AN AUTOCODE PROGRAMME FOR COMPUTING EDDY CURRENT EFFECTS IN VACUUM CHAMBERS FOR THE P.S.

1. GENERAL DESCRIPTION.

A Mercury Autocode programme has been prepared in order to compute the effect of eddy currents in vacuum chamber structures inside the PS magnet. It is thought to be useful in designing new special vacuum chambers, e.g. for target and ejection purposes.

The input data for the programme have to be presented in the following way.

The chamber (supposed to be infinitely long and symmetrical with respect to the median plane) is divided into longitudinal slices (see fig. 1). The coordinates of the centre of each slice are punched on the data tape, as will be described in chapter 2. Only the slices of the top half (above the median plane) should be taken. The results, however, are given for the whole chamber.

For obtaining a good precision, the part of the chamber that is near the equilibrium orbit (not further than 10 cm away) should be divided into at least 20 slices. Further away, larger slices may be taken (e.g. 1 cm wide).

The total number of slices can be divided into several groups. All slices inside one group must have the same resistance per unit length (i.e. equal value of resistivity divided by cross-section). Different groups may have different resistance per unit length.

The origin of the coordinate system to be used is the equilibrium orbit. Coordinates (r,z, see fig. 1) must be in cm. Positive r-direction is towards the narrow side of the gap.

The programme calculates

$\frac{\Delta n}{n}$ as a function of r,

B_o,

the lateral force on the vacuum chamber due to eddy currents,

the power absorbed in the vacuum chamber,

the total circulating current,
the current flowing in each slice.

The computing time (including print-out) is between 0.5 and 1.5 min, depending on the number of slices used.

The method of computation was described in CERN-PS/MM 35.

The programme was tested with the existing vacuum chamber, and yielded the same results as were measured earlier.

2. INPUT.

The input data must be punched on the data tape in the following order:

a) number of groups (maximum 5, see chapter 1)

b) for the first group :
number of slices in first group
conductance of a slice of length 1 m (in ohm^{-1})
r - coordinate of first slice
z - " " " " in cm
r - " " second "
z - " " " "
etc. for all slices of first group

c) for the second group (if any) :
number of slices in second group
conductance of a slice of length 1 m
r - coordinate of first slice
z - " " " "
etc.

d) the same for the third group (if any)
etc.

The total number of slices must not exceed 110.

The data tape must be fed intc the computer after the programme tape (no. 313).

3. OUTPUT.

The output data are printed in the following order :

a) first line : title ("eddy currents in vacuum chamber")

b) second line: $\frac{\Delta n}{n}$ in o/o for r = - 6, - 4, -2, 0, + 2, + 4, + 6 cm respectively. The figures given represant the value at injection of

$$100\left(\frac{\Delta G}{G} - \frac{\Delta B_o}{B_o}\right) \qquad \text{(G = gradient)}$$

Strictly speaking, the second term does not contribute to $\frac{\Delta n}{n}$ if only one vacuum chamber is exchanged. However, $\frac{\Delta B_o}{B_o}$ will have to be corrected by means of backleg windings, or short circuited pickup loops in the poleface windings, which will at the same time contribute to $\frac{\Delta G}{G}$. The values given are, therefore, the values of $\frac{\Delta n}{n}$ that would result after $\frac{\Delta B_o}{B_o}$ has been corrected. As a reference, the magnet without vacuum chamber and without poleface windings is taken.

c) third line : 1) ΔB_o at injection in gauss, again compared with a magnet without vacuum chamber and without poleface windings.

2) the lateral force in Kg per m length at 14 Kgauss, positive if in the direction ofthe narrow gap during the increase of the magnet current.

3) the power absorbed in the vacuum chamber in W per m length (for 100 o/o duty cycle).

4) the total circulating current in A.

d) fourth line and after : a table giving the current (in A) in each slice. Each line should be read from left to right, before proceeding to the next line. The currents are given in the same order as the slices on the data tape. As on the data tape, only the slices of the top half ofthe chamber are represented here.

All figures are valid for 90 o/o magnet voltage.

A good precision (5 o/o of the given results) is expected for vacuum chambers in the linear part of the field. For chambers with parts outside the magnet the precision might not be better than 10 or 20 o/o, due to the approximation that had to be made to the field in these regions.

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