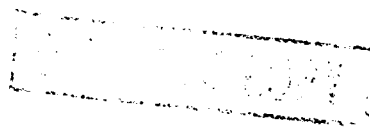


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CRANFIELD INSTITUTE OF TECHNOLOGY

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RADIAL INFLOW TURBINE STUDY

FOURTH INTERIM REPORT

by

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United States Army
EUROPEAN RESEARCH OFFICE OF THE US ARMY
London England

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<p>The radial inflow turbine is a primary component used both in small gas turbines and turbocargers. Better understanding of the flow processes occurring within the small passages of the machine could well result in the improved design of units. As most of the detailed aerodynamics is still ill-defined, a joint research project with the objective of improving our understanding has been instigated by Cranfield, the US Army and Turbomach (San Diego).</p> <p>This document gives the fourth report on the project. It describes the manufacture of the window arrangement, the preparation of seeding systems for the laser anemometer, assembly and trial of the anemometer.</p>			
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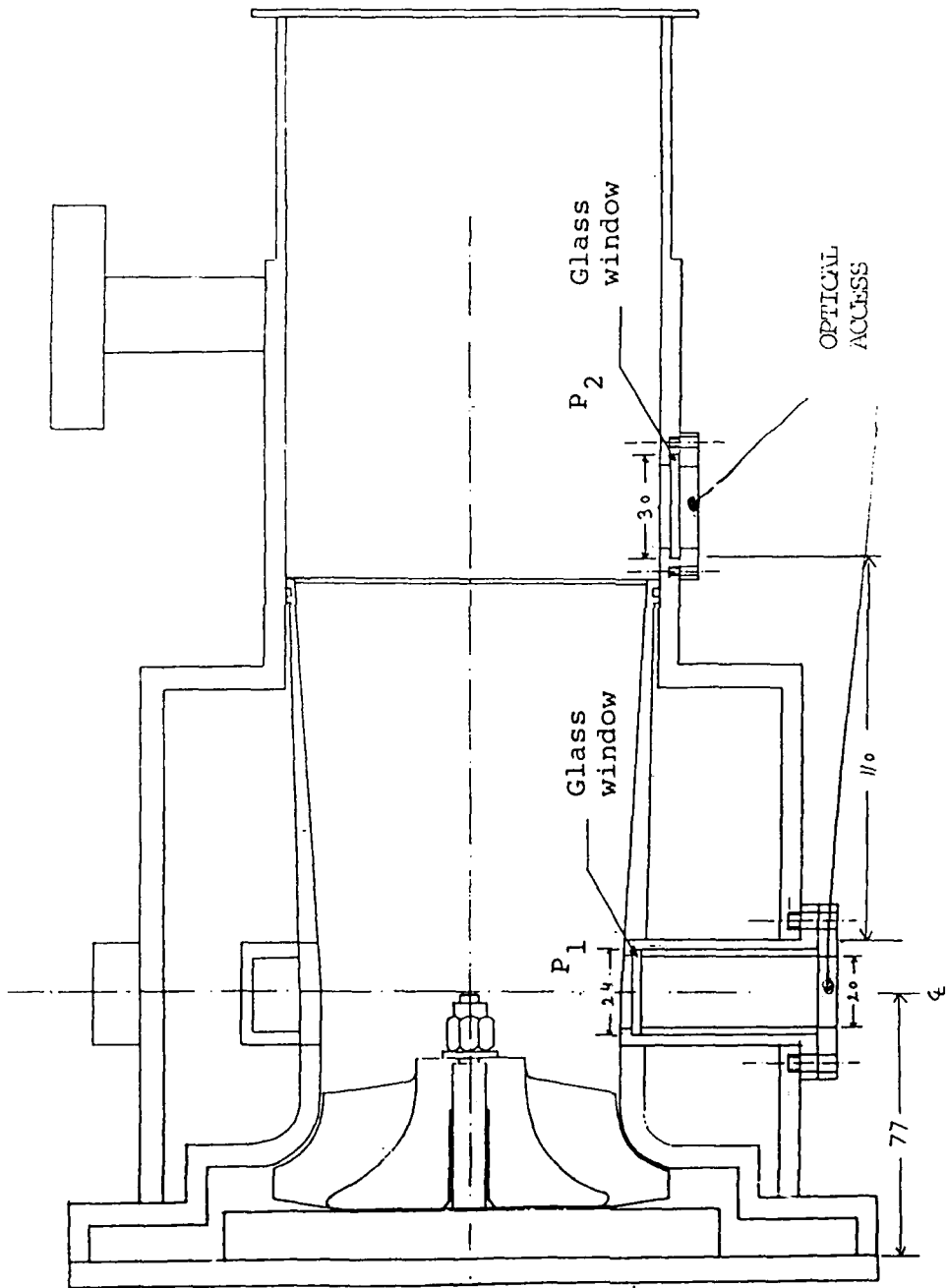
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During the period starting from July 1990, tasks have largely been concerned with the manufacturing modifications to the test assembly described in the previous report and shown in Figure 1. Operation of the rig has not been possible in this period as the test machine is being modified in our workshops.

The rig stand had previously been prepared which included the connection of the unit to the main plant air and the provision of an upstream combustor. It also included the installation of an ejector at the outlet of the turbine and associated instrumentation. Figure 2 is a diagram of the fully instrumented turbocharger in the test cell.

In addition to the preparatory work described in the first paragraph, work has also been undertaken on the development of a solid seeding device. A seeding device is required to 'seed' the flow with small particles which when passing through the measurement volume of the laser anemometer, scatter light which can be detected by the photodetectors. The particles involved must follow the flow and to achieve this they must be sub-micron. Devices for generating liquid seed particles have been in continual use over recent years but liquid 'seed' has temperature limitations associated with the properties of the liquids being used (a discussion of the problem is made in reference 1). Cold flow tests typically use kerosene or propane diol as liquid but these have severe temperature limitations. Following the advice of Dr A Boutier of ONERA, Cranfield has used silicon oil as a liquid for seeding at temperatures up to 250°C but this appears to be the limit for liquid seeding. Whilst sufficient for some studies in compressors and cold turbine tests, there is a severe limitation for turbine tests and solid seeding techniques have to be adopted. Solid seeding methods have received little attention and are considerably more difficult to use than the liquid variety. When dealing with sub-micron solid particles it is essential to avoid compaction and to avoid moisture since the substances often involved (e.g. titanium dioxide) are highly hygroscopic and quickly forms into aggregate lumps.

The method employed to generate these particles at Cranfield takes a dry air supply through a set of porous plates to a fluidised bed consisting of



FIG; 1 Optical window positions (P_1 , P_2) downstream the turbine rotor.

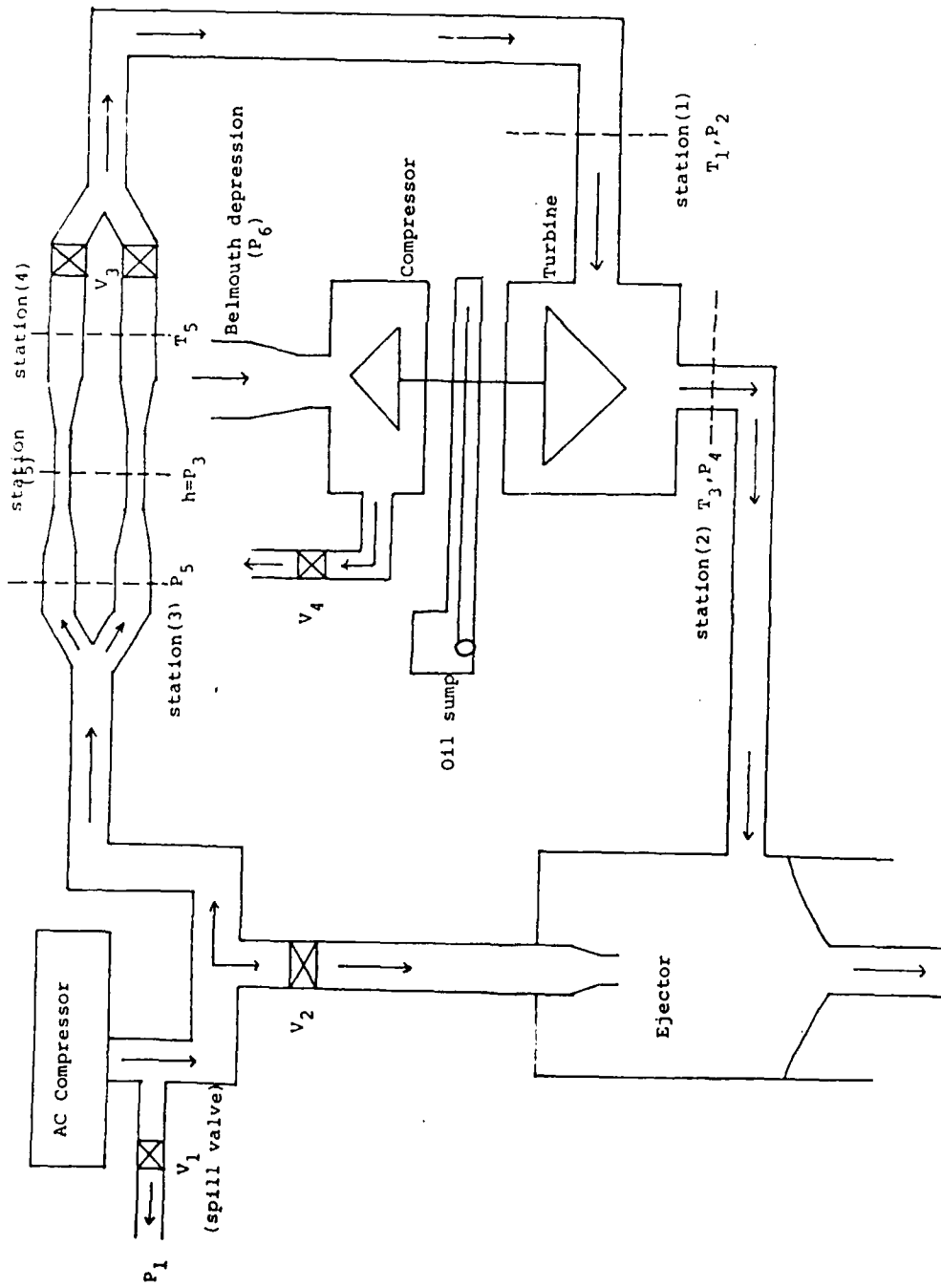
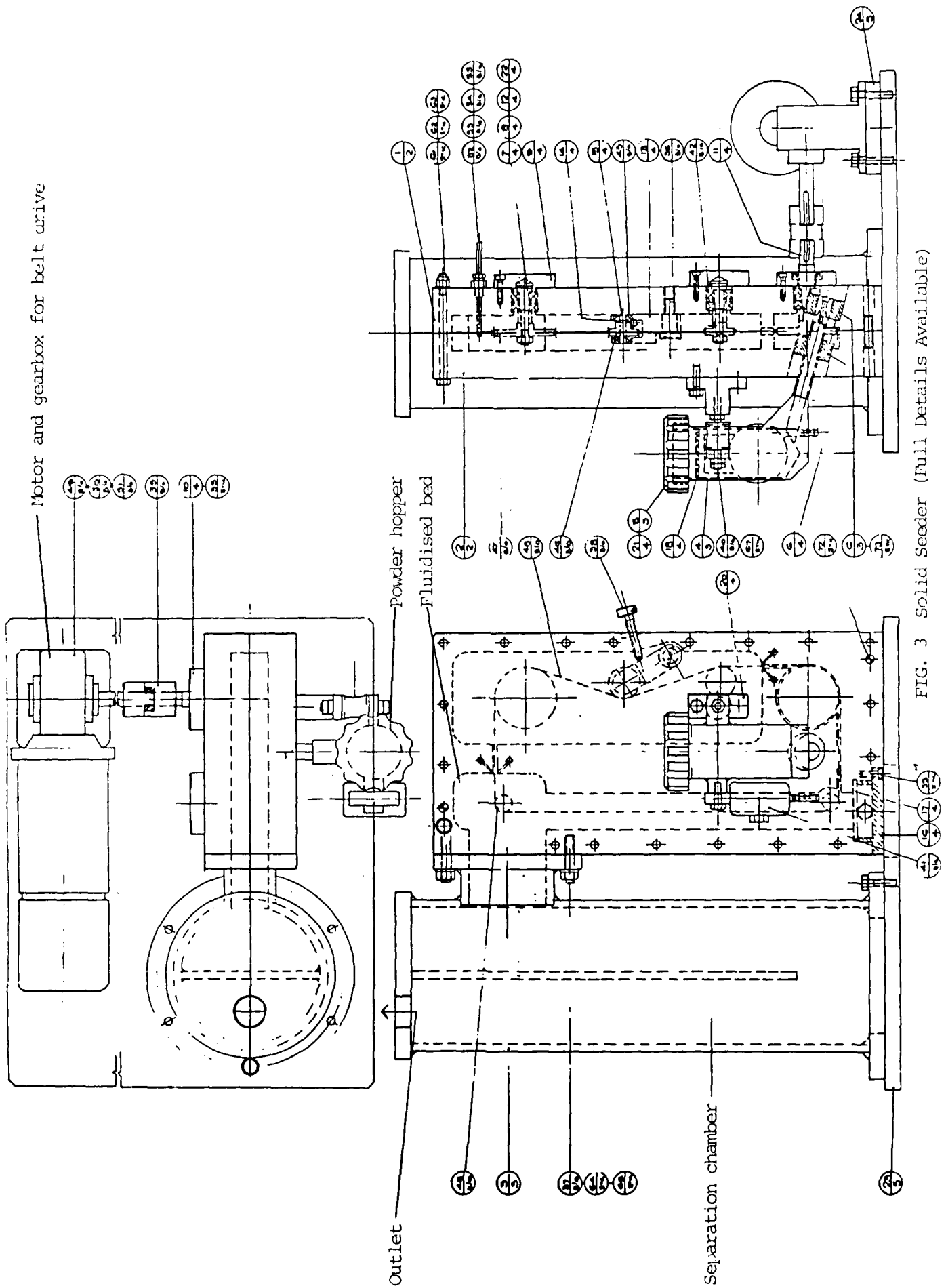


FIG. 2 Schematic diagram for rig installation.



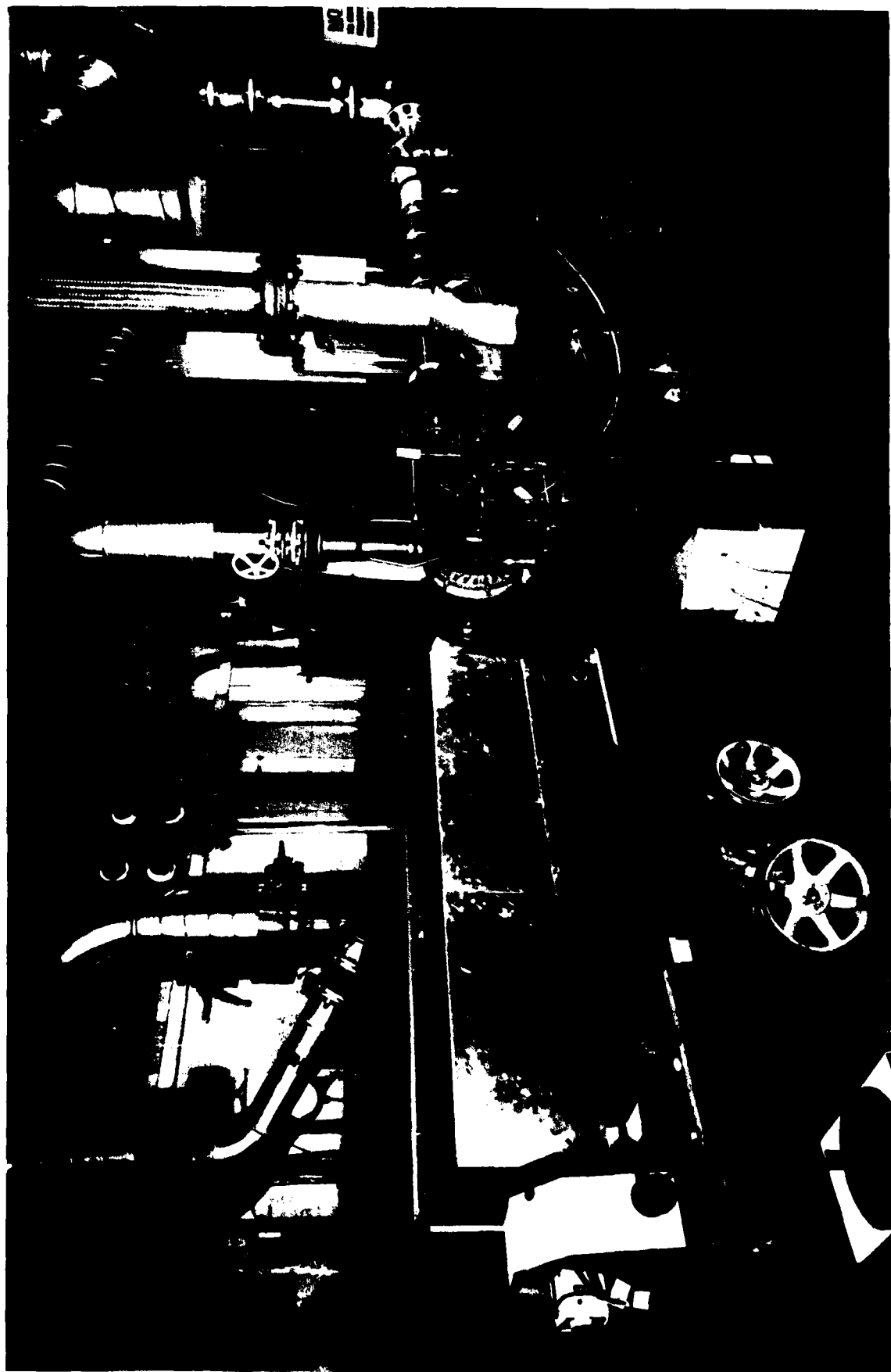


PLATE 1 - LASER ANEMOMETER POSITION ON TURBINE RIG