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THE MAGNET SYSTEM OF HESYRL RING

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Abstract This paper deals with designing and constructing of the bending and quadrupole magnet of HESYRL ring. It expounds the material choice, physical and construction design, technique and the measured results.

INTRUDUCTION

The magnet of HESYRL storage ring consisted of 12 bending magnets, 32 quadrupole magnets and 14 sextupole magnets. The material of the magnet core choosed the W20G undirectional electrical steel strip, its main magnetic properties are following:

H	1	2	12.5	25	50	100
B	8300	11200	15200	16100	16900	17900

BENDING MAGNET

1. Magnet Design

The bending magnet adopted the cross section of the type of C shape, its size is as figure 1. The two dementional field distribution at the full and 1/4 energy is showing at figure 2, it has enough good field width. The parameters of bending magnet is following:

Field strength	T	0.3-1.2
Good field width	mm	60
Central curvature radius	m	2.2221
Gap	mm	55
Coil circles		64
Efficient magnet length	m	1.1635
Current (at 800 MeV)	A	825
Power per magnet	KW	9.53

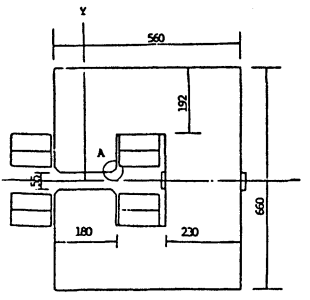


Fig. 1.

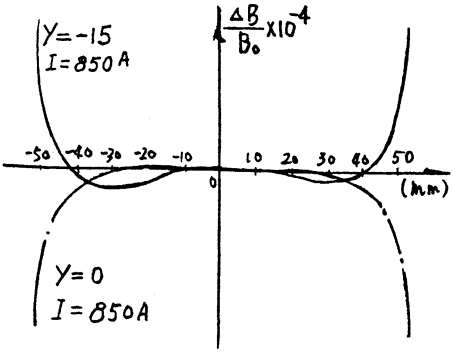


Fig. 2.

2. The Main Technology of The Magnet Manufacture

a. For eliminate the inhomogenett of the 12 magnets property, all the punching slices used special mixing technology.

b. For keeping the certain force and iron containing everywhere in the arc shape core, we separate the magnet into 12 glued blocks, exert pressure on it and solodify with heat.

c. 12 core blocks and two end plates fixed in the formed mould. Then adhibit the 2 cover plate on the core. This technique avoid the deformation caused by the mean of connect with weld.

d. The conductor of the magnetizing coil is T2 copper pipe with 22x16/ϕ8, it used upset butt welding without flux to connect one another.

3. The Measured Results of The Bending Magnet

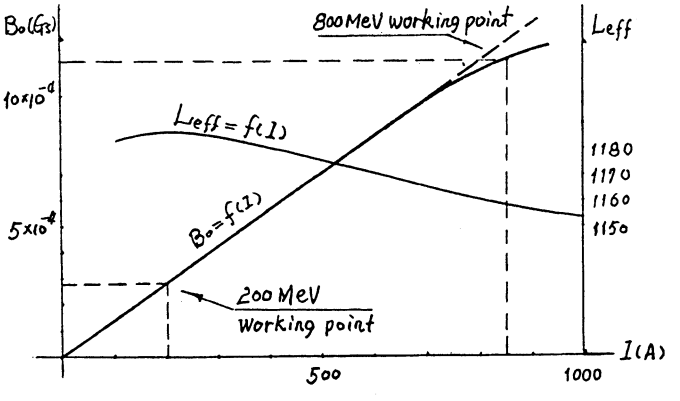


Fig. 3.

a. The magnetizing curve of the bending magnet. The magnetizing curve showed in figure 3 point out the work point of the magnet at 800 MeV and 200 MeV.

b. The effective length. At 800 MeV, leff=1163.5mm, but it is 1161.1 mm actually, the deviation is only 2.4 mm, it is very small.

c. The magnetic field integral distribution. About the storage ring, the magnetic field integral distribution of the bending magnet is very important. We use the moveable end pole to engaged in end shimming, at last, we get the satisfied result. As figure 4 showing.

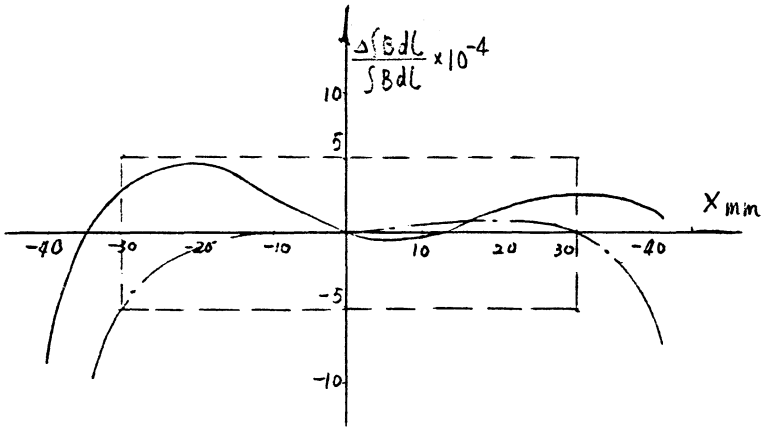


Fig. 4.

d. The identity of the 12 bending magnets

$$\Delta \int Bdl = \int Bdl - \overline{\int B\,dl}$$

Bdl is the avarage value of the integral field of the 12 bending magnets. The RMS error of the integral field of 12 bending magnets is 0.6 x 10E-3 at different magnetizing current. The largest relative error is 2 x 10E-3.

The 12 identical bending magnets are connected electrically in series from a common power supply. On the yoke of the magnet, there are 32 circles additional coil which produce 120 Gs additional magnetic field, compensate the unidentity between 12 magnet field and correct the level position of electron bunch.

The outline picture is showing at page 6.

The QUADRUPOLE MAGNET

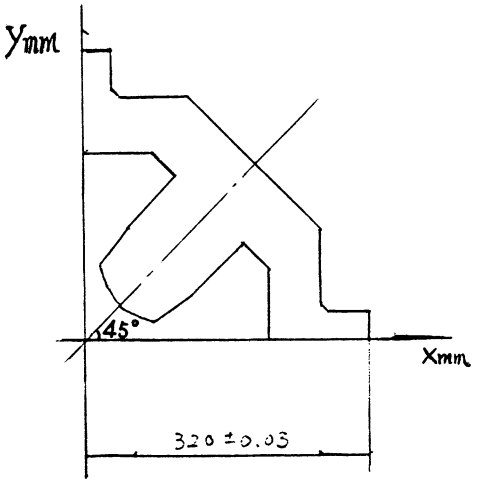
1. Magnet Design

The magnet field distribution in the aperture of the quadrupole magnet required: $\partial Bx/\partial Y = \partial By/\partial X$ = constant.

Such distribution require that the magnet poleface is a hyperboloid, we usd the hyperbola-straight line type, the tangency point and the ploe size is showing at Fig. 5.

The parameters is following:

magnetic field grade	Gs/mm	50-1285
radius of the inscribe circle	mm	50
radius of good field area	mm	40
magnetic effective length	m	0.3
circle number of each pole		36
magnetizing current	A	325
power	KW	4.712



Xmm	Ymm
35.355	35.355
36.369	34.370
37.378	33.442
38.383	32.566
39.395	31.730
40.408	30.934
42.424	29.464
43.435	28.778
44.445	28.125
45.457	27.498
46.466	26.901
48.388	25.833
50.673	24.668
53.534	23.350
56.567	22.098
60.601	20.627
64.645	19.336
78.90	15.05

Fig. 5.

2. The Technology Characteristic of The quadrupole Magnet.

The total length of the core is 250mm, after rough punch, slice become certain shape then adherbit them forming a block with epoxy, usea the electrical discharge machining to cut the pole, assure the precision of the magnet. The other manufactrue technique is similar to the bending magnet.

3. The Measured Results of Quadrupole Magnet

a. After the end shimming, the ridio of the each harmonic value to the 4 pole part value (R = 46.54 mm) is below the 1 x 10E −3 .

	10A	50A	100A	200A	300A	375A	400A
2	1000	1000	1000	1000	1000	1000	1000
3	0.407	0.553	0.607	0.601	0.622	0.786	0.806
4	0.459	0.123	0.180	0.197	0.278	0.293	0.248
5	0.230	0.147	0.139	0.149	0.095	0.078	0.093
6	0.582	0.926	0.516	0.183	0.421	0.869	0.882
7	0.074	0.012	0.053	0.071	0.031	0.072	0.036
8	0.182	0.173	0.173	0.087	0.194	0.194	0.170
9	0.166	0.068	0.159	0.071	0.066	0.122	0.061
10	0.367	0.781	0.649	0.379	0.478	0.231	0.318
11	0.009	0.032	0.034	0.023	0.054	0.023	0.019
12	0.139	0.054	0.016	0.016	0.009	0.025	0.036

4# quadrupole magnet

b. The relation of the gradient, field integral, the effective length and the magnetizing current. G = f(I), Leff = f(I). Let us look at figure 6, the effecfive length is about 8mm shorter than the design value. We can increase G to keep the $\int$ Gdl as a constant when change the current, if the Loeff reduced.

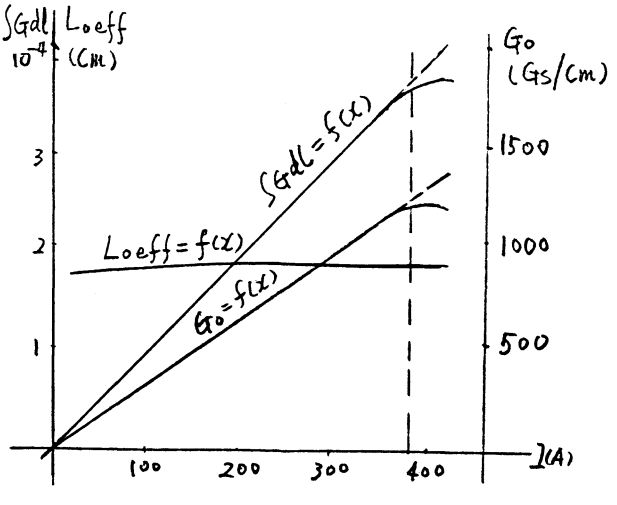


Fig. 6.

There are additional coils with 30 circles on each magnetizing coil of quadrupole magnet. It produce 200 Gs level magnetic field, correct the vertical position of electron bunch, each additional coil of the magnet used a (0-30A) power supply

The magnet system has been assemble and has been adjusted on March, 1989, April in the same year, the storage ring come into operation, the first synchrotron radiation light bunch has produced on April 26, 1989.

(Adding figure)

The outline of the bending magnet and quadrupole magnet.