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The pulsed-wire anemometer

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Abstract. The principles and practice of pulsed-wire anemometry are reviewed. Flow velocity is deduced from the time taken for the thermal wake of a thin wire, heated by a short pulse of current, to reach a sensor wire operating as a resistance thermometer. The advantage over the hot-wire anemometer is that reversed flows can be measured by adding a second sensor wire on the "upstream" side of the pulsed wire: the main advantages over the laser Doppler anemometer are cheapness and simplicity of use. The pulsed-wire anemometer can now be regarded as a cost-effective instrument for measurements in turbulent separated flows.

1 Introduction

The pulsed-wire anemometer (PWA; Fig. 1) is an application of the general technique of measuring fluid velocity by timing the passage of a marked particle or fluid element between two points. A short-duration electric current is passed through a fine wire (the "pulsed wire"), producing a heat "tracer" which is convected by the fluid (usually air: the authors are not aware of any applications in liquids). A "sensor wire", operated as a resistance thermometer, is mounted perpendicular to the pulsed wire and a distance h (about 1–2 mm) downstream of it. The time taken for the tracer to reach the sensor (the "time of flight") is deduced from the sensor wire output (Fig. 2). The time of flight is proportional, to a first approximation, to the reciprocal of the component of velocity in the direction perpendicular to both wires. This simple response is modified by the effects of viscosity and thermal diffusion, but this is not a severe disadvantage: individual calibration of probes is needed anyway because the wire spacing cannot be set accurately.

The pulsed-wire principle was first reported by Bauer (1965), who used two parallel wires for measurements in laminar flow. The pulsed wire as a turbulence-measuring instrument is the result of independent developments by Tombach (1969) and by Bradbury (1969; see also Bradbury and Castro 1971). Electronic measurement of the time of flight, and evaluation of statistical results, are straightforward in principle using a microcomputer-based system: practical difficulties are discussed below.

The Bradbury-Castro type of probe (Fig. 1) consists of three wires. The central wire is the pulsed wire, and at a distance h on either side of this are the sensor wires, with their axes perpendicular to the pulsed wire but parallel to one another. This allows the velocity component perpendicular to both wire axes (the x-component of velocity in Fig. 1)

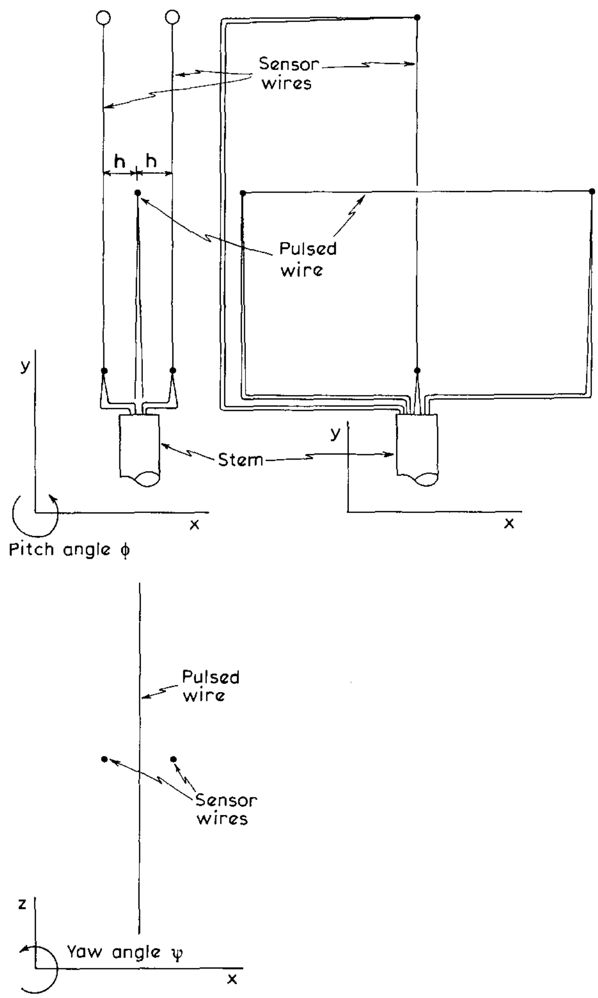

Fig. 1. Three-view drawing of typical pulsed wire probe