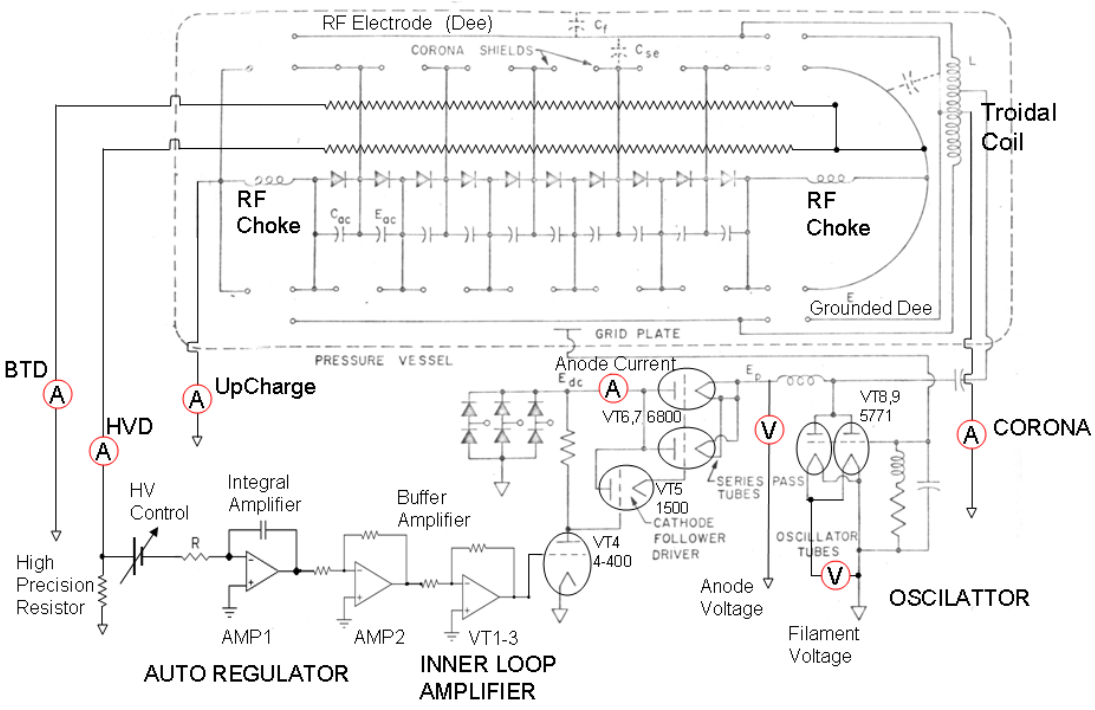
A 4.5 MV Dynamitron accelerator was constructed in 1974 for neutron and ion-beam experiments. The Dynamitron accelerator is a single-ended type with a Schenkel type high-voltage power supply. Voltage ripple of the accelerator is about ±1kV at 3MV ($\Delta E/E=6\times10^{-4}$, specification). Voltage range of the accelerator is 1.5 to 4.5 MV. The accelerator was provided with a high-current duoplasmatron ion source, which can generate hydrogen, deuterium, or helium ion beams. The maximum beam current is greater than several hundred microamperes (3 mA recorded).

To improve the performance of the accelerator, the Dynamitron accelerator was upgraded in 2007. For this upgrade, an ion source, with lenses in the terminal, and an acceleration tube were replaced with new ones provided by National Electrostatics Corporation (NEC). The whole control system was developed by our group.

A proportional integration (PI) regulator is used to stabilize the high voltage, as shown in the figure. The PI controller acts on the error signal from the comparison of the set reference voltage and the voltage generated on the precise resistor by the high voltage divider, HVD current (load current of the resistors, which were connected from the terminal to the ground). The error signal is amplified by Amp-1, chopper-stabilized amplifier (GAP/R, USA-3) and further amplified by Amp-2 (GAP/R, K2-XA). The signal is transmitted to inner loop amplifier, generates high voltage of the accelerator and causes a change in HVD current. Since the Amp-1 is used as an integrating amplifier, output of the Amp-1 increases/decreases until an error vanishes.

The voltage ripple was sometimes larger than 10^{-3} and was larger than the specification. The voltage ripple came from bad adjustment of the voltage regulation circuit. The response time is very important to stabilize the terminal voltage. The response time was adjusted at installation of the accelerator when rectifier tubes were used for high voltage generation. After changing the rectifier tube into diodes, readjustment was not carried out. Readjustment should be carried out because the response of the diodes is faster than that of the rectifier tubes. Because voltage stability was not im-

portant for any application at that time, adjustment was not carried out. After adjusting the response time, the voltage ripple decreased to a level that was within the specification



HVコントロールシステムとHVメータ系統

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