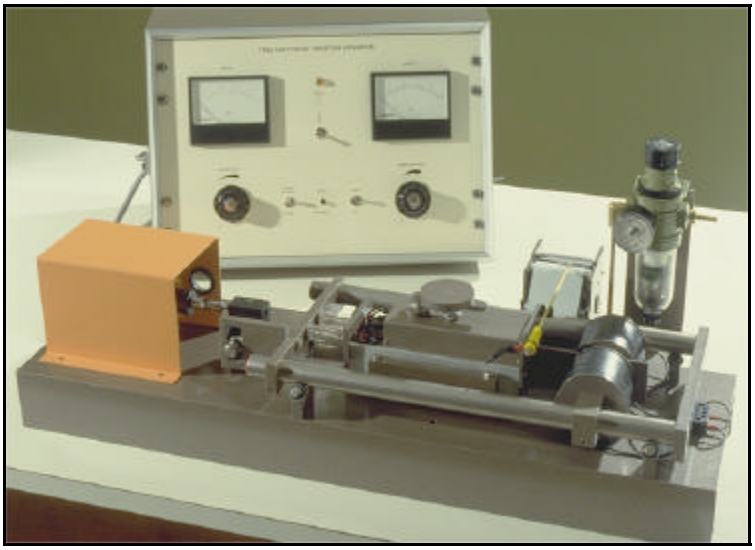
cussons
TECHNOLOGY



P5000

APPARATUS FOR FREE AND FORCED VIBRATION WITH DAMPING

APPLICATIONS

- Experiments on free and forced vibration of single degree-of-freedom systems with and without viscous damping
- Investigations on both steady state and transient conditions

FEATURES

- Employs relatively large masses supported virtually friction free on air bearings
- Low natural frequency
- Extreme sensitivity due to true viscous damping by eddy currents
- Pen recorder to observe mass motion

INTRODUCTION

Cussons P5000 Apparatus for Free and Forced Vibration with Damping has been developed from original designs due to Bristol University to present vibration phenomena with true viscous damping in a form such that they can be readily seen as well as accurately analysed. The two most significant features of the apparatus are, first that it employs relatively large masses supported in a virtually friction free manner on an air bed and excited by small forces so that the natural frequency is low and, secondly, that damping is introduced by eddy currents thus providing true viscous damping that can be regulated with extreme sensitivity.

DESCRIPTION

The apparatus enables a number of experiments to be carried out on the free and forced vibration of a single degree-of-freedom system with viscous damping. Both steady state and transient conditions can be investigated. The vibrating mass, constrained by an externally pressurised air bearing system, has an undamped natural frequency of about 1Hz and maximum amplitude of about 20 mm so that the motion of the mass can be readily observed and recorded directly on the pen recorder (Teledeltos paper) system incorporated in the apparatus. The uncontrolled damping of the vibrating mass is very small (equivalent to a damping ratio of 0.003) and the viscous damping generated by the eddy current system is continuously variable up to a damping ratio of about 1.5.

Forced vibrations are excited in one of two ways; either by oscillating the support frame in SHM at variable frequency or by applying a rotating out-of-balance force at varying frequency to the vibrating mass. A single power pack for connection to the AC mains provides low voltage DC supplies for all the various drives and the damper current as well as the pen recorder supply. A 60 tooth timing disc and magnetic sensor are incorporated in the drive to the forcing frame so that the frequency can be determined with a digital counter.

EXPERIMENTAL CAPABILITIES

The following are some of the experiments that may be carried out with the apparatus:

1. **Experimentals on the variation of undamped natural frequency with vibrating mass**

   With a varied mass and constant spring rate the angular velocity ω to mass relationship can be determined.

2. **The effect of viscous damping on free vibration and the determination of the damping ratio *c***

   Using a freely vibrating mass and different values of damping current the damped free motion can be recorded. A graph of damping ratio *c*, against damper current can be plotted and used as a guide in setting particular values of *c* in other experiments.

3. **Forced vibrations excited by oscillating the support**

   A variation of the amplitude of the steady state vibration of the vibrating mass with forcing frequency ω and damping ratio *c*, shows that damping is needed to control the motion at low frequency, but it is a disadvantage at high forcing frequency.

4. **Forced vibrations excited by rotating out-of-balance forces**

   With a variation of the amplitude and phase angle of the steady state vibration of the vibrating mass with forcing frequency and damping ratio, *c*. Experimental results plotted on a graph can then be compared with theoretical equations. It can then be shown that at low frequency the vibrating mass is in phase with the rotating out-of-balance force and at high forcing-frequency it is in anti-phase with the force.

5. **The response of the vibrating mass to forcing, illustrating the decay of the transient vibration and the establishment of the steady state vibration**

   When the air supply is switched on suddenly at different points during the forcing cycle the resulting motion of the vibrating mass can be recorded. This motion is a combination of a decaying free vibration and steady state forced vibration at the forcing frequency.

The experiment can be repeated using the rotating out-of-balance force instead of the forcing frame.

TENDER SPECIFICATION

P5000 Apparatus for Free and Forced Vibrations with Viscous Damping

Comprising a vibrating mass (mass variable) mounted in air bearings with one degree of freedom (translation) and provided with means of exciting by

1) external forcing frame moving in SHM at variable frequency
2) rotating out-of-balance at variable frequency mounted on the mass, pen recorder system employing Teledeltos paper and constant speed electric drive, eddy current damper coils and armature.

Supplied complete with compressed air filter and control unit for connection to external compressed air supply at pressure not less than 1 bar (15 lb/in²).

If a compressed air supply is not available in the laboratory where the apparatus is to be used, a self-contained electrically operated compressor set (P5003) can be supplied. Alternatively the apparatus may be supplied from a cylinder of compressed air or nitrogen.

P5001 Digital Counter for use with P5000

Four digit counter for operation on 220/240 volt AC 50 Hz single phase supply. Counters for alternative voltages and frequencies to special order.

P5003 Oil Free Air Compressor

For use on 220/240 volt AC 50Hz single phase supply.

SERVICES

220/240 volt AC 50 or 60Hz single phase supply. Other power supplies to special order.

DIMENSIONS

Arranged for bench mounting with dimensions approximately 90 cm long x 60 cm wide by 30 cm high for the bed and 50 cm long x 30 cm wide by 30 cm high for the control unit.

SHIPPING SPECIFICATIONS

Gross 116 Kg Nett 76 Kg
97 cm long x 79 cm wide x 53 cm high

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