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MAGNETIC INFLECTOR FOR 200 MeV INJECTION,.

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AGS DIVISION TECHNICAL NOTE

No. 45

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MAGNETIC INFLECTOR FOR 200 MeV INJECTION

A memorandum dated September 22, 1967 from John Claus to A. van Steenbergen suggested the possibility of a magnetic inflector for 200 MeV injection into the AGS. He stated the requirements for such an inflector, and suggested the desirability of two dimensional stackings.

This note is the first preliminary look at the feasibility of designing a magnetic inflector in such a configuration that the vertical stacking, as well as horizontal stacking, can be achieved.

A number of consultation meetings were held between J. Claus, J. Grisoli, E.B. Forsyth and the writer since November, 1967.

The preliminary requirements were given as follows:

1. Total inflector bend angle at 200 MeV = 200 mrad
2. Septum thickness at exit end = 0.5 mm
3. Septum aperture height = 3 cm
4. One magnetic pole piece thickness for vertical stacking = 5 mm
5. Flat top 1 ms

In view of the large change of direction required on this inflector, we have approached this problem by finding a reasonable combination of magnet segments so that the requirements could be fulfilled.

From conversations with J. Claus for 200 MeV protons

$$\alpha = \frac{BL}{2.15}$$

Where α = change of direction in radians

B = magnetic field strength in Tesla

L = magnet length in meters

Due to the extremely thin septum requirement at the exit end of the inflector, the least amount of bend angle is assigned to the third magnet segment, in order to minimize the severity of both thermal and deflection problems.

With α_3 = 10 milliradians

L_3 = .61 meters (24")

$$B_3 = \frac{2.15\alpha_3}{L_3} = \frac{.01 \times 2.15}{.61} = .0352 \text{ Tesla} = 352 \text{ gauss}$$

$$B = \frac{.4\pi\, NI}{\ell}$$

where

N = number of turns of the coil

ℓ = aperture height in cm

I = exciting current in amps

Hence

$$I_3 = \frac{B_3\ \ell_3}{.4\pi} = \frac{352 \times 3}{.4\pi} = 845 \text{ amps}$$

Peak force on the thin septum due to the magnetic field will be .17 pounds per linear inch and the deflection will be 3.25×10^{-4} inches.

We have chosen the steel length of the second magnet segment and first magnet segment to be 32 inches and 24 inches respectively.

$$\alpha_2 + \alpha_3 = (.200 - .01) \text{ radian}$$

$$\frac{B_2 \times .812}{2.15} + \frac{B_1 \times .61}{2.15} = .19$$

Let

$I_1 = I_2$

$\ell_1 = \ell_2$

$N_1 = 2N_2$

Then

$B_1 = 2B_2$

Therefore,

$$\frac{B_2 \times .812}{2.15} + \frac{B_2 \times 1.22}{2.15} = .19$$

$B_2 = 2$ kg

$B_1 = 4$ kg

$I_1 = I_2 = 4800$ amps

$\alpha_2 = 76$ milliradian

$\alpha_1 = 114$ milliradian

A shunt will be required in parallel with the third magnet segment for bypassing the excessive current of 3955 amperes.

The width of the magnet aperture can be optimized by having three magnet segments arranged as in Fig. 1.

Iron-nickel steel such as Allegheny-Ludlum's 4750 is considered to be the lamination material for the third magnet segment in order to minimize the reluctance in the magnet core. However, the electrical grade steel such as M-19 would be sufficient for the first and second magnet segments. Dry stacking of the laminated core seems to be feasible, therefore, the organic adhesive material would be excluded from the core assemblies.

Average heat dissipation of these magnet segments is rather low. The magnet coils can be kept cool with a pressure drop of 35 psi.

The total voltage across the magnet will be under 40V. A non-organic type insulating material can readily be obtained.

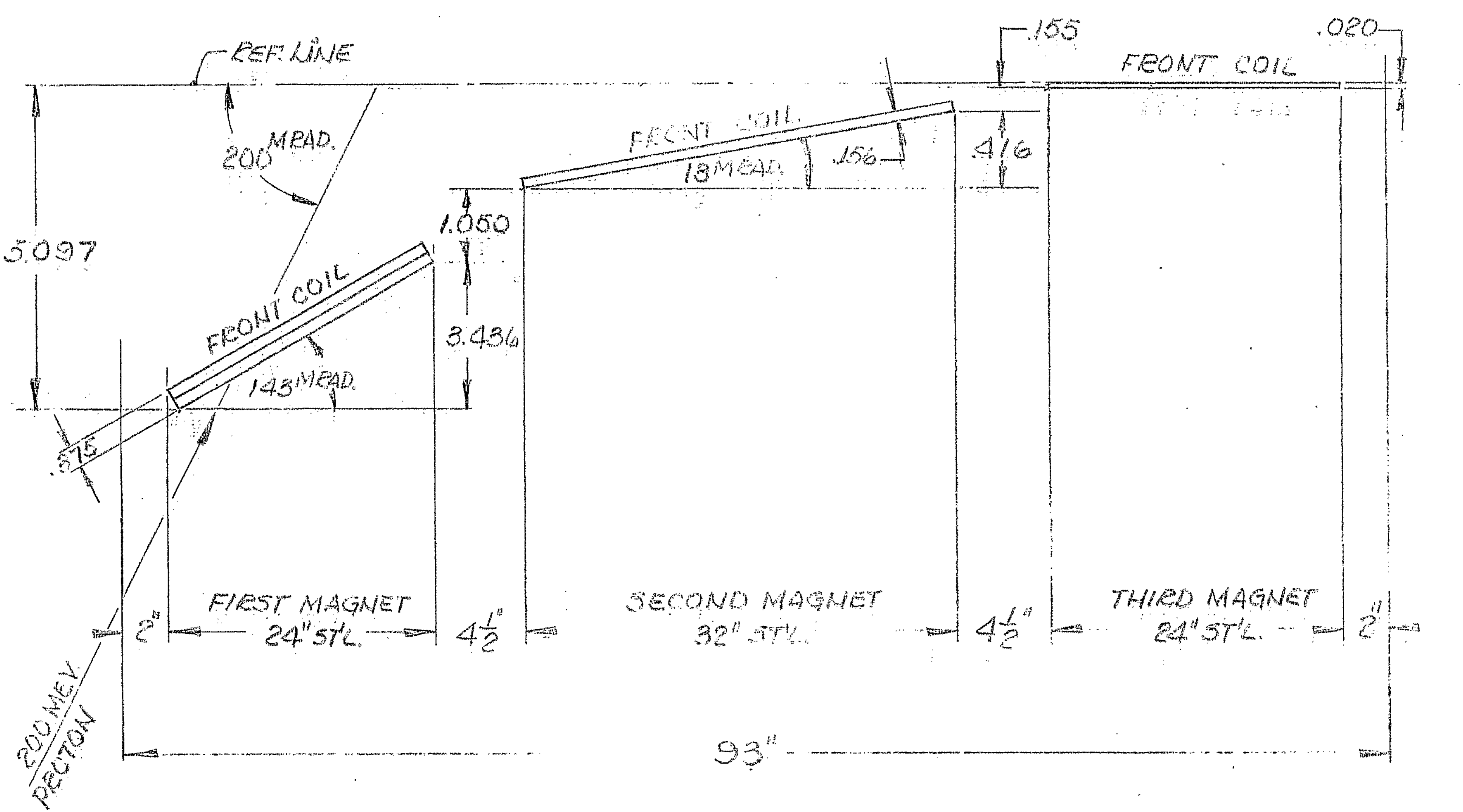
The cross section of the individual magnet segments is shown in Fig. 2 to Fig. 4.

Conclusions:

1. It is possible to fabricate a magnetic inflector for 200 MeV protons stacking in the horizontal plane with our present technology.

2. With some development time it seems feasible to design an inflector for both vertical and horizontal stacking.

FIG. 1 ARRANGEMENT OF MAGNET SEGMENTS



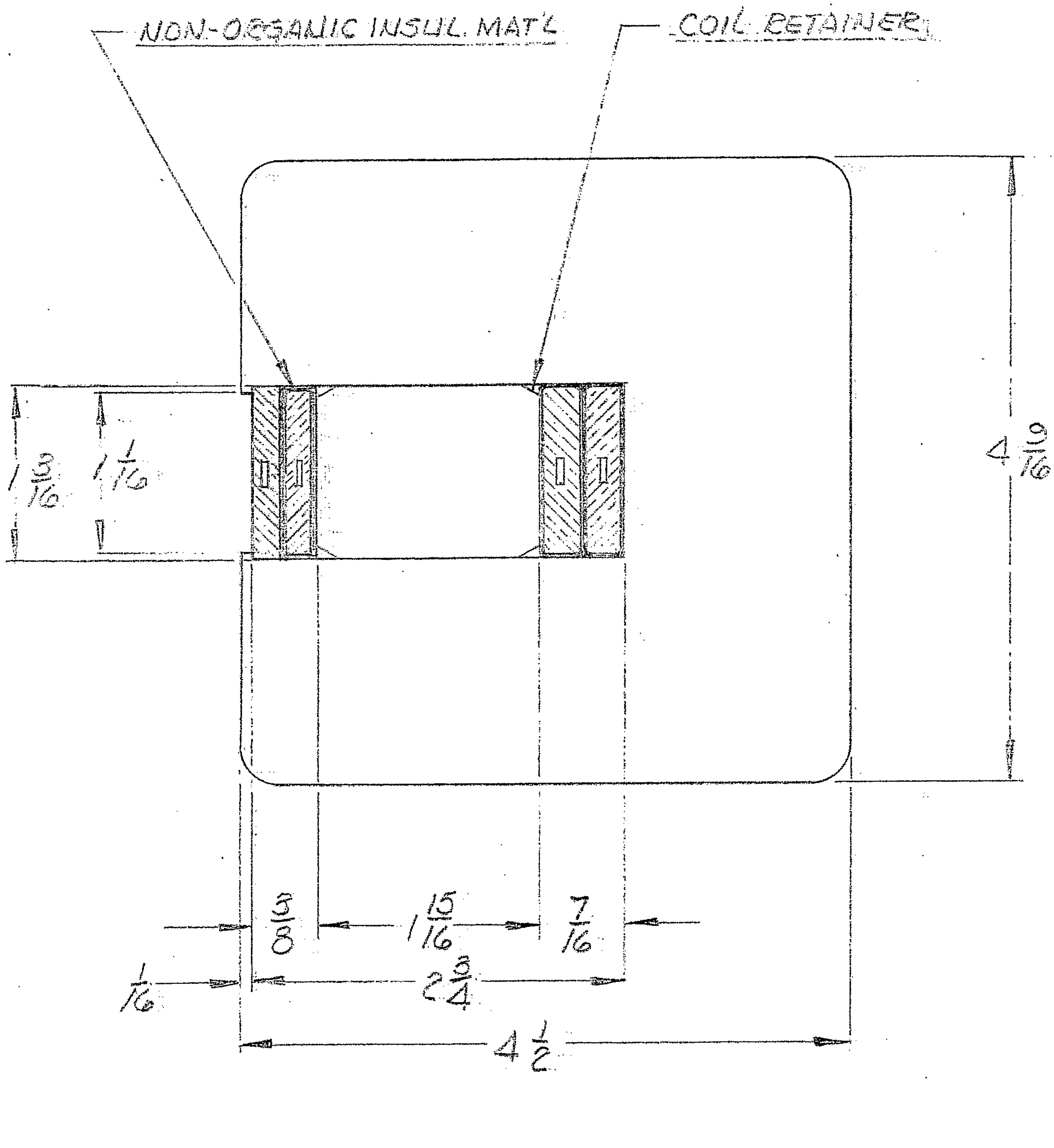


FIG. 2 FIRST MAGNET SEGMENT

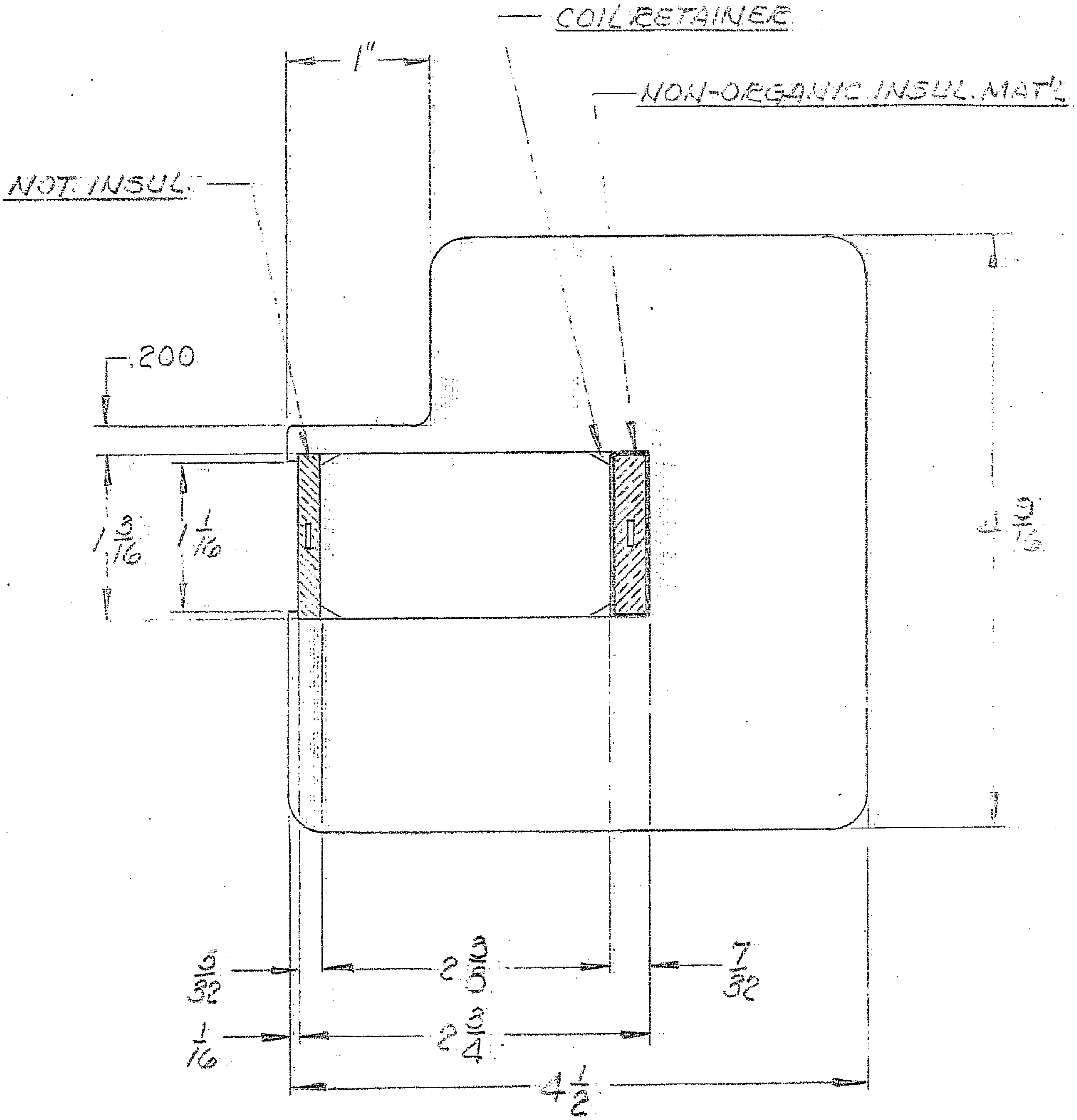


FIG. 3 SECOND MAGNET SEGMENT

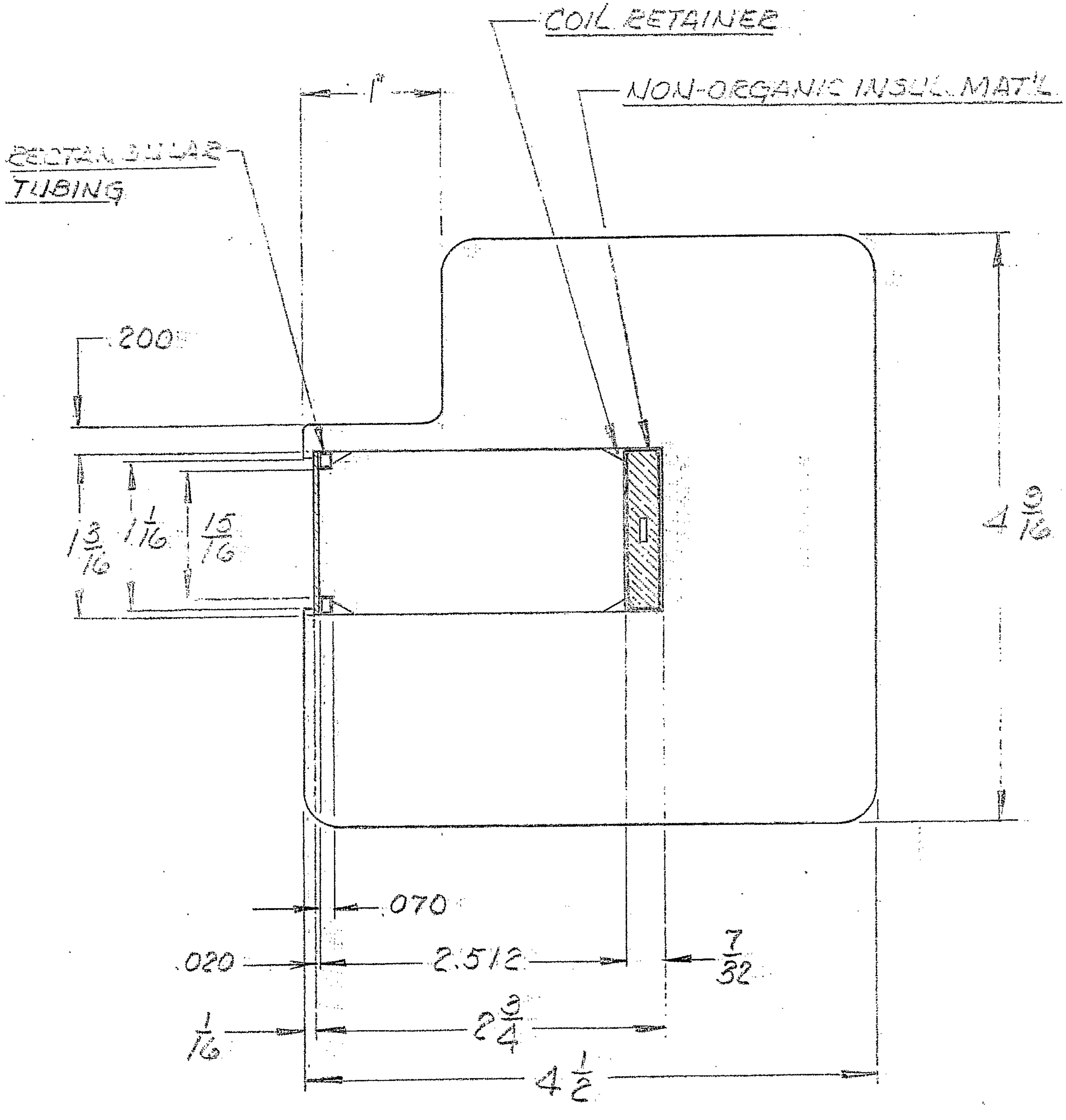


FIG. 4 THIRD MAGNET SEGMENT

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