ENGINEERING RESEARCH INSTITUTE
UNIVERSITY OF MICHIGAN

AUTOMATIC REDUCTION OF WIND TUNNEL DATA

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Progress Report No. 1   Interim Report

for the period

February 17, 1951 to May 17, 1951

Project
M-938

Submitted for the project by:

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INTRODUCTION

This progress report will be concerned with the work on this project during the period February 17, 1951 to May 17, 1951. It should be noted that this project is operating under a letter of intent dated 17 February 1951, and the contract has not been signed as of the date of this report.

Generally, the work for this period has been restricted to initial studies of systems requirements, subdividing the project into tasks, and placing certain orders that will require several months for completion.

Included in this report will be a certain amount of background material and presentation of the problems involved so that future reports may refer to this information and will not require restatement.

BACKGROUND

This project has as its goal the development of equipment for the automatic reduction of wind tunnel data. The specific aims for this year are the development of equipment to:

a. Compute normal force, pitching moment, center of pressure, and drag force from static wind tunnel tests.

b. Compute pressure coefficient directly from static wind tunnel tests.

c. Have self-balancing of all reduction and computing equipment.

d. Obtain items a) and b) above for various Mach numbers during one run.

e. Obtain items a) and b) above for various angles of attack during one run.

f. Compute normal force, drag force, and moment coefficient directly from static wind tunnel tests.

g. Integrate pressure coefficient over a model to eventually obtain center of pressure and force coefficients.

To accomplish these objectives, two basic problems present themselves. These problems are the computation of a straight line least squares fitting for n test points in the evaluation of force and moment data and the computation and integration of a series of variables for the pressure data.

The solution of these problems will be by analogue computor techniques.

The equipment will be designed to have as sensing units strain gages, differential transformers or other elements which will yield voltage input to the computor and to apply the computed data to ordinary voltage or current recording equipment such as Brush, Miller, Leeds and

Northrup, etc. All equipment will be designed to have a maximum interchangeability of components for operational efficiency.

RESULTS OF INITIAL STUDIES

The results of the initial studies of the problems involved and possible solutions have led to the system schematically presented in figures 1 and 2.

It has been decided to use identical systems for the force, moment computation and the pressure computation up to the point where a DC signal proportional to the actuating quantity is obtained. This decision has simplified the construction and has decreased the operational complexity of the system.

In general, the equipment will use the strain gages or differential transformers in bridge circuits. The output of a bridge will be applied as the input to an AC amplifier where the gain will be set according to the requirements of the particular gage or transformer by calibration. This information will then be supplied to the demodulator and filter. The AC amplifier will have a class B section which will drive a servo motor to balance the bridge when the system is not in operation.

In the demodulator section, an AC component will be added so that the demodulation and the filtering can be accomplished with greater ease. The component that has been introduced will be taken out in the last stage.

In the computation of the least squares fitting or in the force, moment problem the equation can be placed in a form such that the measured

quantity is the only variable and the constants are functions of position of the gages. Using this form, the DC equivalent of the actuating quantity is introduced into ordinary DC operational amplifiers of the Reac type, through appropriate resistors, and are summed. The output of this system is then the slope (force) and the zero intercept (center of pressure).

In the computation of pressure coefficient and integration of the coefficient over the body the DC equivalent of the pressure is applied through a resistor (which is a function of the constants of the tunnel, position and area over which this pressure is assumed to be acting) and a commutator to a DC operational amplifier connected as an integrator.

The AC systems will operate on a two kilocycle carrier supplied from an oscillator regulated in amplitude as well as frequency.

The AC amplifier and demodulator design, engineering and construction will be under Mr. Richard Leite. Mr. Gilles Corcos will supervise the design of the filter, balance control circuits and bridge. The power supplies and DC operational amplifier design will be the responsibility of Mr. D. V. Theofil.

Future progress reports will present the status of these sections.

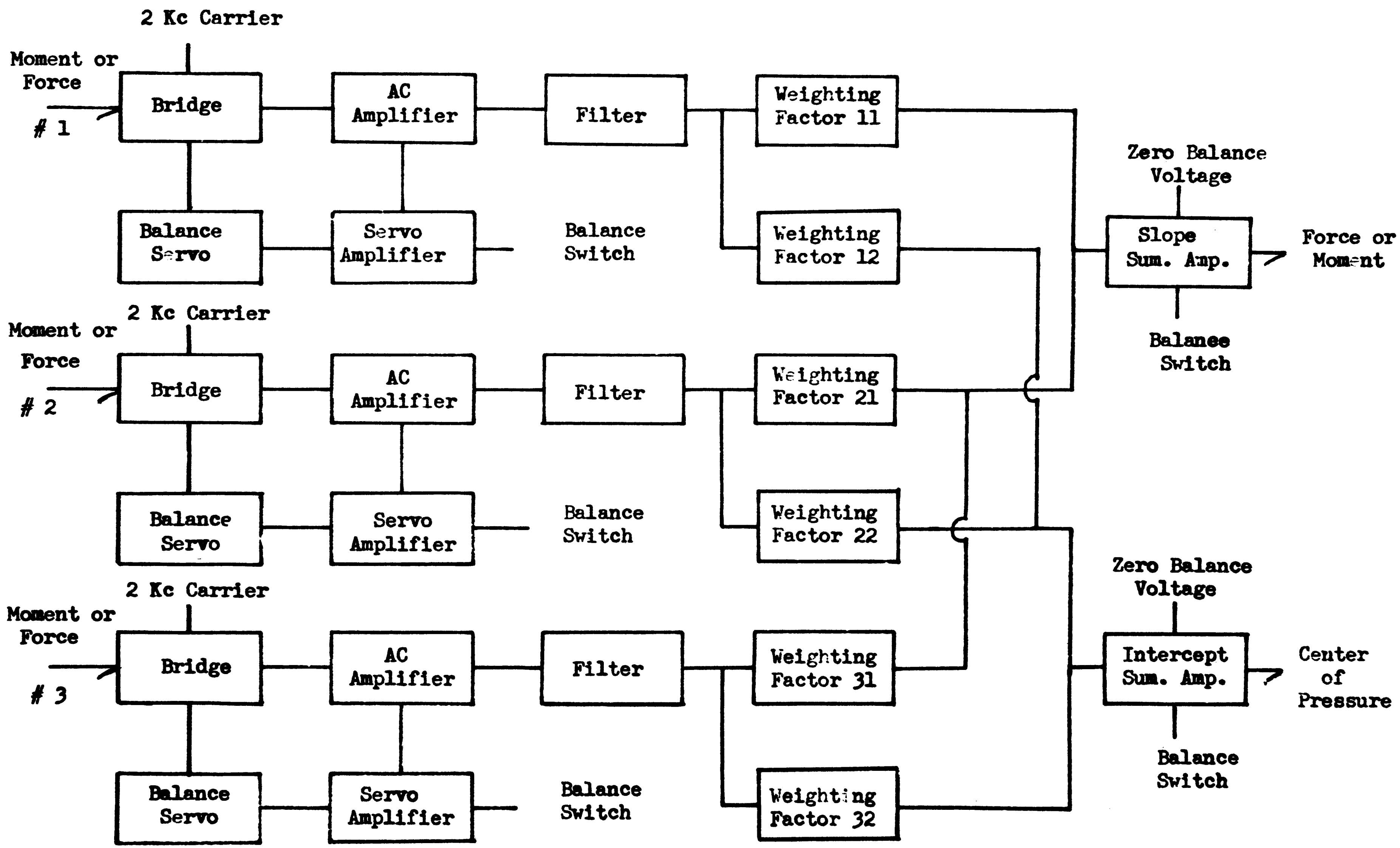

FIGURE 1 SCHEMATIC BLOCK DIAGRAM OF FORCE MOMENT SYSTEM

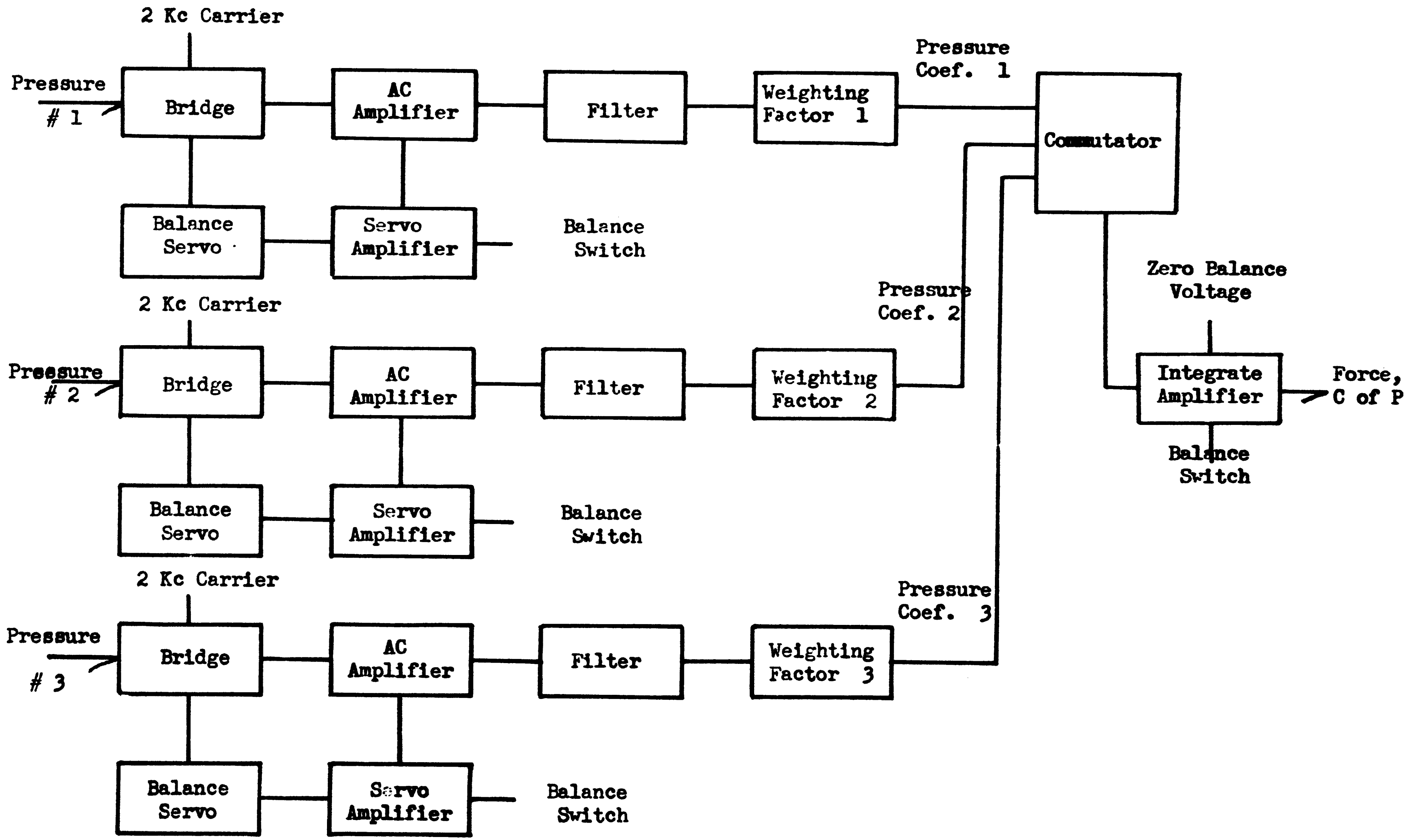

FIGURE 2

SCHEMATIC BLOCK DIAGRAM OF
PRESSURE SYSTEM