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TEMPERATURE STABILIZATION AND SUPPORT OF THE RF DRIVE LINES

This note gives a description of the possible methods of obtaining proper temperature stabilization and support for the rf drive lines of the two-mile linear electron accelerator.

I. Temperature Stabilization:

Early in 1962, a standard rigid coaxial line ($1\frac{5}{8}$ or $3\frac{1}{8}$ inch diameter)was tentatively adopted for the rf main and subdrive lines. This choice assumed that expansions and contractions due to temperature changes of the main drive line would be absorbed by suitable expansion joints. These expansion joints were to be located every 333 feet, i.e. one per sector, and possibly even more frequently if required.

To eliminate or at least to reduce the expansion problem, it has been decided that the main and subdrive lines will be insulated as a group with the ignitron temperature control water which will be regulated to $97 \pm 0.5^{\circ}$F. The total expansion of the 10,000 feet length of copper for a 1°C change is 2.05 inches. However, with this temperature control, it is unlikely that all sectors will vary in concert; hence, the total shift might only be of the order of $\pm \frac{1}{4}$ inch to $\pm \frac{1}{2}$ inch. In spite of this smaller anticipated motion, the system should be capable of the total maximum expansion (or contraction) without damage to any of its elements. For this reason and other reasons discussed below, it does not appear conservative to eliminate the expansion joints, even in the presence of the above temperature stabilization.

The expansion sections would:

1. Provide for expansion and contraction during construction without damage to the hangers, coaxial line, etc.
2. Provide for minor expansions or contractions due to imperfect insulation or control water temperature variation.
3. Provide for expansion or contraction in the event a sector ignitron water system should fail or needed to be shut down.
4. Provide for building or site movements on a seasonal basis during the life of the accelerator.
5. Provide a means for repair, removal, or insertion of couplers or other

components without including an additional "breakaway" section (typical $1\frac{5}{8}$ or $3\frac{1}{8}$ inch line has to be assembled sequentially or a breakaway (compressible section) has to be included.)

Temperature stabilization, as proposed, will be obtained by clustering the main and subdrive lines and the ignitron temperature control water line together into the smallest cross-section practical. Insulation could be of the preformed type or the "foamed" in place type. Either method should be satisfactory. The cost of installation and repairs will probably dictate what type is to be used.

The proposed temperature stabilization method appears to be the most logical and economical and will cost the least to obtain.

The following benefits will be obtained using this method:

1. Expansions or contractions of the line will be minimized and thus phase changes will be minimized.
2. The phase change contribution of the expansion joint will be minimized.
3. By sharing hangers, costs may be reduced.
4. Drive lines and ignitron water systems can share insulation costs (assuming insulation was required for effective ignitron water temperature control).
5. Phase changes due to ambient temperature changes will be minimized.

Group insulation as proposed has disadvantages, some of which are listed below:

1. Additional installation costs of clustering and insulating.
2. Additional cost of insulating material.
3. Possible extra cost of rerouting of ignitron waterpipes.
4. Increased costs for repairs and changes in going to Stage II.

II. Support Considerations:

The klystron gallery will be exposed to a wide range of temperatures and will expand and contract accordingly. Therefore, it will be necessary to isolate the drive lines from the gallery by means of movable hangers or trapezes. To maintain the desirable physical relationship between the accelerator pipe and the main and/or subdrive lines, it will be necessary to anchor them to the ground at the beginning of each 333 foot sector. The main drive line should be anchored at the sector coupling point and the subdrive lines should be anchored near the sub-booster tube. Thus, both lines should be anchored at the same place.

To preserve the proper phase relationships, the geometrical configuration formed by the drive lines, the accelerator pipe and the rf feed lines should be a parallelogram and if possible a rectangle.

Figure 1 illustrates this point: It shows how the phase of the drive signals $(\varphi_1$ and $\varphi_2)$ can change as a function of expansion or contraction with respect to the electrons in the accelerator pipe. Tolerable motions are those which would cause both the drive line and accelerator pipe to expand or contract by the same amount; hence, the side of the parallelogram would remain parallel to its original position during and after the motion, regardless of the cause.

Assuming that for small flexures, the flexible coaxial cables (coupler to klystron) produce no phase changes, small motions of the subdrive lines beyond the anchor point will produce no phase changes other than those caused by the relative expansions between anchor point and coupling point.

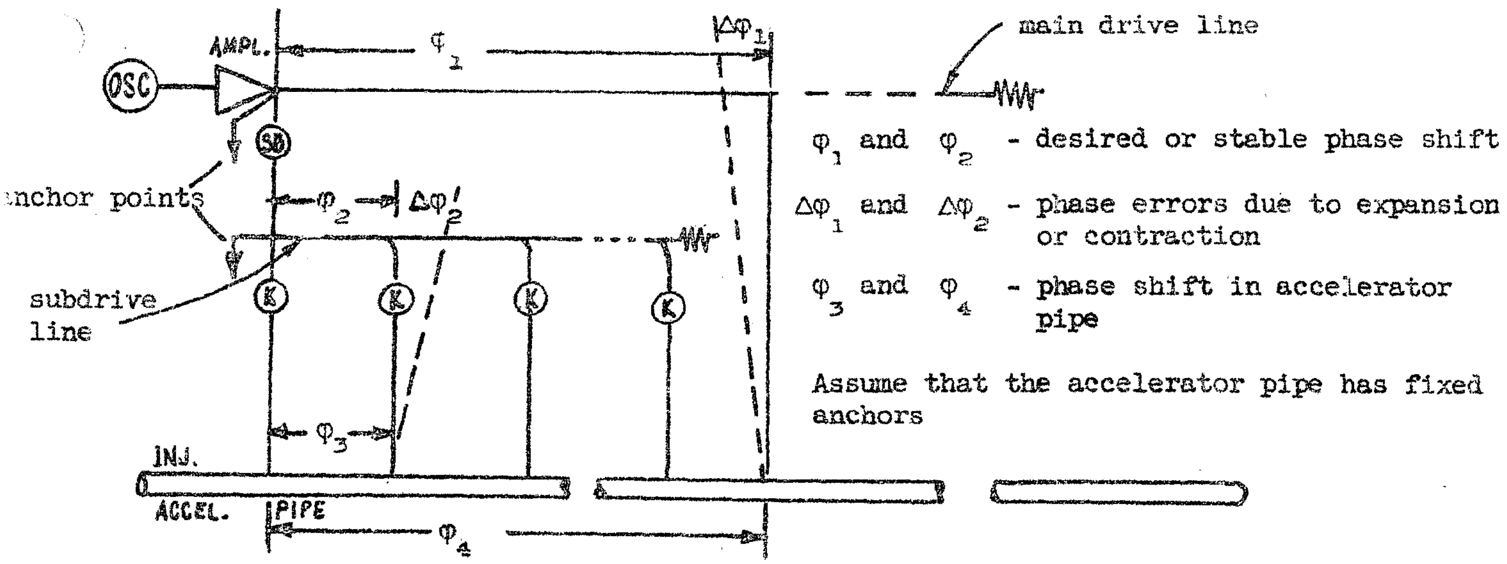

FIG. 1--Schematic drawing of drive system and accelerator pipe showing geometric and rf phase relationship between them.

If the concrete floor (ground) should move more than a tolerable amount, then the penetration tubes could be used. The penetration tubes are expected to be very stable and should only undergo seasonal or long term movements.

The gallery will only supply vertical and lateral support. The hangers should be flexible in the longitudinal direction so that in spite of longitudinal gallery motions, the drive lines will remain fixed relative to the accelerator pipe.

III. Summary:

Based on the above considerations, the present recommendations for the temperature stabilization and support of the drive lines are made:

1. Include suitable expansion sections in the main drive line.
2. Insulate as a group the drive lines and ignitron temperature control water pipe.
3. Anchor to the ground the main drive line at each coupling point (the beginning of each sector) together with the beginning of each sub-drive line.
4. Suspend the drive lines and ignitron water pipe on longitudinally flexible hangers or trapezes.