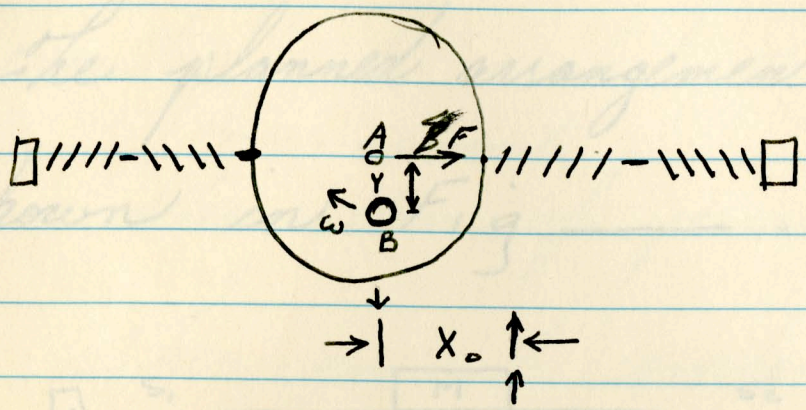
Mass Experiment
#3

7530-286-6951
FEDERAL SUPPLY SERVICE
16—74548-1 GPO

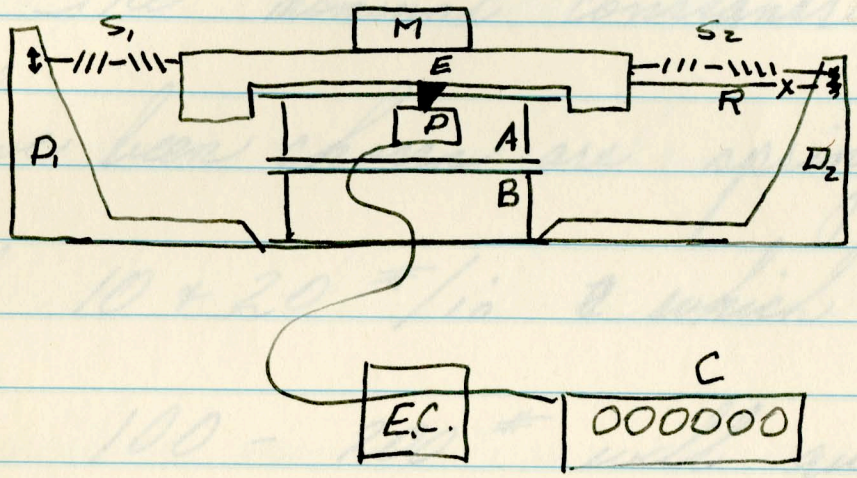
air bearing. ~~at~~ ~~A~~ All of these could be small units since the forces will be correspondingly small. In the interest of expediency ~~however~~ and in the absence of a ~~solution~~ theoretical solution to the problem ~~i~~ 3 degrees of freedom restraints will not be initially employed and the ~~errors~~ magnitude of motion in the undesired plane and their effects upon accuracy will

be measured - It is obvious that ~~what~~ care will have to be taken in alignment of the springs and direction of release from initial displacement to ensure that these are coincident ā the desired plane of measurement. It also seems probable that rotatory motion may be introduced if the center of mass is not in the axis of motion. This is



Shown in Fig - One after an initial displacement X_o, at the moment of release a force $F = K X_o$ will be developed by the springs and if the mass is off center by ΔY a torque will be developed by $\bar{c}$ some rotational motion being produced.

The planned arrangement is shown in Fig ——.



An adaptor E and D_{1-2} will be fabricated to allow attachment of the springs S_{1-2}, release mechanism R, & displacement pick off P to the existing bearing which will support a series of masses M. Electronic

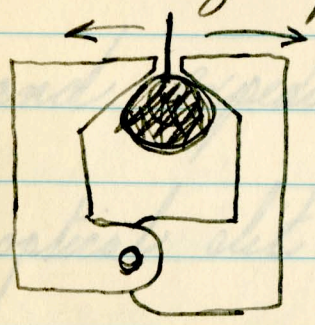
circuitry E.C. will control the counter, C for measurement determination of period.

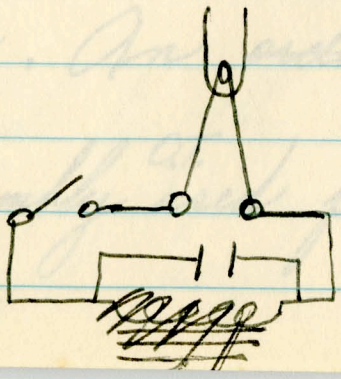
The nominal constants which have been chosen are spring rates of 10 & 20 #/in & which ā masses of 100 - 200 # will give periods of ~ 1 - 3 secs. & Max. displacement will be ≈ ± .5".

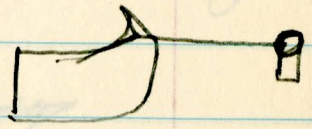
The only requirements for the adapter gear include rigidity such that displacement under max. loads

is $<< 10^{-3}$ ins. and ~~pr~~ adjustment to allow accurate alignment of the spring forces ⊥ the axis of motion.

Considerable care will have to be exercised in the release mechanism to preclude movement in undesired axes. This ~~co~~ could take the form of a pair of jaws that ~~mo~~ open ~~in~~ exactly equally in opposite directions.



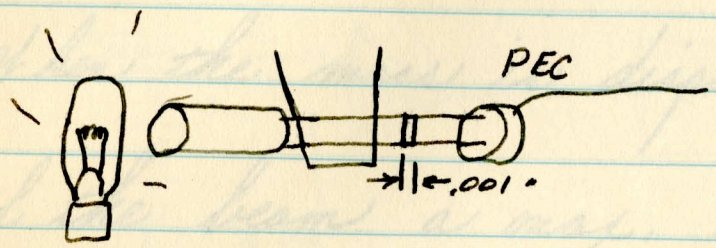


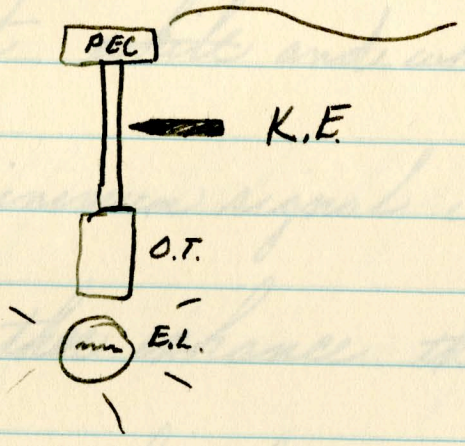


If extreme accuracy were desired some form of exploding wire arrangement as in Fig — 6 could be used -

It has been shown that ultimate sensitivity will be a function of the resolution of the zero displacement detector. It is now planned to use an optical scheme for accuracy and expediency. An ~~ordinary~~ O.T. optical slit assembly used for sound film

c the lamp E.L.
reproduction will be used to provide
a beam of light 10^{-3} in.
wide which will fall on a
light sensor, PEC. This assembly

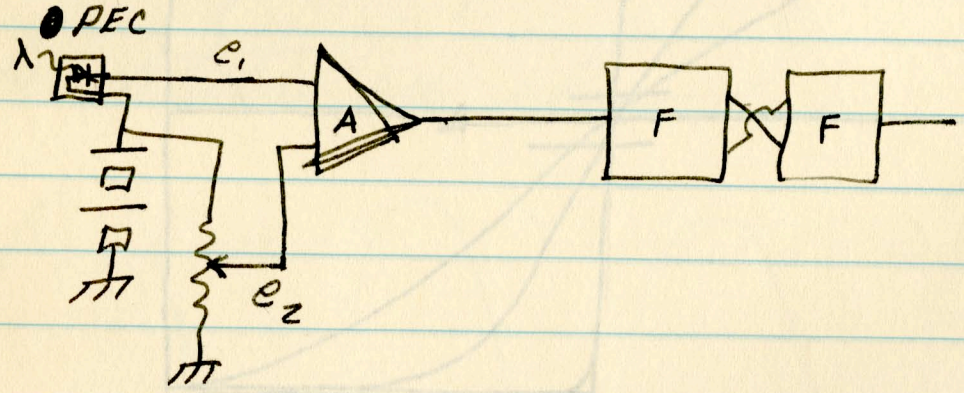




will be attached to the base c the
beam at a right angle to the
the point of zero displacement, &

direction of travel of ~~the~~ a precisely ground knife edge (K.E.) attached to the moving mass. This ~~will then provide a distance~~ When the mass is displaced right of the beam a max. signal will be present ~~while~~ and when displaced left a minimum signal will be present. To further enhance the distance resolution especially in the face of possible ~~defos~~ crossing at a defocussed (broadned) area of the beam a vertical skew

of the knife edge, an electrical mid point point detector will be added as shown in Fig.

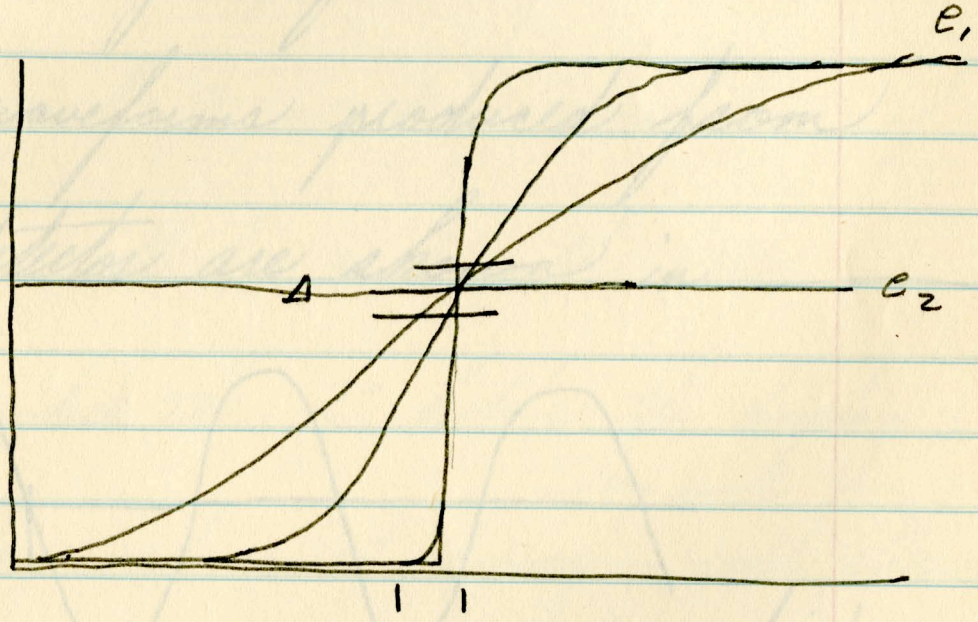


The differential high gain amplifier A will provide an output of ~ 20V for a few mV difference in the signals e_1 & e_2. e_2 will be set such that

it is $\frac{\Phi'}{2}$ of e_1 at max output-

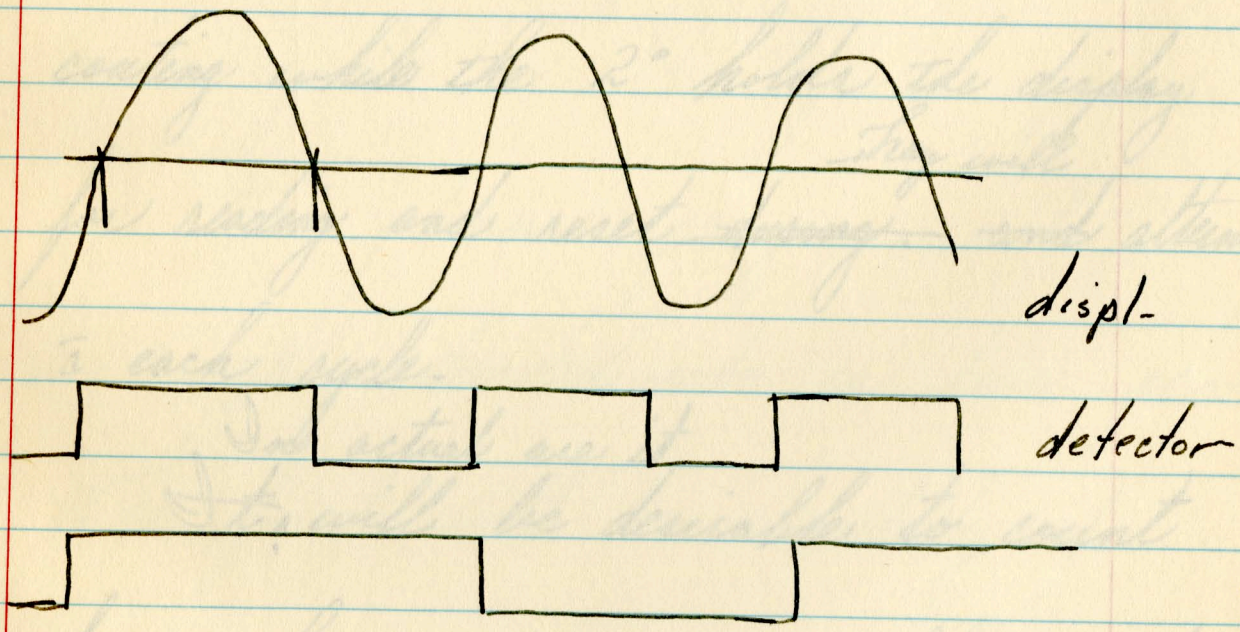
The resulting curves are shown in

Fig ———— .



The net result is that zero resolution crossing is enhanced many fold and accuracies of $<< 10^{-3}$ should be possible -

A second function of the electronic control is to provide a proper gate for the counter. The waveforms produced from the detector are shown in ——



In order to convert these to full cycle an Eccles Jordan scale of two

will be used. Since it is desirable to know the variations in each cycle during the developmental phases, two counters each ~~i~~ a time resolution of 10^{-5} sec. will be used with one counting while the 2° holds the display for reading and reset. ~~During~~ They will ~~and~~ alternate ~~i~~ each cycle.

In actual use it, it will be desirable to count for the maximum possible number of cycles since random variations

summate
~~add~~ as $\sqrt{N}$ while the measurements summate directly as N for an increase in resolution ~~of~~ as $\sqrt{N}$. i.e. ~~the~~ random errors would be reduced by 1/2 by 4 ~~some~~ cycles or 1/3 by 9 cycles.

The planned program will be roughly divided ~~into~~ in two phases. The first will be a study of errors & variations ~~involved~~ ~~using~~ in the method & particular instrument. ~~At~~ & During this phase it may

be necessary to add a 2°
~~testing~~ bearing system or make
other changes - The 2° phase
will consist of measurements of
man and the development of whatever
~~techniques~~ additional techniques are
required -

Assuming that the method
proves practical, and there appears
to be no reason why it will not
at this time, ~~one~~ there remains the
problem of use under actual

conditions. This will be easier in several ways. ~~If~~ Large ~~supports~~ bearings capable of supporting heavy loads will not be required. A single pair of ~~two~~ cylindrical bearings as shown in _____ ~~using~~ requiring only 1-2 P.S.I. will be required. "Drag" friction will be further reduced. One possible arrangement is shown in _____. A chair, which could be used in normal duties will be provided c foot + hand holds for the

muscular ~~tight~~ rigidity to be developed.

In normal ~~use~~ it ~~would~~ be latched to ~~the~~ its frame while for weighing it would be unlatched and free to move along the axis provided by the air for the bearing could simply be bled from the vertical air bearings. This unlatching would also ~~tension~~ apply tension to a set of springs which would then ~~displace the man~~ hold the man at ~~rest~~ some neutral position until a small ~~disp~~ ~~tatet~~ initial

ships circulating air system.

displacement caused oscillation about this point. A simplified optical or other zero pickoff system would then provide a signal to a counter. The counter might well be part of other equipment - In any event ~~the~~ a ~~any~~ major portion of the counter, an accurate time base, will certainly be on board & suitable for use. This ~~&~~ seat scale could be absolutely calibrated in free fall prior to launch or else ē known masses

on board the ship after launch.

A single scale will obviously not cover the entire range accurately and smaller versions in other configurations of this arrangement could be made for measurements that are bound to occur ~~c~~ man in space -