ETCHED SCANNING COILS

E.W. Bull.

Scanning coils for television type displays consist basically of two sets of coils at right angles to one another and surrounding the electron beam which they deflect. The shape of the deflecting field which is produced is dependent upon the positions and density of the current carrying conductors. This aspect of design will not be considered here, but it will be assumed that an ideal disposition of conductors is known. The problem is to translate the ideal disposition into a practical coil with a high degree of precision.

The fact that scanning coils both in the camera and receiver may be of the order of 3 cm in diameter, whereas the picture viewed may be of 60 cm in diameter, gives some indication of the precision required in the coils simply to produce adequate geometry. For colour television, however, the requirements are much more stringent since several rasters have to be superimposed and misregistration also produces a loss of resolution, to which the eye is far more sensitive than a geometrical error.

Wire Wound Coils The conventional wire wound scanning coil has for each coordinate of deflection a minimum of two coils, one on each side of the tube neck. These coils are in effect pile wound so that the finishing size is dependent upon wire size and winding tension tolerances. The variation can be reduced to some extent by subdivision of the coil into smaller sections. When a pair of coils or coil sets has been made, they have to be assembled parallel to one another on either side of the axis of a central supporting tube. This is a critical adjustment in the assembly procedure, and as there are no valid mechanical reference points on the coils, they are best positioned by adjusting each coil in turn to have no mutual coupling to a test coil which is temporarily inserted in the bore of the centre tube. If the scanning coils for both coordinates are mounted on separate tubes, one of which slides over the other then they can be rotated until no mutual coupling exists. This procedure is lengthy and relies upon the skill of the operator to ensure that individual coils are not skew to the axis, or displaced relatively along the axis.

Etched Coils The development of printed circuit techniques and their extension to the use of flexible laminates suggested a method of placing conductors in precise positions. The conventional method of winding the conductor in a spiral form was found to be unsuitable for etched coils, due to the comparatively small number of turns in each layer, and the resulting skew field of the layer interconnections. A system of

E.W. Bull is with the Research Laboratories of E.M.I. Ltd.,
Hayes, Middlesex.

square wave windings superimposed in alternate phase was found to overcome the objections to the spiral form. The layout of conductors is shown in Fig. 1, only four conductors are drawn for simplicity, but normally up to twenty may be used.

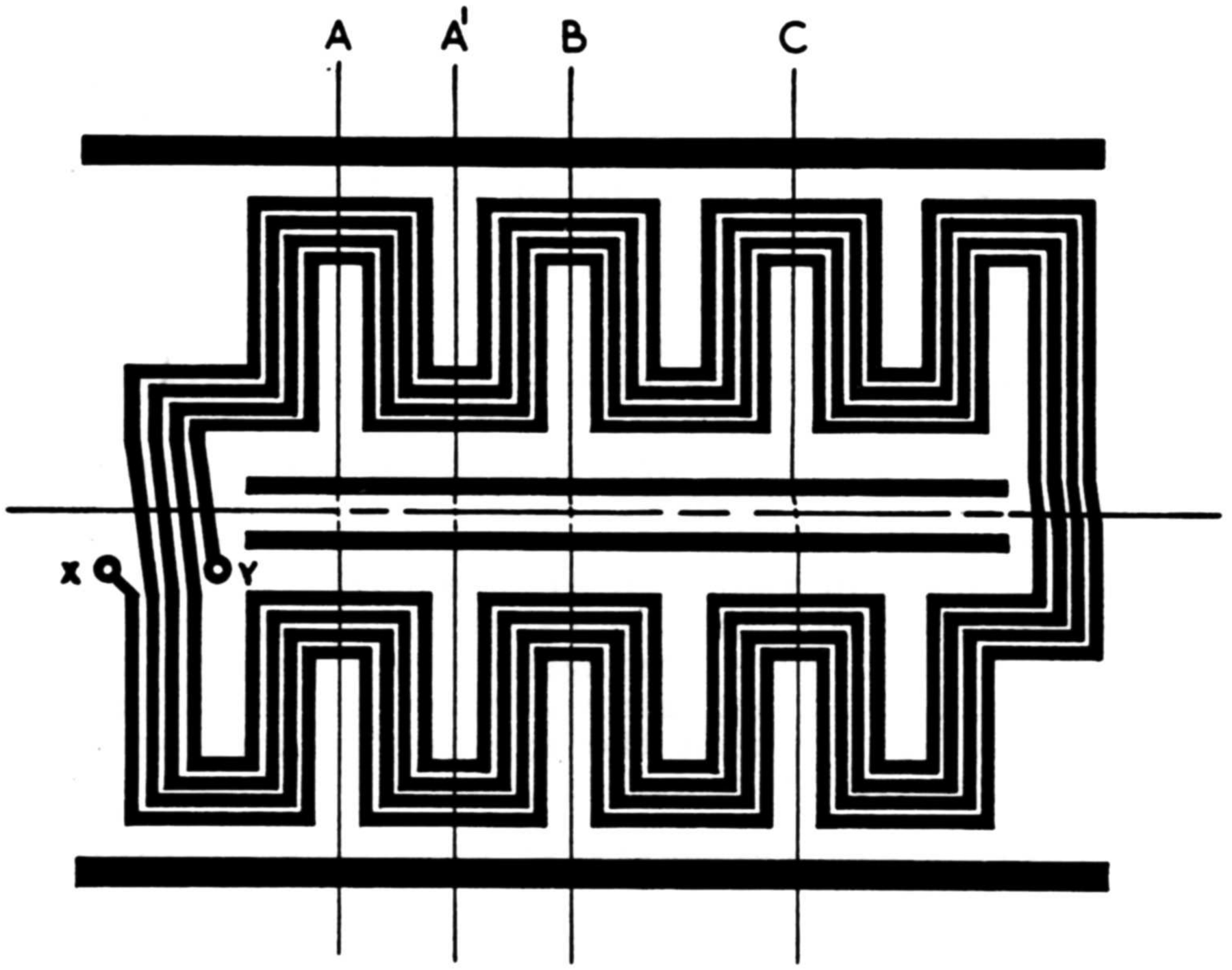


FIG. 1

A strip of flexible insulating material about 25 μM thick bonded to copper of about 37 μM or 75 μM is the basic material used. The unwanted copper is etched away according to a 'Master' transparency leaving only the desired conductor form. The strip shown in Fig. 1 is folded in half lengthwise so that the square waves are superimposed. The strip is then wound on a cylindrical former of such diameter that the lines A. B. C. etc. are superimposed, and when current is fed into points X and Y a field is produced in the direction A A'.

As each cycle of the conductor pattern is wound at a different diameter, due to the spiral form, the longitudinal scale of each cycle is made proportional to its winding diameter in order to preserve angular registration. To obtain accurate registration during winding, four copper strips (Fig. 1) alongside the coils are etched with suitable registration marks, and these are subsequently punched to form circular holes. The winding mandrel is fitted with four radial pins which engage in the punched holes and position each turn. During the winding process a strip of flexible insulating material is interleaved to prevent contact between adjacent turns. It is usual to include coils for both coordinates of deflection and a series of electrostatic screens on the same strip, so that the whole system is wound in a single operation. The completed coils are subsequently vacuum im-

pregnated with an epoxy resin. Several types of coil have been made using etched laminates and these all show a very high order of accuracy. The residual errors are usually less than those due to misalignment and other effects in the camera tube. Etched coils tend to have a higher self capacity than the wire wound type due to the strip like form of the conductor. The capacity can be reduced by staggering the conductors in alternate layers of winding. The symmetrical form of the winding reduces a tendency to split up and resonate in individual sections. The first 'harmonic' resonance which has been observed is at about seven times the basic resonant frequency.

Examples of Etched Coils

(1) Coil Assembly for 4 Plumbicon Colour Cameras

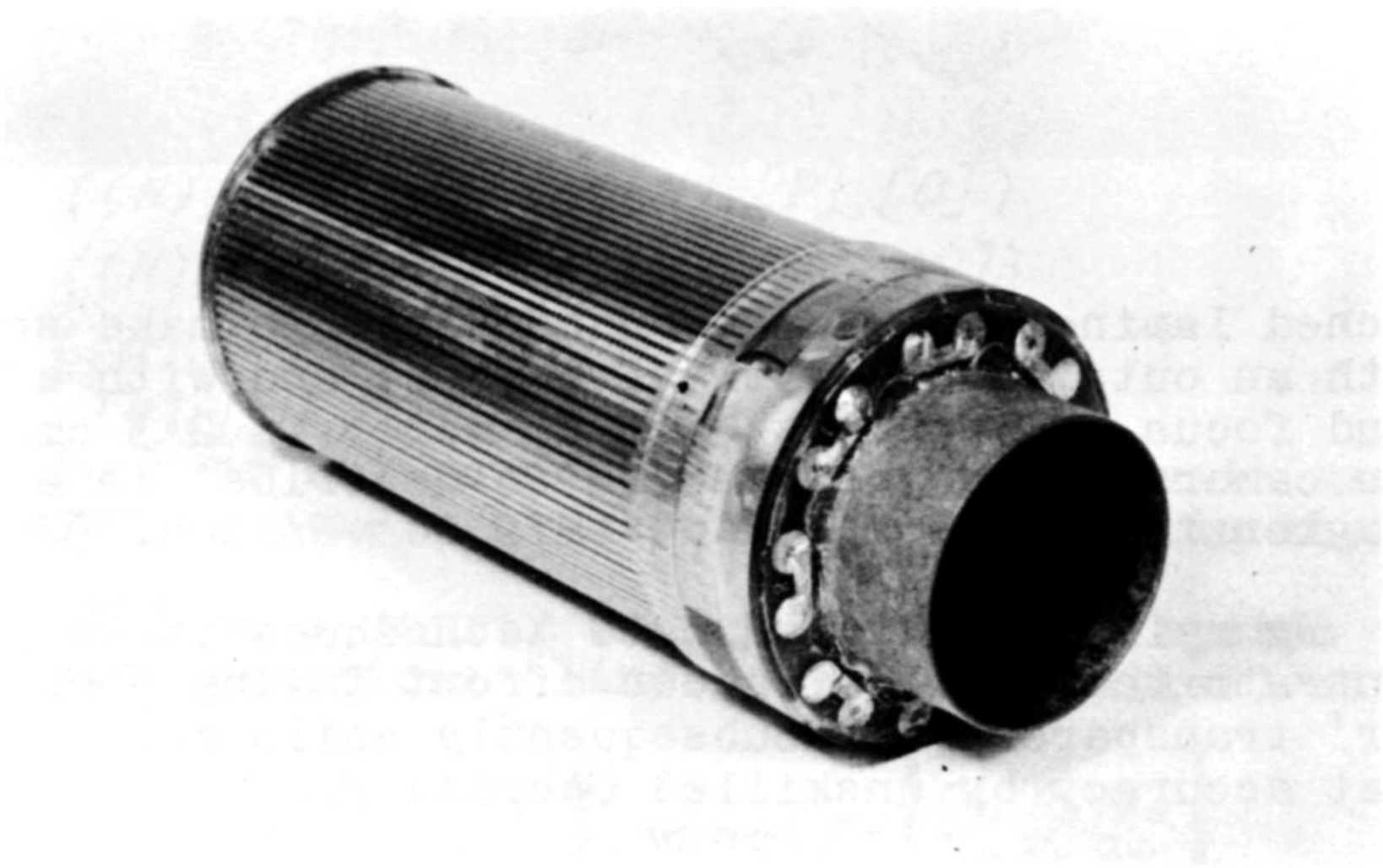


FIG. 2

A coil assembly using etched scanning coils and wire wound focusing and alignment coils has been produced for use in a colour camera. The coil inductances, resistances and sensitivities are practically identical with a wire wound alternative. The accuracy and consistency are very high, and no selection of individual coils is made to produce a set of four for a camera. The coils are checked for performance by an inductance bridge measurement. The mutual inductance between line and frame coils is the most important test, and is a real indication of field accuracy in this type of coil although it has little meaning for a wire wound coil. The maximum coupling is less than five parts in a thousand and about half of this is contributed by small irregularities in the Radiometal wire wound round the coils for a flux return path. An elaborate system of electrostatic screens enables the coils to be used with very low signal levels in the camera.

(2) Scanning Coils for a Miniature Camera To make effective use of the 1·27 cm Vidicon the deflecting and focus-

ing systems should be of minimum size.

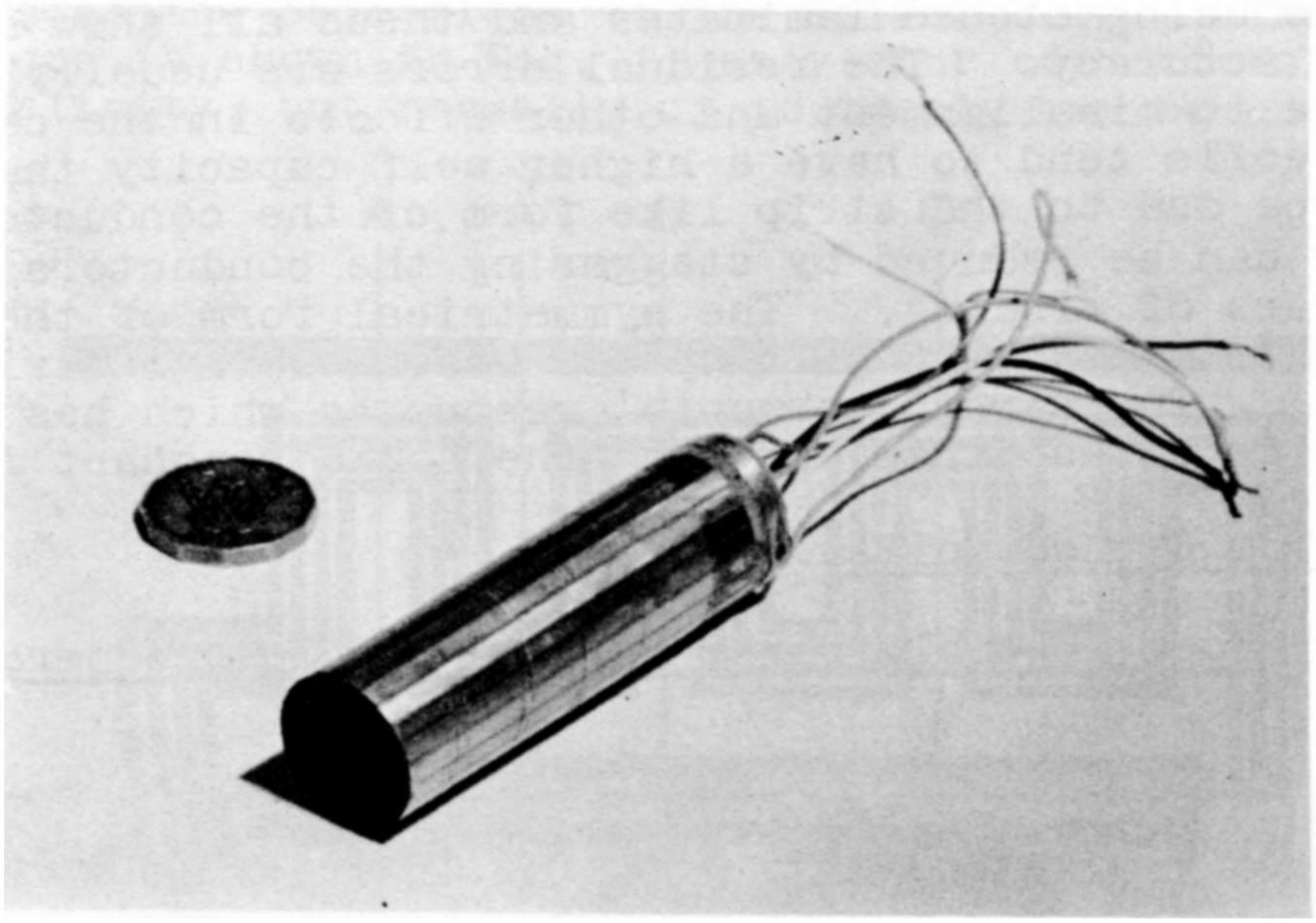


FIG. 3

Using etched laminate it has been possible to make scanning coils with an outside diameter of 1·9 cm, and with a suitable wire wound focus coil the overall diameter is 2·3 cm. The miniature camera using these coils is described in a paper by Mr. J. Taylor to be presented at this Convention.

Summary By using etched laminate techniques it is possible to concentrate the skilled labour effort in the production of a 'Master' transparency. Subsequently coils can be produced with great accuracy by unskilled operators.

Acknowledgements The development of these etched coils is due to the combined efforts of a team under Mr. G.C. Newton which has prepared the accurate 'Masters' and converted them to etched laminates, and my own team under Mr. A.M. Sampeys which has prepared the designs and converted the laminate into coil systems.

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