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Status Update On The Seal/Bearing Rotordynamics Test Facility At Case Western Reserve University

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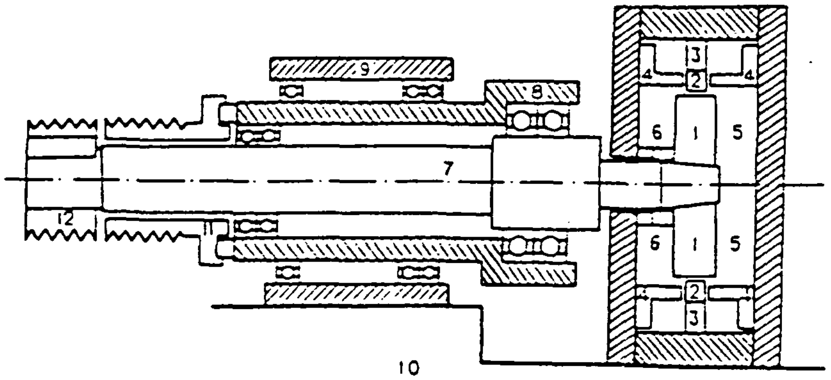
OVERVIEW

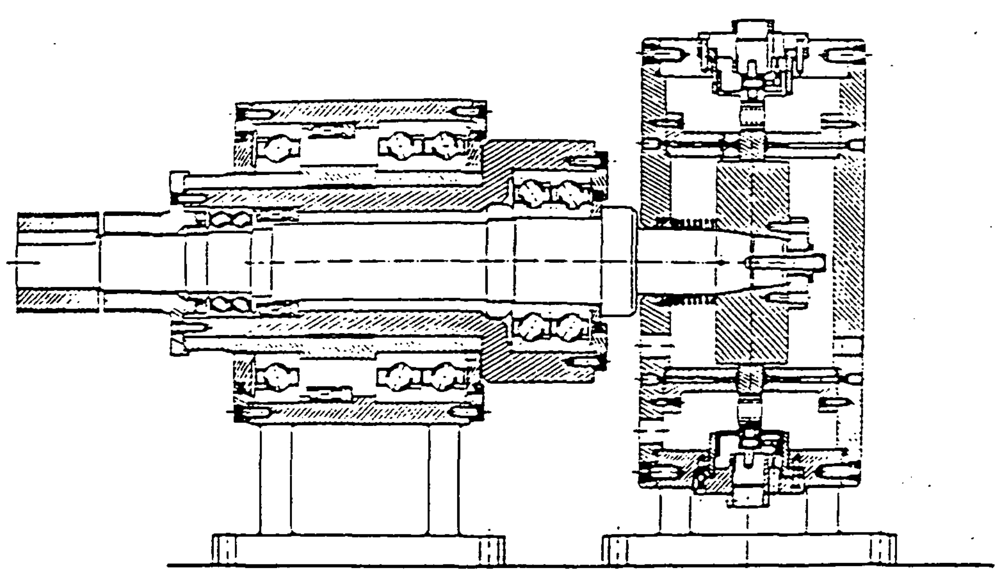
The CWRU Seal/Bearing test facility is shown in Figures 1 through 3, and the revised force measuring system is sketched in Figure 4. This facility has recently been retrofitted with a high-pressure high-flow oil system, which was acquired to conduct basic research on hydrostatic journal bearings for NASA Lewis Research Center. Mr. Russell Capaldi is the NASA grant monitor. The high-pressure high-flow water system remains in place to test seals. Also, a new high-flow air system is now installed. Thus, testing to determine static and dynamic properties can now be performed using oil, water or air on this single facility.

We are currently using the oil system to determine rotordynamic properties of a NASA four-pocket hydrostatic journal bearing. The revised dual system force measuring configuration (see Figure 4) is performing with excellent accuracy. That is, the dynamic force measurements are made simultaneously with two independent systems, one with piezoelectric load cells and the other with strain gage load cells. The difference is less than 2% (see Figure 5 through 7) between these two sets of load cell measurements on recent tests with a static eccentricity set close to zero (e= 0.001 inch, C = 0.009 inch) and an orbit radius of 0.0004 inch. Table 1 shows the extracted stiffness, damping and inertia coefficients for the test conditions shown, as extracted from the two independent dynamic force measurements. These coefficients were extracted using a linear-regression least-squares fit of the dynamic force and orbit displacement signals over a frequency range of 250 to 2,400 cpm, without constraining the inertia matrix to be symmetric.



1 - Test rotating element
2 - Test annulus ring
3 - Piezoelectric load cells
4 - Hydrostatic axial ring supports
5 - High-pressure compartment
6 - Low-pressure compartment
7 - Inner spindle rotor
8 - Outer spindle rotor
9 - Spindle housing
10 - Support base
11 - V-belt pulley
12 - V-belt pulley

1(a) Conceptual Sketch of Rotor Support Component Test Apparatus



1(b) Assembly Layout of Rotor Support Component Test Apparatus

Figure 1. Test Apparatus

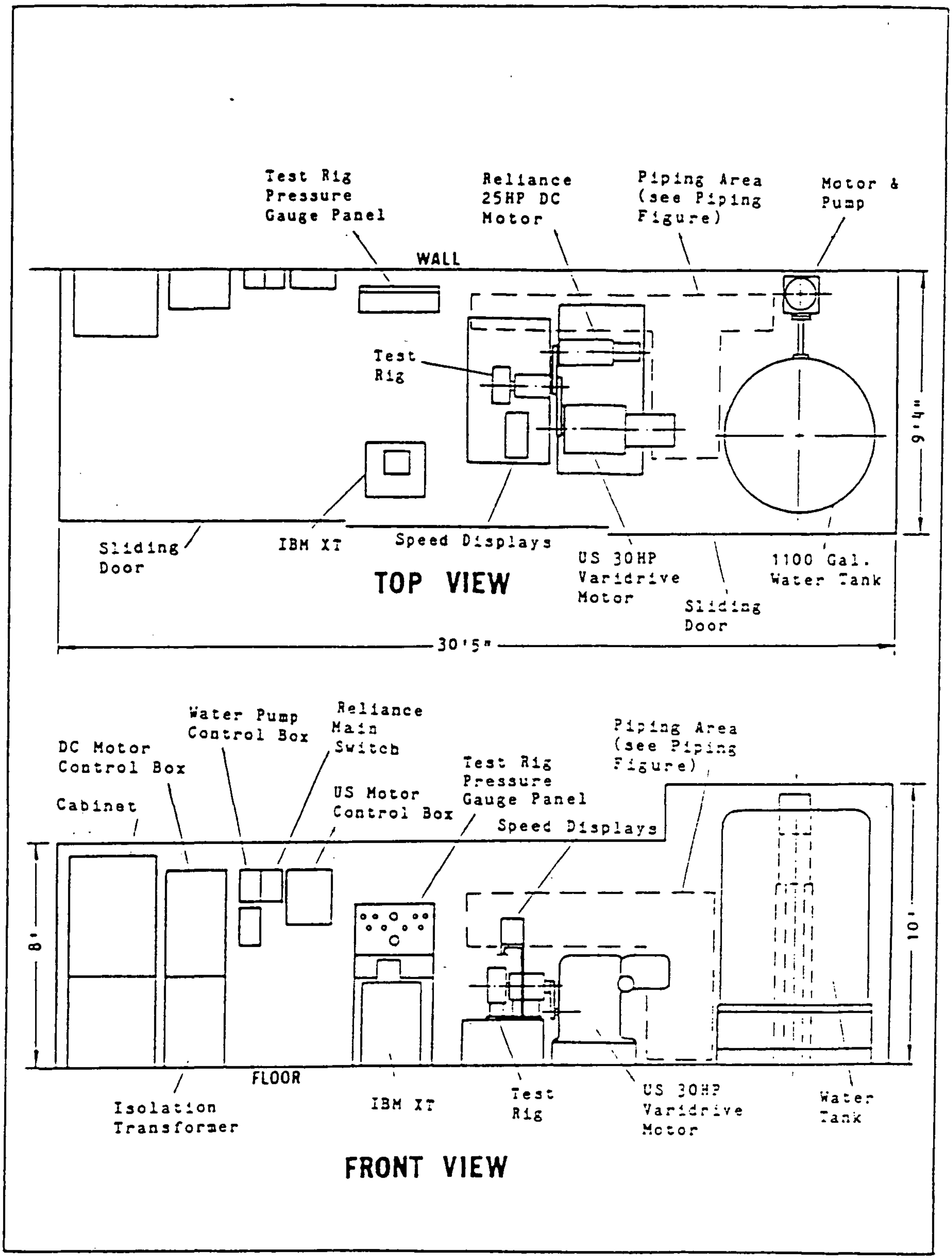


Fig. 2. Floor plan and elevation view of test facility.

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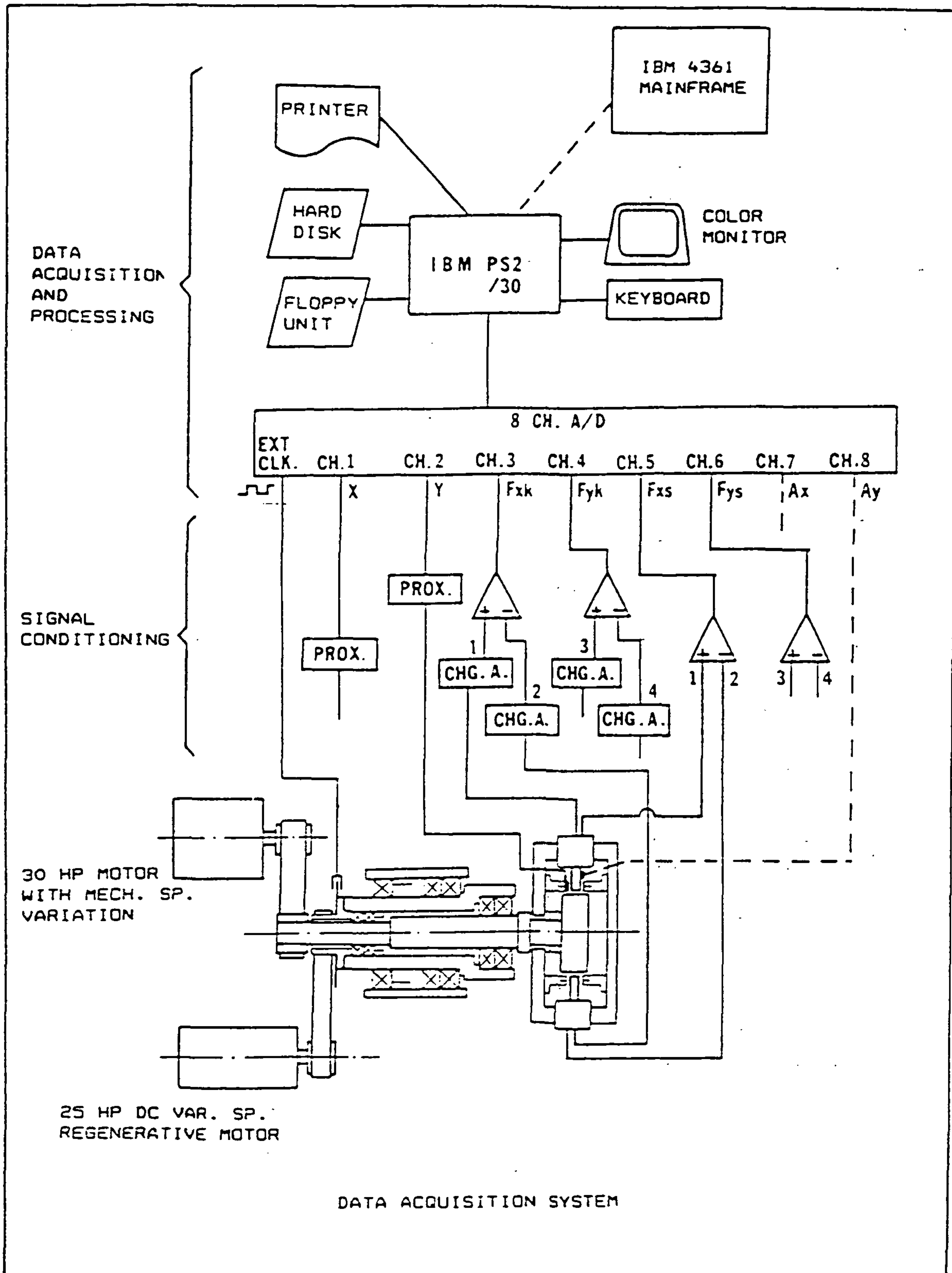

Fig. 3. Schematic of data acquisition system.

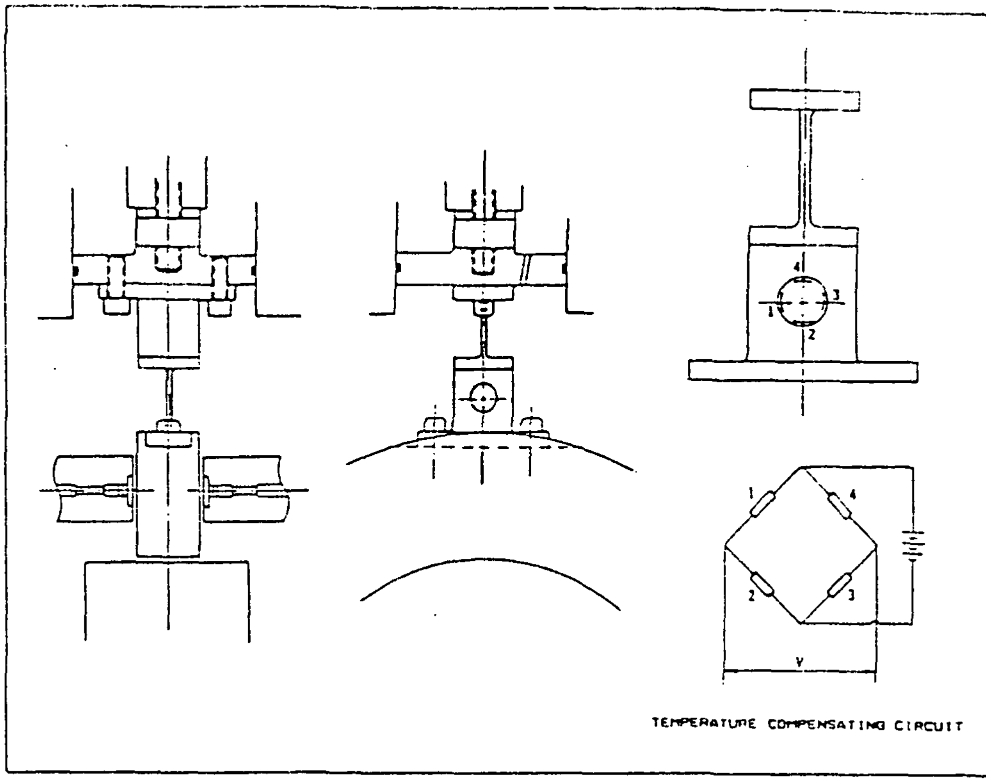

Figure 4(a) New load measuring and support system with strain gage transducer.

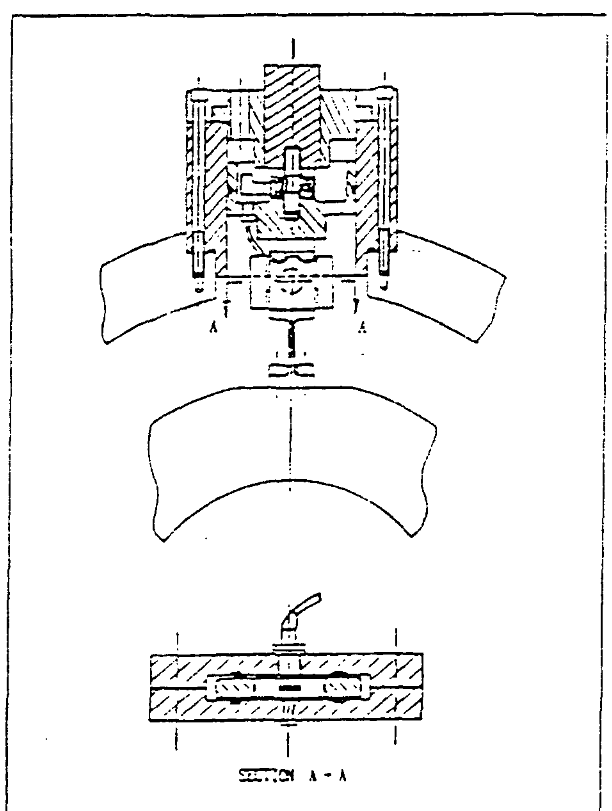

Figure 4(b) New load measuring system, showing complete assembly with water-seal barrier.

TOTAL TIME-AVERAGED SIGNAL (50 cycles)

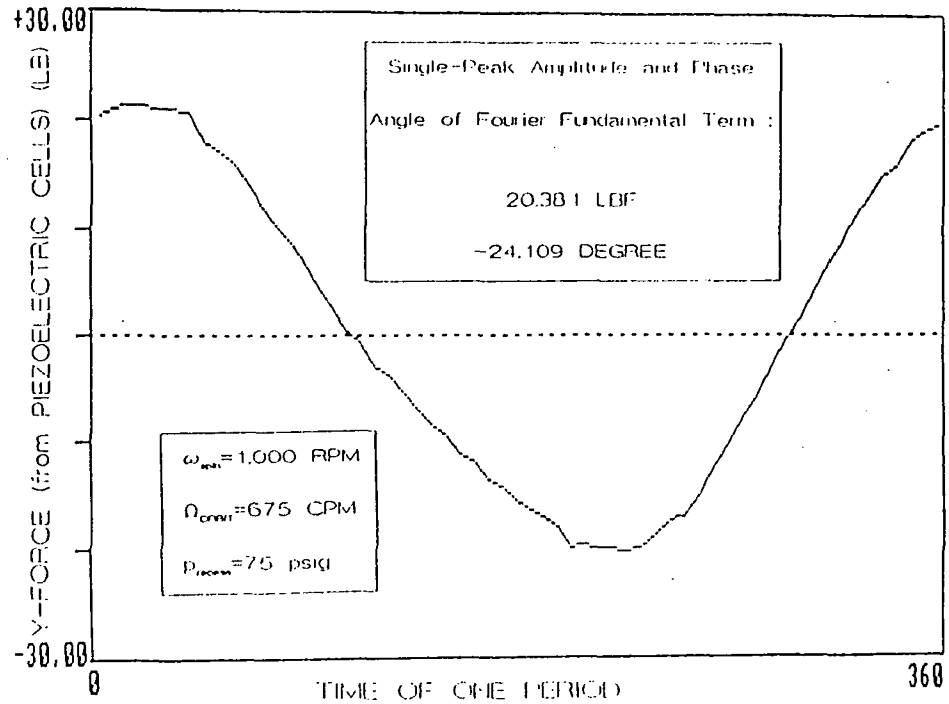

Figure 5

TOTAL TIME-AVERAGED SIGNAL (50 cycles)

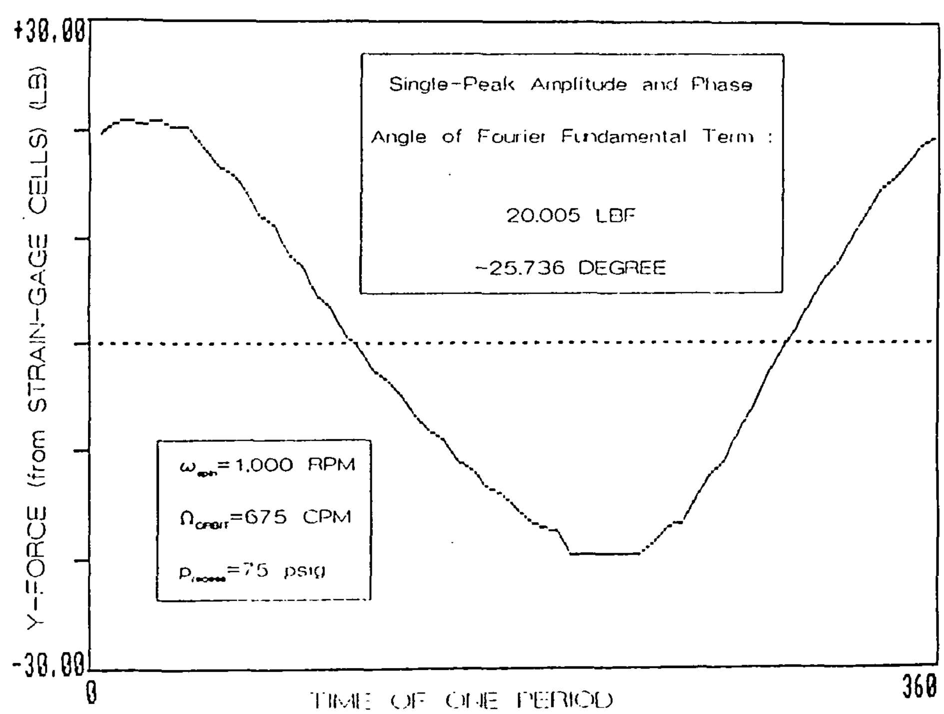

Figure 6

FIRST TERM OF FOURIER DECOMPOSITION

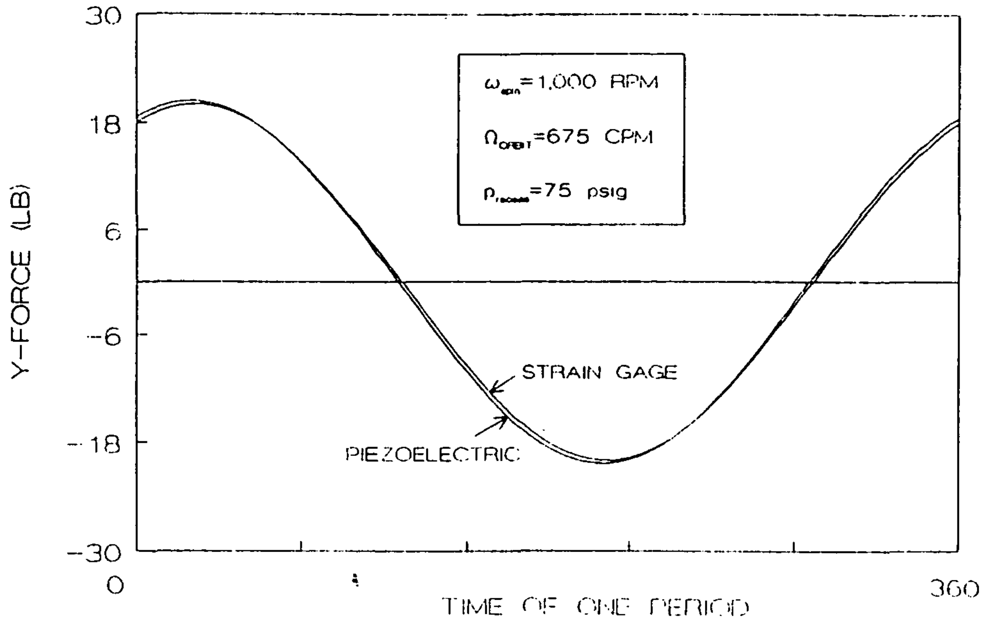

Figure 7

DYNAMIC COEFFICIENTS REPORT

SPECIAL FILENAME IS : CCF.INP

TOTAL INPUT FS DATA FILE IS : 10

SHAFTSPEED (RPM) IS : 1000

RECESS PRESSURE (PSI) IS : 75

INPUT DATA FILENAME	NO. OF CYCLE	ORBIT FREQUENCY (RPM)
CC1F.FS	1	247
CC2F.FS	1	363
CC3F.FS	1	476
CC4F.FS	1	569
CC5F.FS	1	677
CC6F.FS	1	765
CC7F.FS	1	871
CC8F.FS	1	1041
CC9F.FS	1	1139
CC10F.FS	1	1247

ROTORDYNAMIC COEFFICIENTS :

[Kk] LB/INCH		[Ks]	
0.122362E+06	0.396070E+05	0.127923E+06	0.470087E+05
-.441426E+05	0.124812E+06	-.470378E+05	0.132163E+06
[Ck] LB*SEC/INCH		[Cs]	
0.623928E+03	-.244494E+03	0.652728E+03	-.303505E+03
0.101049E+03	0.934374E+03	0.978187E+02	0.951065E+03
[Dk] LB*SEC*SEC/INCH		[Ds]	
-.142564E+01	-.213640E+01	-.159256E+01	-.256475E+01
0.189671E+01	-.607746E+00	0.201067E+01	-.499795E+00

Table 1(a)

DYNAMIC COEFFICIENTS REPORT

SPECIAL FILENAME IS : IIF.INP

TOTAL INPUT FS DATA FILE IS : 10

SHAFTSPEED (RPM) IS : 2000

RECESS PRESSURE (PSI) IS : 75

INPUT DATA FILENAME	NO. OF CYCLE	ORBIT FREQUENCY (RPM)
II1F.FS	1	384
II2F.FS	1	573
II3F.FS	1	775
II4F.FS	1	979
II5F.FS	1	1181
II6F.FS	1	1377
II7F.FS	1	1572
II8F.FS	1	1783
II9F.FS	1	2135
II10F.FS	1	2375

ROTORDYNAMIC COEFFICIENTS:

[Kk] LB/INCH		[Ks]	
0.136658E+06	0.740354E+05	0.126282E+06	0.739171E-05
-.968657E+05	0.139754E+06	-.889112E+05	0.133641E+06

[Ck] LB*SEC/INCH		[Cs]	
0.501801E+03	0.114119E+03	0.448836E+03	0.104627E+03
-.192791E+03	0.871380E+03	-.206396E+03	0.874430E+03

[Dk] LB*SEC*SEC/INCH		[Ds]	
0.660029E-01	-.304506E+00	0.730574E-01	-.240757E+00
0.767267E+00	0.754499E+00	0.825507E+00	0.814563E+00

Table 1(b)

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