Number 150

AGS STUDIES REPORT

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Subject A/D Line Steering

OBSERVATIONS AND CONCLUSION

Since the D line was first operated, there have been inconsistencies in the horizontal steering and unusual losses in region of CD2-3 and DD4-5. The problem is similar to the skew quad moment developed by the thick Lambertson magnets. Re-alignment of the A line would aleviate this problem.

With the A line beam centered at AF171, typically DD 4-5, the first independent D line benders, has been run 20% below design current in order to center the D line beam on the D146 flag. To transport this beam through the 21° bend, the next dipoles had to operate at maximum current. For this test, the current in DD4-5 was set to design value and the current in AD2-3, magnets that bend both the A and D beams, was adjusted to center either the A line or the D line beam. A difference of 220 Amps was noted. Using the current/field curves of 10/14/80, the field to center the beam in D was 3.9% lower than the field to center the beam in A.

The field at the surface of the flat iron pole of AD2 and AD3 show a large sextupole moment. As the surface of the iron is the location of the symmetry plane of the magnet, the beams go through "off axis" (Figure 1). The off axis sextupole moment causes an apparaent skew quad moment as:

$$B_y = B_o (1 + S(x^2 - y^2) + --); \quad \frac{\partial B_y}{\partial y} = -2Sy$$

$$\text{and } \frac{\partial B_y}{\partial y} = -\frac{\partial B_x}{\partial x}, \quad (\text{as } \nabla \bullet B = 0)$$

where y is the distance above the iron. Thus, the apparent skew quad's strength is proportional to the sextupole moment and the beam's elevation above the magnetic median plane. This effect has been somewhat corrected by the addition of skew quads in the A and D lines downstream of AD2 and 3. It should also be noted that B_y increases with y (as $s < 0$), thus the higher D line beam would be deflected more than lower A line beam.

J. Jackson estimated the sextupole and tenpole field moments from his measurements of these magnets. This estimate predicts a field difference to center the A or D line beam of 2.77 to 3.4% depending on the beam's elevation.

This misalignment has probably caused some beam scraping in this region (mainly noted on the loss monitor near CD2 and 3). Increased D line flux has increased the loss noted here. Reducing AD2-3 by 100 Amps and increasing DD4-5 by 200 Amps has reduced these losses by a factor of two, but the A line beam is misaligned by 1/2" to the east. Further reductions in beam scraping should result from better alignment. Ideally, D line should be moved 1" west to utilize the larger bend for D line beam in AD2-3, but moving the D line "Big Bend" magnets is a formidable job with their common captive vacuum chambers. Conversely, the A line could be moved to accept the A line beam with the reduced current in AD2-3 that centers the D beam. The entrance to AD4 should be moved 2" east and the other magnets in the bend to A station moved to make a smooth arc. Also, DD4 and 5 should be moved slightly to maximize the clearance in the A and B/C beam channels. The calculated distance to move the A line was checked on the A171 flag.

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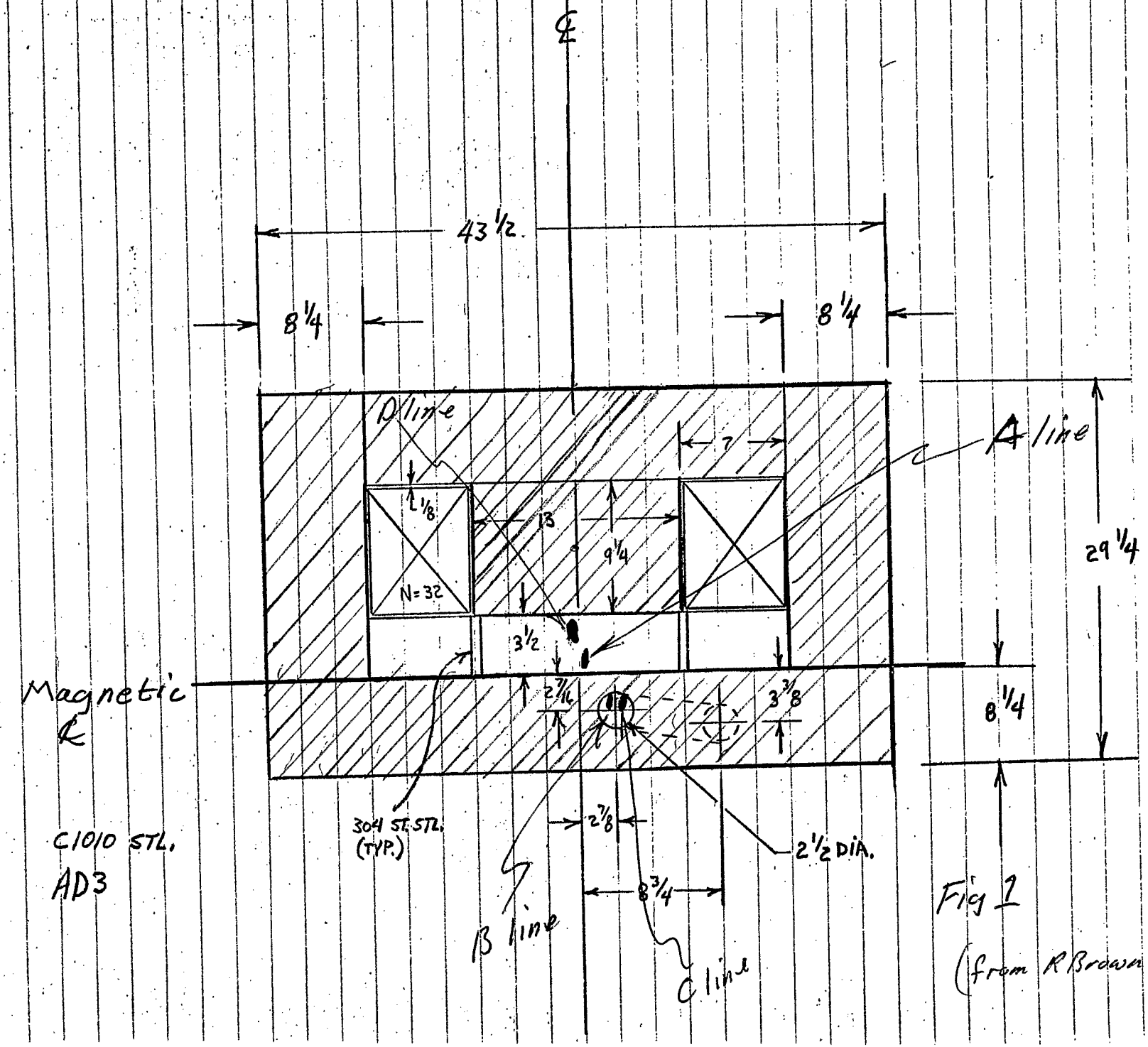

Fig 1

(from R Brown)