} \dots$
- pumped by Ti sublimation pump
 - 1600 l/s for H_2
 - 1000 l/s for $\text{CO}, \text{ N}_2$
- 20 l/s ion pump
 - 10 l/s for CH_4