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A PROPOSAL FOR A NEW TYPE BENDING MAGNET FOR USE IN NAL EXPERIMENTAL AREAS

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At the high fields available with superconducting materials the support of the long narrow coils which will be needed in NAL bending magnets becomes a problem. In addition because of the saturation of iron,considerable coil shaping must be done to attain uniform fields. I suggest here a configuration which eliminates both of these problems.

Let us take a long circular solenoid skewed at an angle θ as shown in Fig. 1. On analysis of the field pattern it is found that the field inside such a configuration is completely uniform and makes an angle of $\theta/2$ with the Z axis. The magnitude of the Z component of the magnetic field is the same as that of an unskewed solenoid with the same current and turn spacing in the Z' direction.

If we now send a beam of particles through along the skewed axis, they will be bent perpendicular to the plane of the paper. (Of course they will follow a helical path around B but for the small angles used in bending magnets we may neglect the small helical component.) The amount of bending will depend on the component of B perpendicular to the particle path. Thus the effective bending will be B sin $\theta/2$. If, for example, the skew angle were 70° the effective bending would be 58% of that for a magnet of similar strength in the usual configuration with beam perpendicular to the field.

This lower effective bending is more than compensated for by four factors:

1. The field is completely uniform, dependent of course on close enough coil spacing and a solenoid a number of times the diameter in length.

2. The field volume is used very effectively. The aperture viewed along the beam line is elliptical with the long axis of the ellipse in the direction of bend. For 70° skew, for example, the aperture for 3-in. diameter rings would be 3 in. in the direction of bend and about 1 in. perpendicular to this direction.

3. Since the field is uniform the force due to the B_Z component acts uniformly azimuthally around the ring and this acts to preserve the circular geometry. The B_x component effectively creates a torque trying to turn the individual coils to make an unskewed solenoid. The simplicity of the stress pattern should allow higher practical field limits than are attainable with ordinary bending-magnet configuration.

4. The configuration lends itself very well to being made in modules which can then be stacked to provide any desired bending. This could add greatly to the flexibility of setting up beams and minimize the variety of magnets of different lengths which would otherwise be needed.

It is still necessary to study end effects and stress patterns carefully, however, the idea already looks promising enough that serious thought should be given to starting construction of a model to work out mechanical details.

A more detailed analysis is in progress of fields outside the solenoid to arrive at iron configurations for the return yoke which will not distort the internal field. Preliminary indications are that the field falls very rapidly outside the coil.

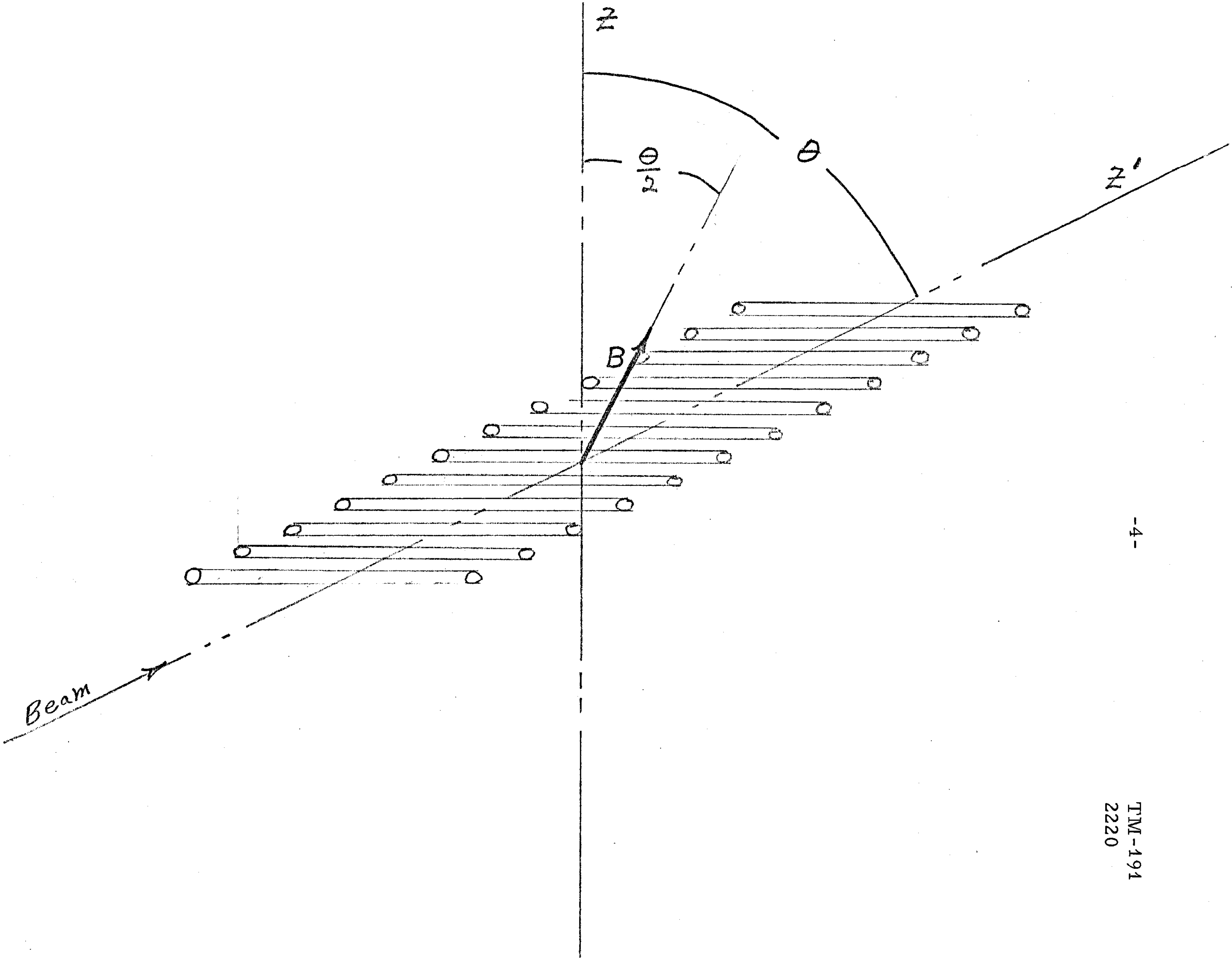

Fig. 1