ACCELERATING STATION ALTERNATIVE
for MEB SSC PARAMETERS

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Abstract

Developed in MRTI alternative version of accelerating station for MEB SSC parameters is described. Comparative analysis of the main components of the accelerating station and its distinctive features are provided. Designs of RF amplifier and accelerating cavity are presented. The 4CW150000E tube has been used for RF amplifier operation. Cavity -generator coupling is realized as the coupling loop is outside the cavity vacuum volume. That provides for the remote control coupling in various mode of accelerator operation. For the frequency detuning in accelerating cavity both varactor and ferrite tuner can be used.

In the course of high power radioengineering equipment design for ion linear accelerators and Moscow caon facility the Moscow Radiotechnical Institute has gained the significant experience in the development of accelerating stations. That enabled the model of accelerating station for the parameters of synchrotron ring MEB SSC station to be designed in a comparatively short time (work performed under agreement with SSCL). The work has been conducted to the end of the development of accelerating station alternative version that meets the parameters of MEB SSCL synchrotron ring:

- output RF power, kW 160
- operating frequency,MHz 60
- accelerating cavity frequency tuning,% 1
- max. accelerating voltage,kV 250

The accelerating station design has some unique assemblies suggested and developed by MRTI that compares favourably this station with the main version designed in SSCL. Among these assemblies are off-vacuum coupling element for the RF amplifier output cascade with the cavity and tuner on the basis of AIU varactor/ 1 /.

It is common knowledge that at the accelerating stations of high power ring accelerators in order to compensate a beam load the Rf feedback coupling with high amplification coefficient in the ring is implemented. Under this conditions the output cascade of RF generator is placed immediately on the accelerating cavity. The design alternative of accelerating station developed for MEB by SSCL is shown in Fig.1. At the output cascade of the RF amplifier the quarterwave anode line and vacuum coupling capacitor with rather high capacitance of about 15-20pF are used. This design hinders the timely change of the coupling capacitance and its tuning in the course of adjustment because it needs decompressing of the accelerating cavity and output cascade dismounting. At the same time to keep the generator optimum operation as the accelerator mode of operation requires it is preferable to control this coupling.

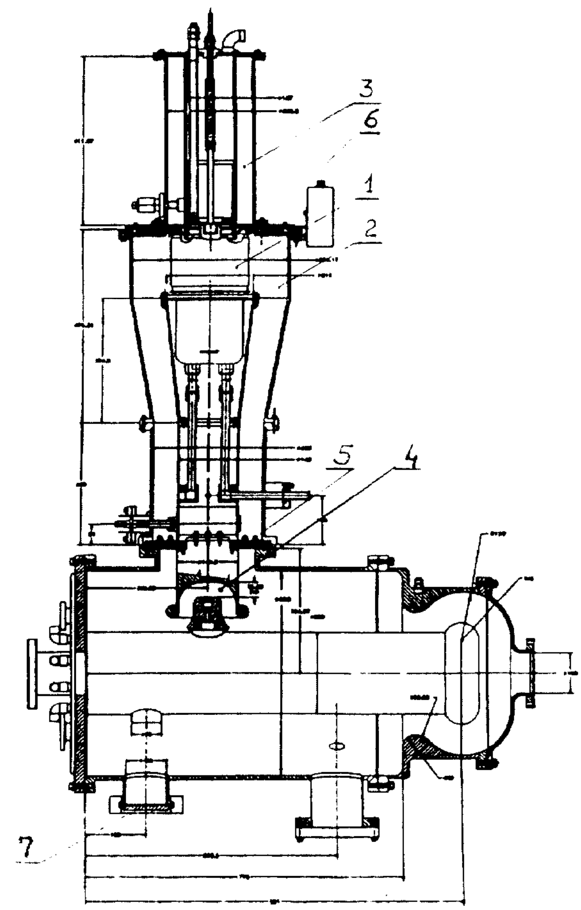

Fig.1.Accelerating Station.
SSCL Alternative Version.

RF amplifier: 1 - 4CW150000E tetrod, 2 - anode line, 3 - input unit, 4 - coupling volume, 5 - RF window, 6 - blocking capacitors unit. Accelerating cavity: 7 - flange for ferrite tuner hook up.

In order to eliminate this disadvantage MRTI applied another type of coupling in its alternative of station which allows the coupling value tuning without decompression of the accelerating cavity and even in the mode of beam acceleration. This version (Fig.2) is based on amplifier-cavity induction coupling therewith the coupling loop is outside the vacuum volume of the cavity. In this case the coupling is defined by the electromagnatic field penetration through the cavity window inside the coupling loop. The coupling value can be effectively changed without cavity decompression by moving the loop relative to the cavity.The coupling units similar to this one have been used in the equipment developed in MRTI and successfully applied in linear accelerators I-100 (IHEP) and in Moscow meson facility (INR) for many years. In this case the geometric length of the generator anode line is minimum and approaches the relative parameter of SSCL generator anode line.

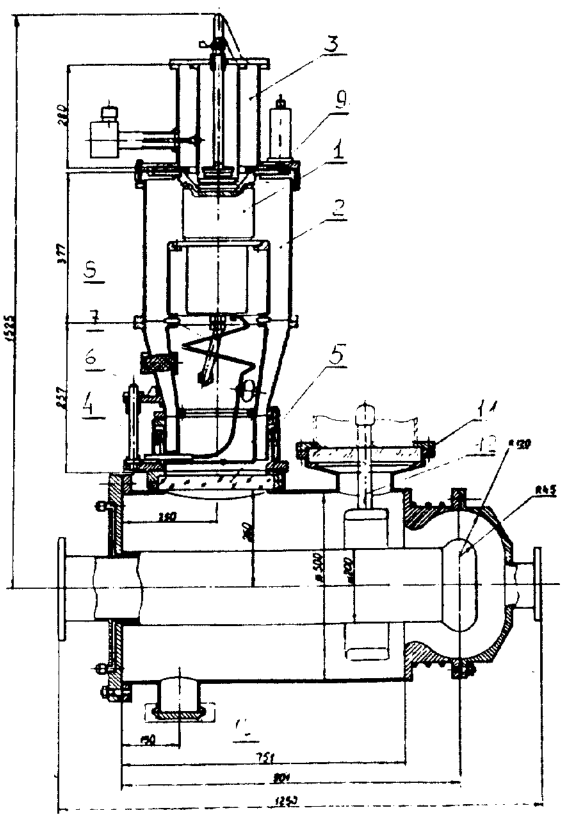

Fig.2 Accelerating Station.
MRTI Alternative Version.

RF amplifier: 1 - 4CW150000E tetrod, 2 - anode line, 3 - input unit, 4 - coupling loop, 5 - RF window, 6 - screw-jack, 7 - support insolators, 8 - RF filter, 9 - blocking capacitors unit. Accelerating cavity:10 - flange for ferrite tuner hook up (or vacuum pump if varactor tuner used), 11 - flange for varactor tuner hook up (or vacuum pump if ferrite tuner used), 12 - varactor coupling unit.

The desing of the coupling unit and generator anode line has been done by the procedure developed in MRTI /2/ . The results of the experimental test kindly granted us by Dr.Kvitkovskiy from SSCL demonstrated that the deviced design with a safety margin provides for the needed coefficient of coupling.

The output amplifier is designed in the ground grid configuration and placed at the cavity flange. The coupling loop of anode line (Pos.4) is executed in sector form with flare angle of 90. It is separated from the cavity vacuum volume by the flat dielectric diaphragm (Pos.5). The generator can move vertically relative to the diaphragm plane by means of the remote control screw-jacks (Pos.6). It results in generator-cavity coupling tuning.The inner conductor of the anode line incorporates the separating capacitor made of standard ceramic capacitors. The output cascade tube is placed with the anode downwards and fixed by means of insolators (Pos.7) to the inner conductor of the anode line. In the water cooling system ceramic sleeves are applied as insulators. The anode supply voltage is delivered to the anode by a high voltage cable running inside the coupling loop. The RF filter (Pos.8) is formed by the blocking capacitor with inductor and placed inside the central conductor of the anode line. The unit with blocking capacitors of control and screen grids (Pos.9) is made on the basis of film capacitor.

The quarterwave coaxial cavity is utilized as an accelerating cavity. The cavity design enables to use both ferrite and capacitor tuners of new varactor-type. It is placed on the flange (Pos.11) for the varactor cavity detuning and connected with a special ring (Pos.12) inside the cavity. For the accelerating station it is supposed to use the varactor deviced for the accelerating station of the Moscow caon facility main ring. It assures the capacitor change from 40 to 150 pF at operation voltage of 100 kV. The calculations and breadbord modeling demonstrated that in this case the achievable detuning is of 4%. The cavity vacuum pumping is performed through the branch pipe (Pos.10) if varactor tuner used.

In case the ferrite tuner is utilized it should be placed on the branch pipe (Pos.10) and connected to the cavity by conductive connection (similar to SSCL version) and vacuum pumping is performed through the top branch pipe (Pos.11).

Cavity parameters were computed by AZIMUT /3/ program starting from gap operating voltage of 250 kV. Overall thermal cavity losses amount of 34 kW, among which internal conducter losses are about 60%, external - 27%, the bottom - 8%, where internal conductor is fixed, and ring - 5%, varcator connected to. Electric field maximum voltage at cavity surface is in the order of 63 kV/cm that is less by a factor of 1,5 than Kilpatric criterion at this frequency. Cavity Q-factor is of 11500 and characteristic resistance is of 57 Ohm.

The second alternative version of generator output cascade design shown in Fig.3 is distinguished from the first one by tube fixed with anode upwards. This design version features with maximum voltage between output line electrodes being less by a factor of 2 than in the previous design version. Furthermore it allows quick replacement of a faulty tube at output cascade and free access to RF generator circuit kept under high voltage.

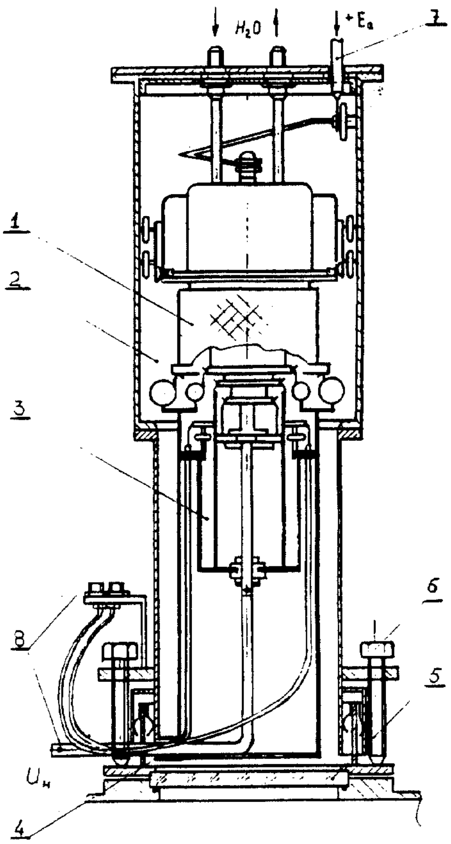

Fig.3 RF Amplifier Design Alternative Version.
1 - 4CW150000E tetrod, 2 - anode line, 3 - input unit, 4 - coupling loop, 5 - RF window, 6 - screw-jack, 7 - anode voltage input, 8 - blocking capacitors unit, 9 - input for RF drive, filament voltage and screen grid.

At present construction of the breadbord for experimental radiotechnical investigations with accelerating station alternative model for MEB SSC parameters is being completed.

REFERENCES

1.Konovalov V.A., Kuznetsov M.I., Murin B.P., Paramonov V.V., Senichev Yu.V. The Perspectives of Application of the Fast-Acting Varactors with Low Losses in High Current Cyclic and Linear Accelerators.-EPAC 92,Berlin,24-28 March,v.2,p.1242-1243.

2.Ivanov Yu.D.Cavity Loop Drive Outside Its Volume.-Charged Particles Accelerators, MRTI RAS, M.,1989,p.33-34. 3.Grigor'ev A.D.,Silaev S.A.Simulation of Electromagnetic Field of Azimuth-Uniform Oscillations for Axial-Symmetric Cavity with the Arbitrary Forming.- Electronnaya Technica,Seria Electronica SVCh,1981,2,p.62.