(7) Amplitude 'bursts'—but without previous heterodyne whistles—have been noted on amateur radio transmissions at frequencies of 60 Mc./s. The bursts on this higher frequency appear to be of shorter duration, possibly with greater amplitude change, than those experienced in the lower frequency bands. Although difficult to record on account of the short duration, the increase in signal-level seems often to reach 35 db. (that is, 56 : 1 ratio).

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[1] Chamanlal and Venkataraman, *Nature*, **149**, 416 (1942); summary of article in *Electrotechnics* (Bangalore, Nov. 1941).
[2] Appleton, Sir Edward, and Naismith, R., *Proc. Phys. Soc.*, **59**, 461 (1947).

Open-Hearth Furnace Models

LARGE-SCALE trials recently carried out on open-hearth furnaces[1] emphasize the need for more fundamental knowledge of the flow of fuel, air and combustion products through the furnace chamber. To obtain such information by experimental work on a production furnace presents extreme difficulties due to the high working temperature and the necessity of avoiding interference with production. The problem of flow through such complex ducts having also proved too difficult to solve mathematically, it was decided to use a model technique. Models of open-hearth furnaces with differing port designs were therefore made in 'Perspex' on a 1/24 linear scale.

Both fuel gas and air are represented in the model by water. The two flows ('air' and 'gas') to the model are separately metered and can be controlled so that the Reynolds numbers at the incoming ports are equal to the corresponding Reynolds numbers on the actual furnace. The partition of 'waste gases' between outgoing gas and air ports can be similarly controlled by adjusting valves. Flow through the model has been studied in three dimensions using a variety of methods. At present use is made of fine aluminium particles suspended in the water, and illuminated in any desired direction by means of an

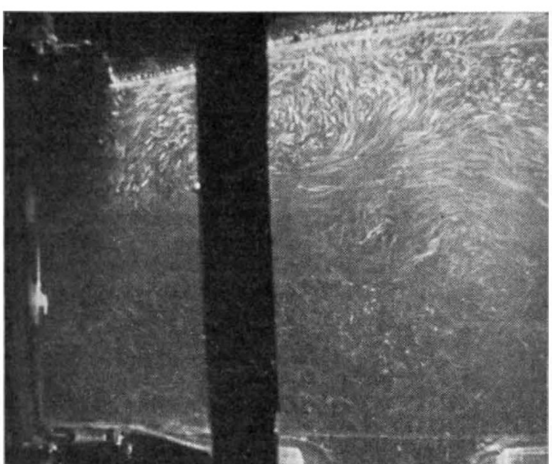
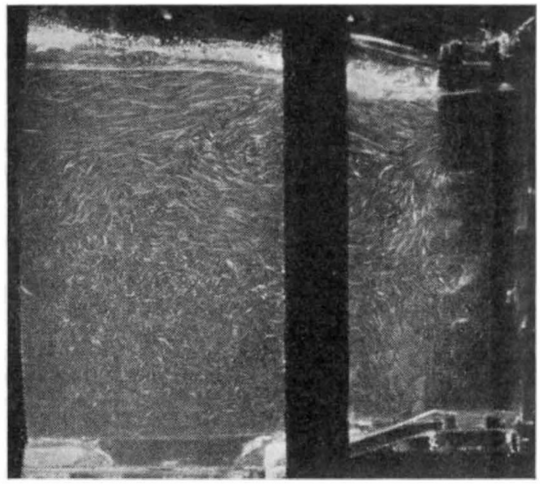


Fig. 1



intense sheet of light. By suitably compounding the two-dimensional patterns thus obtained, a three-dimensional pattern of flow throughout the furnace can be built up. The patterns are recorded photographically, the light source being either (*a*) an over-run 2 kW. line filament lamp; or (*b*) a specially designed Mullard discharge tube, the duration of flash from which is adjustable.

The work is still at an early stage; but preliminary conclusions with a model of a Maerz open-hearth furnace show:

(1) At the incoming end of the furnace a major vortex is produced on either side of the incoming gas stream over a wide range of flow (Fig. 1). The vortices are asymmetrical and are actually three-dimensional in character.

(2) In the centre of the furnace there is a region of instability in which the particles are moving in all directions.

(3) Near the outgoing end of the furnace, the flow tends to align itself before entering the outgoing ports (Fig. 2) and is particularly rapid along the back-wall.

The general eccentricity of flow is also apparent from a study of the photographs. In particular, Fig. 1 shows that the incoming gas stream is deflected towards the furnace back-wall, although the centre-line of the gas ports is parallel to the centre-line of the furnace. This is of practical interest as it is normal for the line of the gas port on a furnace to be inclined towards the front-wall at an angle of about 3° to the centre-line, in order to counteract the tendency for the flame to be diverted towards the back-wall. The need for this correction has generally been ascribed to air inleakage through the doors, whereas it would appear to be desirable purely because of the asymmetrical furnace design.

It is of interest to note that a somewhat similar flow pattern has been found in the flame tubes of jet engines[2].

A report giving detailed results of the present work will be published elsewhere.

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[1] Iron and Steel Institute Special Report No. 37.
[2] *J. Inst. Fuel*, **21**, No. 116, 1 (1947).