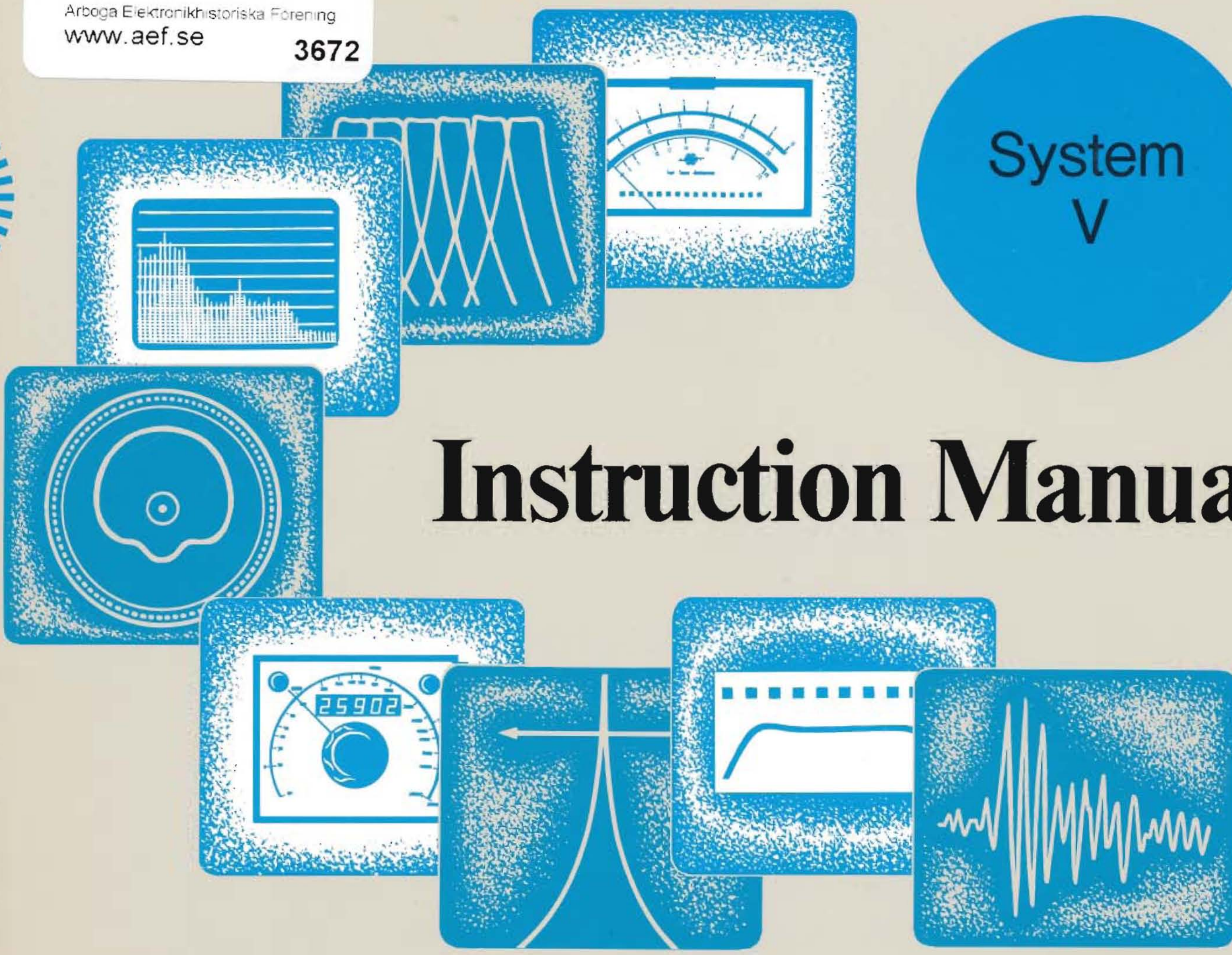


System
V

Instruction Manual

Vibration Exciter System V

• Exciter Body
Type 4801 with
General Purpose
Head Type 4812

• High g Head
Type 4811

• Mode Study Head
Type 4814

• Big Table Head
Type 4813

• Permanent Magnet
Body Type 4805
with Calibration
Head Type 4815

This Vibration Exciter System can be used over a large range of conditions for vibration tests of instruments and structures. It consists of two exciter bodies and five exciter Heads.
The exciter employed is driven by a Power Amplifier 2707 and can deliver a peak force of 380 to 445 N with Body Type 4801 or 267 to 310 N with the Permanent Magnet Exciter Body Type 4805. The Exciter is protected mechanically and electrically. Cooling of the Exciter is performed by a built-in fan in the case of the 4801 and by an external extractor fan (not supplied) in the case of the 4805. Any angle of operation through 360° may be chosen, the body being locked in position by a handwheel.

Brüel & Kjær

033-0070

VIBRATION EXCITER SYSTEM V

EXCITER BODY 4801
EXCITER BODY 4805
HIGH g HEAD 4811
GENERAL PURPOSE HEAD 4812
BIG TABLE HEAD 4813
MODE STUDY HEAD 4814
CALIBRATION HEAD 4815

(Applicable to 4801 from serial no. 807 327)

Revision February 1980

CONTENTS

1. INTRODUCTION

Until recently, all electrodynamic vibration exciters, or shakers as they are often called, looked like the one shown in the sketch in Fig.1.1a. A drive coil, carrying an alternating current, was suspended in a gap in a concentric magnetic field. The drive coil was suspended by upper and lower flexures, which allowed it to move up and down in the gap and kept its motion rectilinear. Because the drive coil was built into the shaker, the characteristics of a particular shaker were fixed. It could be a heavy-duty type, a light-weight type, or a large displacement type.

With the advent of the B & K Exciter Systems, it is now possible to have as many as five different shakers in one system. The difference is that the B & K exciters have set both sets of flexures up above the drive coil (Fig.1.1b).

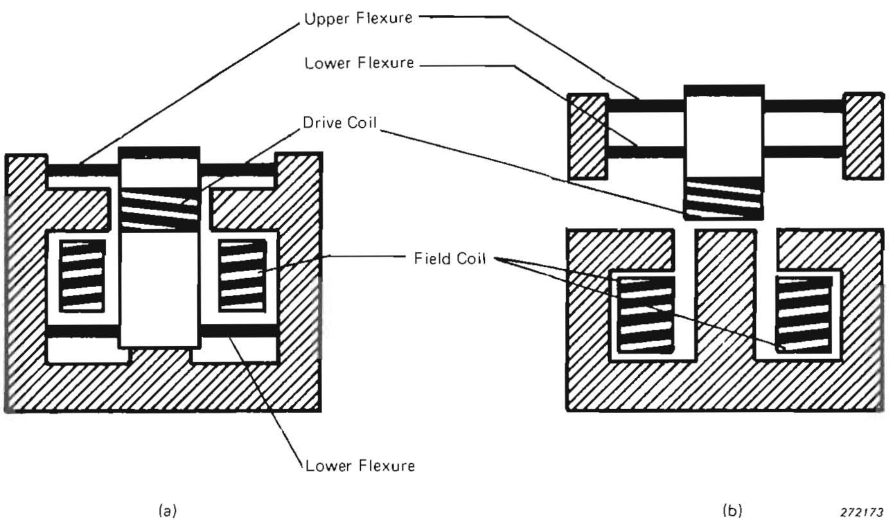


Fig. 1.1. Construction principles of Vibration Exciters

The flexures and drive coil therefore form a Head which can be lifted off the Body containing the magnetic field and exchanged for another Head. Hence, specialized Heads can be built which all fit the same Body. The V System of Exciters has five such specialized Heads and two bodies. Each Head can be used on either the electromagnetic Exciter Body 4801 or the Permanent Magnet Exciter Body 4805. The force range available is from 155 to 445 N.

There are three square table Heads, varying from a light-weight, high acceleration type to a large heavy-duty one. There is also a Head with a single, centrally located mounting point for structural excitation, and a Calibration Head with a built-in reference accelerometer.

For the electromagnetic Exciter Body 4801, a choice of two different types of base are also available, under the designations 4801 T and 4801 S. The 4801 T is a spring suspension arrangement which provides isolation at most frequencies and has the facility of full 360° positioning. The 4801 S is a simplified base upon which the Exciter is fixed in one position. Unless otherwise stated, in this book the 4801 T is the Body referred to.

For some applications, it could be preferable to use a Permanent Magnet Exciter Body 4805. It has the advantage of quieter operation since it can be operated without cooling, but the disadvantage of reduced force rating. Use of the permanent magnet bodies reduces the power available to 70% of that available with the 4801.

2. INSTALLATION

2.1. MECHANICAL INSTALLATION OF EXCITERS USING TYPE 4801 BODY

The technique used to install the Exciter Body 4801 depends upon the usage. For most applications, the Base of the exciter may be placed directly upon the floor. For more critical applications, other mounting techniques may be preferred.

2.1.1. Direct Mounting

The easiest way to mount the Exciter Body 4801 is to place the Base directly on the floor. This technique is suitable whenever the forces transmitted from the exciter to the floor do not produce objectionable results and when the motions coupled to the exciter from the floor do not affect the usefulness of the exciter. Motion transmitted to the exciter through its body is likely to be insignificant for operation frequencies over 30 Hz and when an appreciable fraction of the available force is used.

The forces transmitted to the building are seldom bothersome when the exciter is placed on a substantial masonry floor. If the exciter is placed on a thin wooden floor, the forces transmitted from the exciter to the building are likely to cause annoyance, in the form of vibration and noise. For some situations, an adequate reduction in the irritation level over that obtained with direct mounting can be achieved by placing an inch or two of soft resilient material under each corner of the Base.

2.1.2. Mounting upon a seismic block

Vibration isolation better than that provided by the trunnion springs of the exciter usually is obtained only by use of a seismic block.

A seismic block consists of a large mass, typically reinforced concrete supported by a relatively soft spring system. The mass is typically ten times as large as the mass of the exciter itself. Hence the block characteristics dominate and the entire complex of exciter and seismic block may be treated as a simple mass on a spring, i. e., a single degree of freedom system. Such a system has a resonant frequency corresponding to

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$

where k equals the overall spring stiffness of the system and m is the total mass.

Since the mass of the V System Exciter is about 85 kg (187 lb), depending on which head is chosen, its seismic block should have a mass of about 850 kg (1870 lb). This corresponds to 0,35 m^3 (12,5 ft^3) of reinforced concrete. If the Exciter should work down to 1 Hz, then the spring stiffness of the suspension system should be

$$k = (2\,\pi)^2\,m = 33{,}4\ \mathrm{N/mm}\ (190\ \mathrm{lb/in})$$

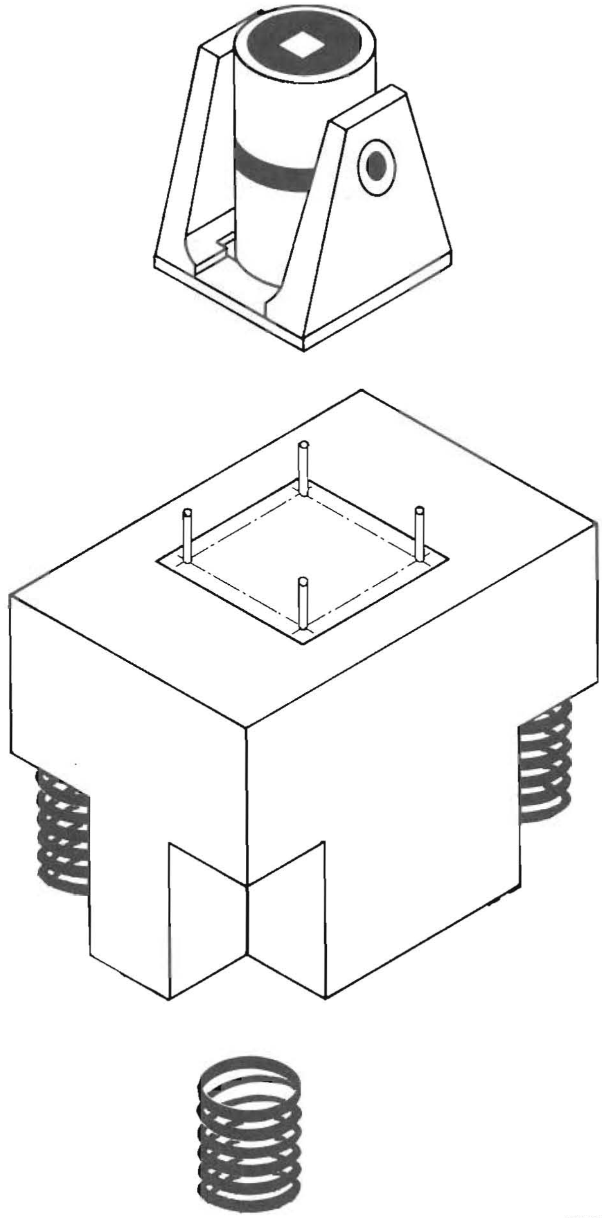


Fig.2.1. Typical seismic block system

A sketch of a typical seismic block system is shown in Fig.2.1.

The block either stands above the lab floor or is mounted in a pit. In the example shown, the springs are in compression. In another type of mounting, each corner of the block is hung from a matched pair of springs in tension (Fig.2.2).

Note that in either case the coupling of mass to springs is done in the plane of the center of gravity.

The mounting bolts for the exciter trunnion can be set into the concrete during pouring, but a better matching of bolt-holes is achieved if the bolts are welded to a plate and the plate anchored to the concrete. This can be done as shown in Fig.2.3.

The bolt is pushed through the location hole in the plate from underneath and the head is welded to the plate. J-bars of suitable dimension can be welded on, to anchor the plate

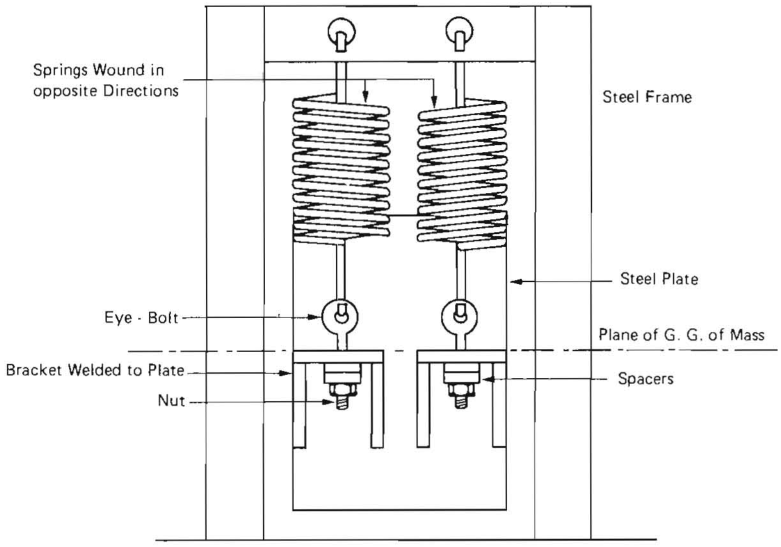


Fig.2.2. Tension support for a seismic block

into the concrete. The bolts should project up 75 mm from the plate, in order to clear the base plate of the Exciter.

Fig.2.4 shows the dimensions of the base plate of the Exciter and the location and size of the bolt holes. Each dimension applies to all four sides.

2.2. ELECTRICAL INSTALLATION OF EXCITERS USING TYPE 4801 BODY

It is recommended that all mains installation and connections be made by a qualified electrician.

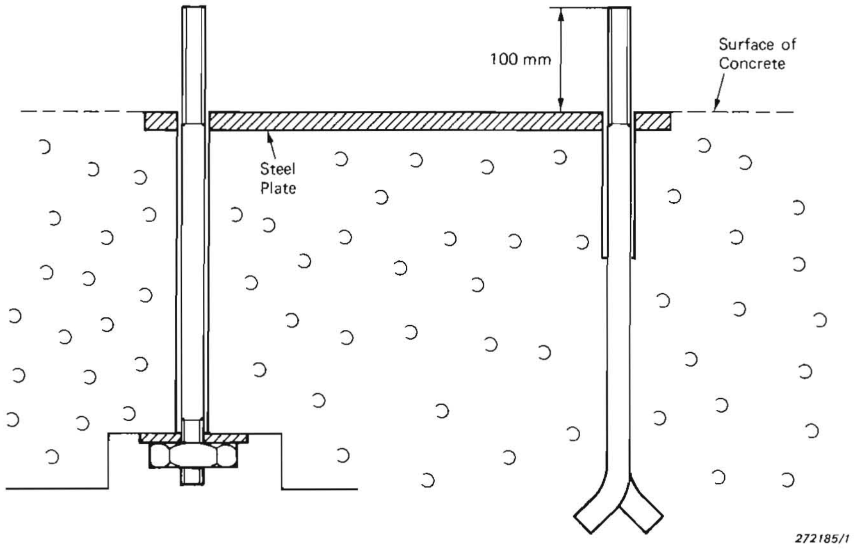


Fig.2.3. Plate anchor details for mounting blocks

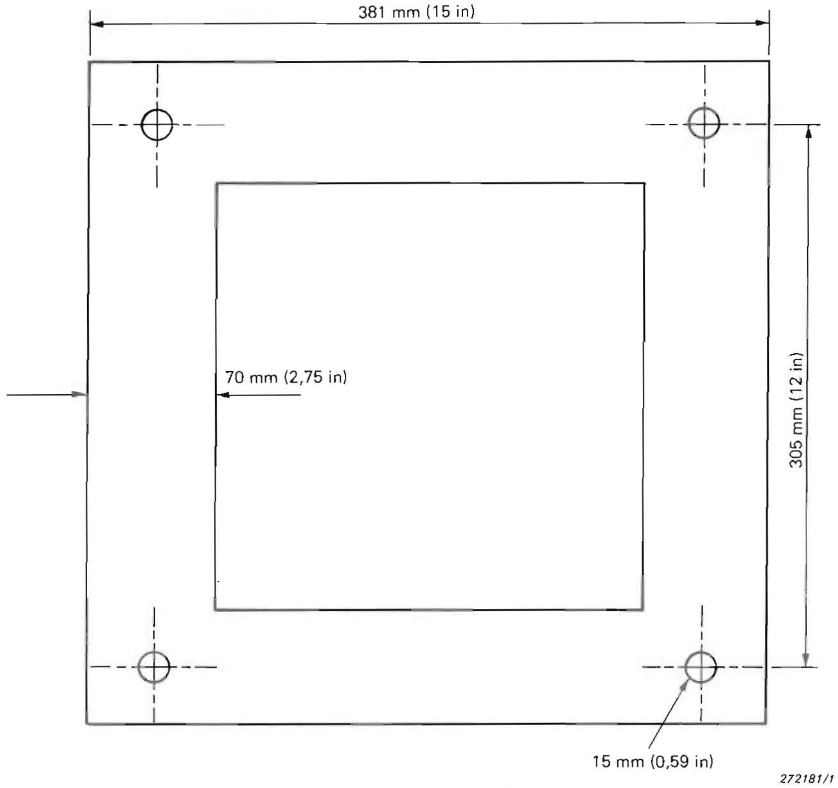


Fig. 2.4. Base plate dimensions for 4801 T

2.2.1. System Interconnection

The Type 4801 Exciter Body is supplied with two captive cables. One of these is a five-core cable, which carries three-phase mains power to the Exciter Body. It includes a neutral and an earth. The other is the safety trigger cable. When the 4801 is used with a suitable B & K amplifier such as Types 2707 or 2708, this cable is used to initiate shutdown in the event of overheating of the field coil, loss of a supply phase or blowing of one of the fuses on the safety circuit board. Shutdown includes removal of both the excitation and the three-phase supply from the Exciter.

For connection of these cables to a B & K Amplifier Type 2707 or 2708, refer to the instruction manuals for these instruments. If the 4801 is to be connected to an older amplifier Type 2707, having single-phase power requirements, consult your B & K representative. Remember to reduce CURRENT LIMIT to a level appropriate to the head in use, especially with the more powerful Amplifier Type 2708.

For maximum operating safety the green/yellow conductor in the power cable **must** be connected to a suitable earth, such as the protective earth contact of a mains socket outlet. The use of extension cables without protective conductor shall be avoided.

Connection of the Exciter Head to the power amplifier is made via drive cable AQ 0026, which has a 3-pin connector at each end. Either end may be connected to the Exciter Head.

2.2.2. Fan Motor Fuses

The three fan-motor fuses are situated on the safety circuit board. To gain access to them remove the base cover of the Exciter, which is held in place by four screws. See

Fig.2.5. Details of the fuses are given in the Specifications. Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse-holders is prohibited.

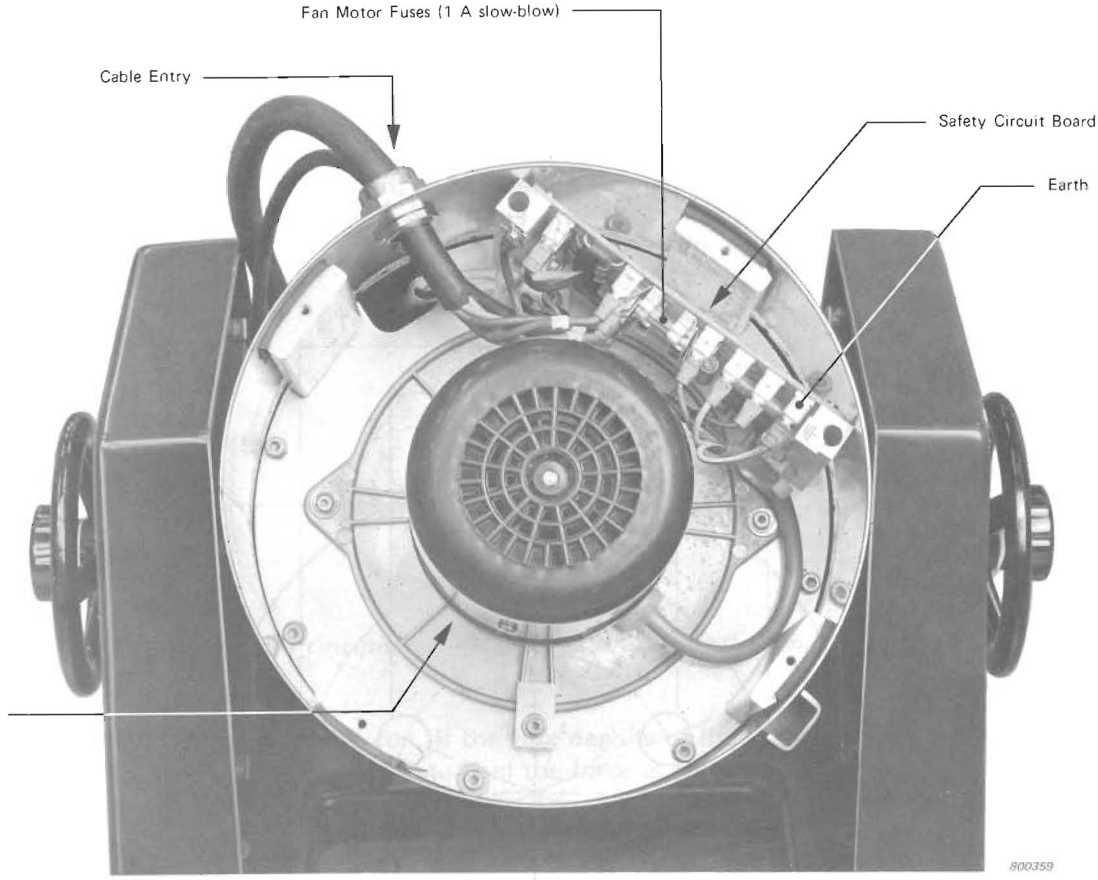


Fig.2.5. Exciter Body with base cover removed

2.3. INSTALLATION OF EXCITERS USING TYPE 4805 BODY

The cable connection between the Power Amplifier 2707 and the Exciter Head is made as in section 2.2. In order to complete the electrical loop which operates the EXCITER INTERLOCK, a connection must also be made from the Exciter Body back to the Power Amplifier. For this reason a single conductor cable has been provided (AO 0103), which should be connected as shown in Fig.2.6. The banana plug is inserted in the hole provided in the 4805 Body. On Power Amplifiers with single-phase mains supplies the free end is connected to terminals 1 and 2 of the terminal board. For connection to Power Amplifiers with 3-phase mains supplies, refer to the Instruction Manual for the Amplifier.

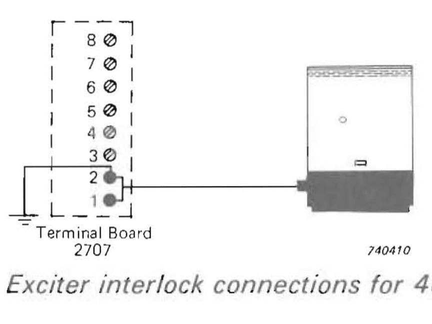


Fig.2.6. Exciter interlock connections for 4805 Body

In order to get the maximum power possible out of the permanent magnet system it is necessary to supply a cool air flow around the drive coil. This air flow should be 0,42 m^3/min at 0,008 kg/cm^2 pressure. An ordinary vacuum cleaner will suffice. The hole in the base of the PM Body is made to receive a vacuum cleaner nozzle. Note that the vacuum cleaner should be used to suck air from the Shaker rather than blow air in. The air blown from vacuum cleaners is generally too warm for use as a coolant.

It should also be noted that the base of the Body is open. Therefore if the Shaker is used in other than the upright position, for instance if it is simply laid on its side, it will be necessary to fix a plate to the bottom in order to ensure an adequate cooling flow. If the Shaker is suspended by using a plate fixed to the mounting holes in the bottom (see section 3.7) then there is no problem. Fig.2.7 is a bottom view of the 4805, showing the placement of the mounting holes.

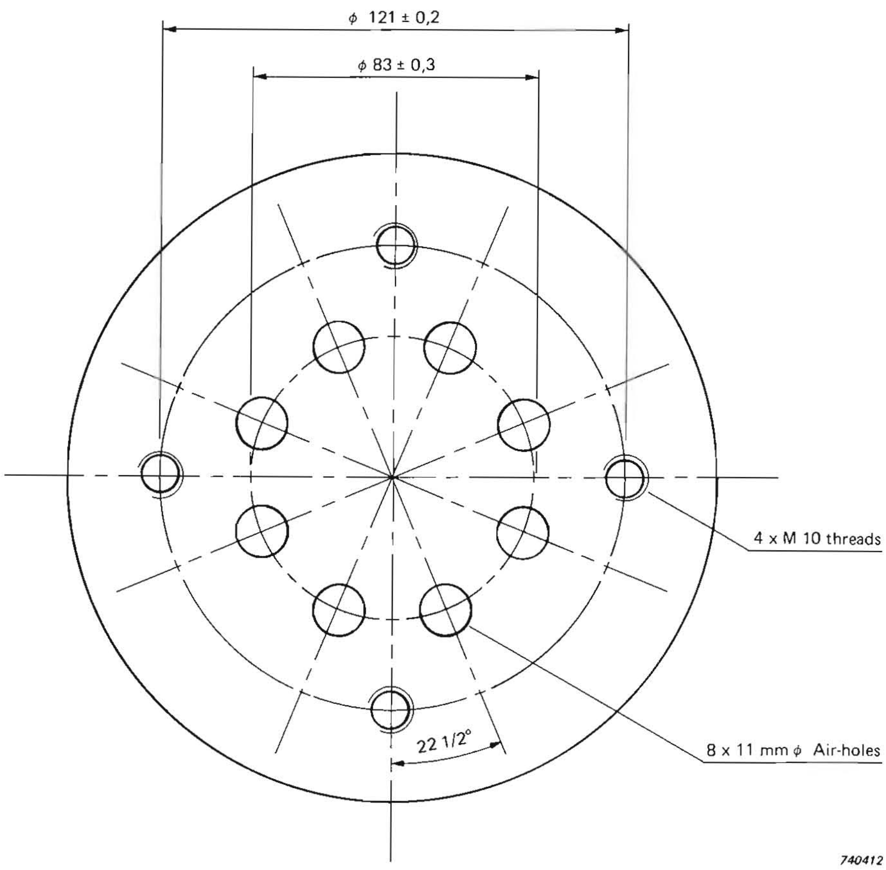


Fig.2.7. Bottom of the 4805

3. OPERATION

3.1. PRINCIPLE OF OPERATION

The forces generated in an electrodynamic exciter are due to the interaction between an alternating current in a coil and a magnetic field. This is illustrated in Fig.3.1.

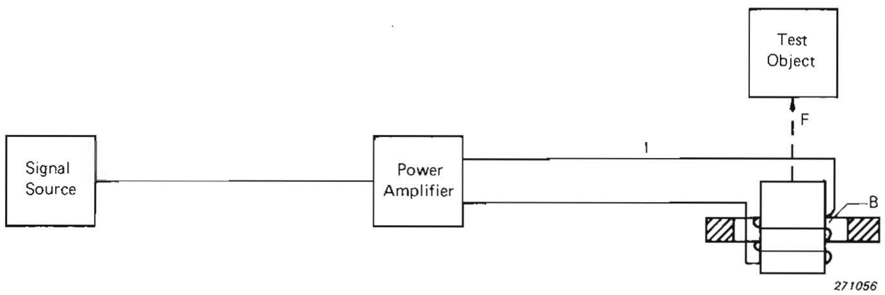


Fig.3.1. Principle of operation of an Electrodynamic Exciter

I is the current in the coil, B the flux density of the magnetic field and F the force generated by the coil. The magnitude of the force is given by

$$F = BIL$$

where F = Force in newtons
B = Magnetic flux, in webers
I = Current in coil, amperes
L = Length of conductor in magnetic field, metres

The current for the exciter is provided by a power amplifier. A signal source, such as a sine-wave or random generator, is connected to the input of the amplifier. As the signal is fed to the coil, a fluctuating force and hence a vibratory motion is imparted to the test object. Of course, the coil itself is wound about a moving element and this has a certain mass. Hence the acceleration due to an applied force F will be

$$a = \frac{F}{m + m_e}$$

where m is the mass of the test object and m_e is the moving element mass.

3.2. SELECTION OF APPROPRIATE B & K EXCITER HEAD

The user is urged to read the detailed specifications for each of the currently available B & K Exciter Heads. He should select the Exciter Head having specifications best suited to his particular application. A brief summary of typical specifications is shown in Table 3.1.

In Table 3.1 the first three lines list the force available from each of 5 B & K Exciter

		B & K Exciter Head Types				
		4811	4812	4813	4814	4815
Force, with 4801	N (lbf)	370 (85)	445 (100)	445 (100)	370 (85)	370 (85)
Force, with 4805 and cooling	N (lbf)	248 (56)	310 (70)	283 (64)	267 (60)	267 (60)
Force, with 4805, no cooling	N (lbf)	124 (28)	155 (35)	142 (32)	133 (30)	133 (30)
Moving Element Mass	kg (lb)	0,18 (0,4)	0,45 (1,0)	0,79 (1,6)	0,23 (0,5)	0,32 (0,7)
Displacement Limit	mm (in)	13 (0,5)	13 (0,5)	13 (0,5)	25 (1,0)	13 (0,5)
Resonant Frequency	Hz	8500	7200	5400	6400	10 000
Mounting Point Locations	Circle, Diameter mm (in)	50,8 (0,2)	76,2 (3,0)	114,3 (4,5)	Threaded hole in center of 19 mm (0,75) diameter table	Reference accelerometer
	Square, Side mm (in)	35,9 (1,414)	53,9 (2,13)	80,8 (3,18)		

Table 3.1. V System Exciter Heads

Heads when connected to the 4801 Body, and when connected to the 4805 Body with and without cooling. This force is the force F described in Section 3.1.

The fourth line lists the mass of the moving elements. Exciter Heads 4811, 4814 and 4815 are wound with aluminum wire and 4812 and 4813 with copper wire. The copper winding permits greater current flow per cross-sectional area and therefore greater force. Use of the aluminum winding lightens the total moving element weight.

The fifth line lists the available peak-to-peak displacement. A displacement of 13 mm (0,5 in) is adequate for almost all environmental vibration testing and calibration applications. The larger displacement of the 4814 is useful when testing structures or models.

The sixth line lists the resonant frequencies of the moving elements. For environmental vibration testing and calibration applications, operation below the resonant frequency provides low distortion and low cross motion. Although operation at frequencies up to 100 kHz is possible, the available force is considerably reduced.

Exciter Heads 4811, 4812 and 4813 have a centre mounting insert and four equally spaced outer inserts. Line seven gives both the diameter of the circle formed by the four outer inserts and the side of the equivalent square.

3.2.2. Brief Description

The High g Head Type 4811 has an 380 N (85 lbf) force rating, a light-weight moving element and high resonant frequency. It is especially well suited to the environmental vibration testing of small objects, either to very high vibratory acceleration levels or to high frequencies.

The Big Table Head Type 4813 has a 445 N (100 lbf) force rating, a large, stiff table, and extra strong flexures, to resist large applied moments. Environmental testing of large devices, of unbalanced objects, and of objects with severe transverse resonances, is best done with this head.

The General Purpose Head Type 4812 has a 445 N (100 lbf) force rating. The table is larger than the 4811 but smaller than 4813. The moving element weight, moment limit, and resonant frequency are intermediate in value between the 4811 and the 4813. The Exciter Head Type 4812 is truly a "General Purpose" head, suitable for a wide range of applications.

The Mode Study Head Type 4814 has a 25 mm (1 in) peak-to-peak displacement capability, compliant springs and a light-weight moving element. The table is round, 19 mm (0,75 in) in diameter, with a centre insert. Both metric and inch inserts are provided. This head is intended to be used either singly or in multiple exciter arrays as a force generator. In most structural vibration testing applications, either a push rod or a tension wire is connected between the exciter table top and the test object to minimize the coupling of skew forces from the test object to the exciter. Typical structural testing applications would include the determination of the frequency and damping for each of the resonant modes of aircraft elements, such as control surfaces, wings, or landing gear. Hydrodynamicists and aerodynamicists may find the Exciter Head Type 4814 useful for cavitation or vortex shedding studies. Chemists and Chemical Engineers may use this head to vary the rate of chemical reactions or to vibrate plastic extrusion dies.

The Calibration Head Type 4815 is designed for the calibration of accelerometers. A Reference Standard Accelerometer (included) is fixed to a mounting block in the centre of the table. The accelerometer to be calibrated is screwed into the top of the reference accelerometer. The skeleton of the Exciter Head Type 4815 is stiff, providing a resonant frequency of 10 kHz without an attached accelerometer, and more than 8,5 kHz with most types of accelerometers. Adequate force is provided for calibration at levels to 100 g at frequencies up to 10 kHz. Calibration at levels as low as 0,01 g is also possible, either by disconnecting the cooling system in the 4801 or by using a 4805 Exciter Body.

3.3. MOUNTING AND REMOVAL OF EXCITER HEAD

3.3.1. 4801 Body

With the power to the Exciter Body turned off, place the Exciter Head on top of the Exciter Body with the connector to the rear (the cable to the Exciter Body is also to the rear). The lower edge of the Head Protective Can will slip over the Upper Wheel of the Exciter Body and the Head Alignment Pins will rest on the upper surface of the Upper Wheel. Rotate the head until the Head Alignment Pins drop into the holes in the Upper Wheel and lower the head until it is fully engaged. The Split Hub of the Head will provide close concentricity guidance. Engage and press down the Head Latches in any order. Attach the cable from the Power Amplifier to the connector on the Head. The Exciter is now ready for operation.

To remove an Exciter Head, first turn off the power switch on the Power Amplifier, which controls the power for the magnetic field of the Exciter. Next, disconnect the cable from the Exciter Head, to eliminate the possibility of burning out the Driver Coil when the Exciter Head is removed from the Exciter Body. Lift the Exciter Head evenly and smoothly straight upward, being careful not to lift one side before the other. If one side is pulled up before the other, it is possible to jam the head with two pins out of their holes and one pin cocked and jammed inside its hole. If this happens, a gentle tap upward with a wooden block on the lower edge of the Head Protective Can or in a handle hole will release the jammed pin. Place the head on a smooth clean surface with the table upward, being sure that there is nothing on the surface that might damage the Driver Coil.

3.3.2. 4805 Body

Place the Exciter Head on top of the Exciter Body with the connector to the rear (the cooling air hole is also to the rear). The lower edge of the Head Protective Can will slip over the Upper Wheel of the Exciter Body and the Head Alignment Pins will rest on the upper surface of the Upper Wheel. Rotate the head until the Head Alignment Pins drop into the holes in the Upper Wheel and lower the Head until it is fully engaged. The Split Hub of the Head will provide close concentricity guidance. The magnetic field should be sufficient to hold the Head in place, but 3 x 4 mm screws are also provided, which can be screwed into the space normally used for the Head Latches.

Attach the cable from the Power Amplifier to the connector on the Head. The Exciter is now ready for operation.

To remove an Exciter Head, remove the hold-down screws from the Head Latch slots. Place your feet against the base on either side, take hold of the Head and jerk it upwards a few centimeters. This will pull the Driver Coil free of the magnetic field, after which the Head can be lifted off easily and smoothly.

3.4. INSERT INSTALLATION AND REPLACEMENT

Exciter Heads which use inserts are supplied with a mounting tool, a bottle of thread locking cement, and two boxes of inserts. One box contains inserts with metric internal threads and the other contains inserts with imperial internal threads.

To install an insert, the insert is placed on the tool, with the pin of the tool inside the insert internal thread and with the blade of the tool in the slot of the insert. Both the insert and the hole should be thoroughly cleaned with a solvent to remove all traces of oil or contaminants from fingerprints. A drop of cement is placed on the insert external threads, and the insert is screwed into the hole.

If properly installed, the upper surface of the insert should be about 0,1 mm (0,005 in) below the surface. If an insert is damaged, it can be unscrewed with the same tool. It is advisable to heat the insert with a soldering iron to weaken the cement before unscrewing the insert.

3.5. FIXTURES

It will almost always be necessary to prepare some sort of fixture to act as a transition from the Exciter to the test object. This is because the test object is usually attached at those places where it will be fixed in service, in order to duplicate field conditions, and these attachment points will seldom match those of the Exciter.

The fixture may be a simple plate with holes for bolting to the Exciter and for mounting the test object, or it may be a very complicated structure. Whether simple or complex, its main function is to convey the force generated in the Exciter to the test object, and therefore its performance can be crucial to the test.

It is beyond the scope of this book to do a comprehensive study of fixtures. However, if there are enough interested persons in a given geographical area, courses in fixture design can sometimes be arranged. Contact your B & K representative for more information.

3.6. MOUNTING THE FIXTURE AND TEST OBJECT

3.6.1. Bolt patterns and mounting screws

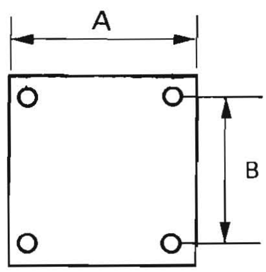
In Table 3.2 are shown the bolt patterns and other pertinent data for the three square table heads in the V Series.

Mounting screws are used to fasten the fixture to the table surface. A steel socket head screw with a large hexagonal socket and good threads is recommended.

Check each screw before it is used to determine:

a) That the threads are smooth, clean and undamaged,
b) that the socket is clean and undamaged, and
c) that the screw is the right length to engage all of the threads of the insert but not bottom in the hole.

It may be necessary to use a steel washer under the screw head either to avoid crushing the fixture or to adjust the length of the screw to avoid bottoming. The mounting screws should be tightened to the torque shown on the label on the Exciter Head. The use of a torque wrench is highly recommended.



		4811	4812	4813
A	mm	44,7	66,5	100,0
	in	1,76	2,62	3,94
B	mm	35,9	53,9	81,0
	in	1,41	2,12	3,18
Depth of Hole	mm	7,5	7,5	15,9
	in	0,30	0,30	0,63
Thread Size	mm	M4	M5	M6
	in	8–32 UNC	10–32 UNF	1/4–20 UNC
Thread Depth	mm	5,6	3,9	4,7
	in	,216	,165	,185

740508

Table 3.2. Fixturing details of the three square table Heads

3.6.2. Positioning the test object

If possible, the effective centre of gravity of the test object should be placed on the axis of the moving element, close to the table surface, and should remain fixed in position throughout the frequency range. For some specimens, this is not possible.

If the centre of gravity is not on the axis of the moving element, a moment is applied to the table, of magnitude equal to the product of the force needed to accelerate the test object and the distance between the moving element axis and the centre of gravity. This moment may deflect the moving element to the side and, if deflection is excessive, the side overload pads on the moving element will rub on the centre post. This problem can be minimized by providing a counterweight so that the centre of gravity of the combination is on the axis.

The test object is likely to have resonances of its own. These resonances may apply moments to the moving element or cause an effective shift in the location of the centre of mass. If the problem is serious, and if only part of the force capability of the exciter is needed to vibrate the test object to the desired level, a judicious addition of mass to the moving system may be helpful.

3.6.3. External Supports

The flexure systems of B & K Exciter Heads are designed to operate with side loads larger than commonly are encountered. If, however, it is necessary to vibrate objects that are likely to apply unusually large side forces to the moving element, it is advisable to use some form of external support to reduce these loads. An external support should not be used unless it is necessary, since it can lead to problems caused by additional mass, cross motion, distortion and/or alignment.

The problem of excessive side loads is most common when vibrating large objects in the horizontal direction. The problem is most severe when the centre of gravity of the object is remote from the mounting surface.

Many techniques have been devised to reduce the side forces on the moving element. A few of these techniques are:

a) Provide one or more wires or elastic cords from an overhead support to counteract the gravitational force.

b) Place the object on a slip table to counteract the gravitational force. Most of these slip tables are essentially a flat plate supported by a thin film of oil on a flat granite block.

c) Drive the object through a flexible link that is stiff axially but bends relatively easily. A thin rod, thinned down regions on a larger diameter rod, or a wire in tension may be a suitable solution for a particular problem.

d) Support the load with linear bearings. If systems using ball or roller bearings are used, some means should be provided to pre-load every ball or roller, or rattling and excessive distortion will result. Air bearings are smooth, and typically free of distortion, but the low stiffness may cause rotational resonance problems. High pressure linear oil bearings work well if carefully made and well maintained. However, they tend to be heavy and expensive and can be ruined by a little dirt in the oil.

3.6.4. Electrical connections to test objects

The test object mounted on the Exciter Head may have electrical connections made to it. For example, cables may be run from accelerometers mounted on the test object for measurement or control purposes. Where such connections are made, it is important to avoid making an earth (ground) connection to the Exciter Head through these connections. Such an earth can interfere with the proper functioning of the interlock system (which depends on the earthing of the Head via the Exciter Body) and can cause measurement or control errors owing to the creation of earth loops. In the case of accelerometers mounted on the test object, this earth connection can be avoided by insulating the bodies of the accelerometers from the test object, using for example insulated studs YP 0150 and mica washers YP 0534. If the test object is a piece of electrical equipment with its frame permanently connected to an energized circuit, then the test object itself should be insulated from the Exciter Head.

3.7. POSITIONING THE EXCITER

For testing of structures and structural models it is quite often necessary to use the Exciter in a position other than its upright position. The Exciter Body Type 4801 can, in fact, be moved through a full 360° circle.

To rotate the Exciter Body, loosen the large hand wheel on each trunnion, rotate to the desired angular position, and re-tighten the hand wheel.

The technique of mounting the Exciter will vary with the type of structure. If, for instance, a flexible structure is to be set in motion and the Exciter used in the horizontal position to move it, it would be desirable to bolt the Exciter Body directly to the floor or to a seismic block. On the other hand, it is sometimes useful to hang the Exciter in some position facing the test object. In this case, the entire Exciter could be suspended with elastic ropes. The Exciter Base can be removed, if desired and the Body and Head suspended by an eye-bolt arrangement screwed into the threaded holes in the lower bowl. When working directly over a structure, the exciter can be slung from ordinary ropes.

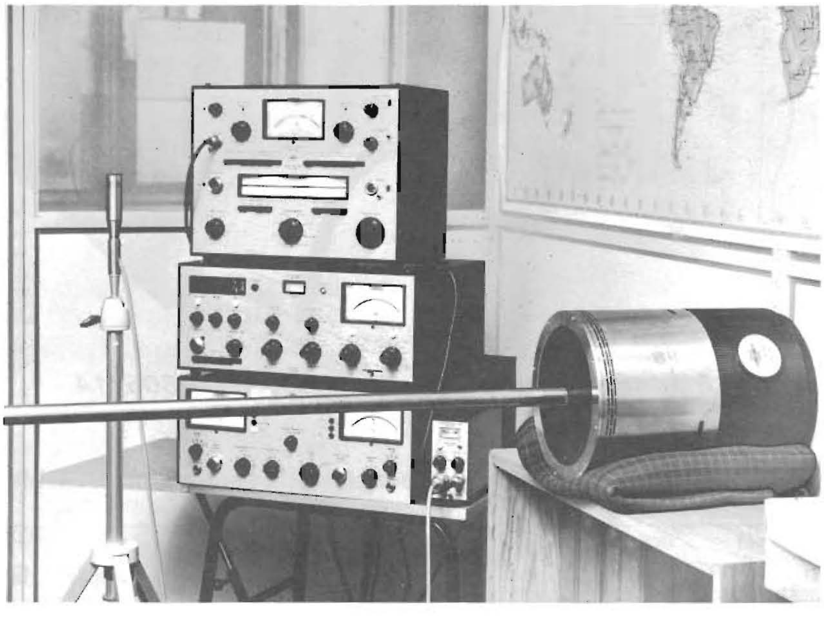


Fig. 3.2. Using the 4805/14 in an infrasonic experiment

Although no trunnion is provided for the Type 4805 body it can be easily used in a horizontal position by laying it on some cushioning material, as shown in Fig.3.2. The Exciter could also be suspended from a crane using the four 10 mm metric threaded holes in the base of the Body to fasten it to a plate. See Fig.3.3.

Dimensions of the plate shown are given in Fig.9.4.

3.8. STATIC LOAD LIMITATIONS

The amount of dead weight that can be placed upon the shaker is a function of three things: the flexure system of the Head used, the vertical centering capability of that particular Body/Head combination, and the test conditions.

The flexure stiffness for the High g Head is 17,5 N/mm (100 lbf/in), that of the General Purpose and Big Table Heads is 21 N/mm (120 lbf/in). The maximum allowable displacement from the horizontally centered position to fully deflected downward position is 6,35 mm (0,25 in). This means that the maximum static load which the flexures alone can bear is 110 N (25 lbf) and 133 N (30 lbf) respectively.

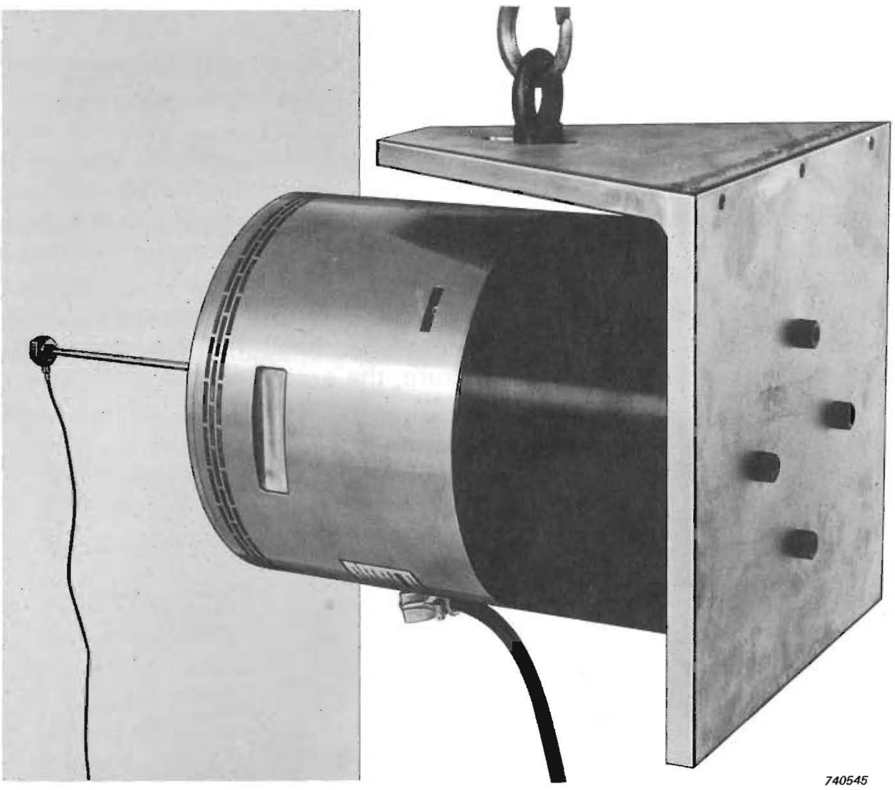


Fig.3.3. Panel excitation with a suspended 4805/14

The graph in Fig.3.4 shows the effect of static loading on available displacement for the three Heads.

Using the Power Amplifier Type 2707, it is possible to supply a DC voltage to the drive coil of the shaker and thereby raise or lower the table level. The total amount of force available depends on the type of drive coil in the Head and the type of Body used.

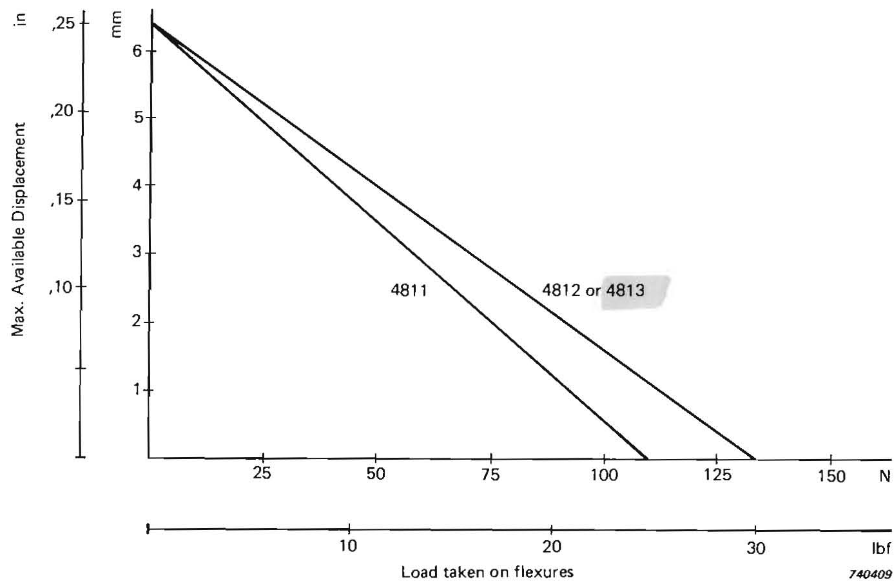


Fig. 3.4. Effect of static loading on available displacement

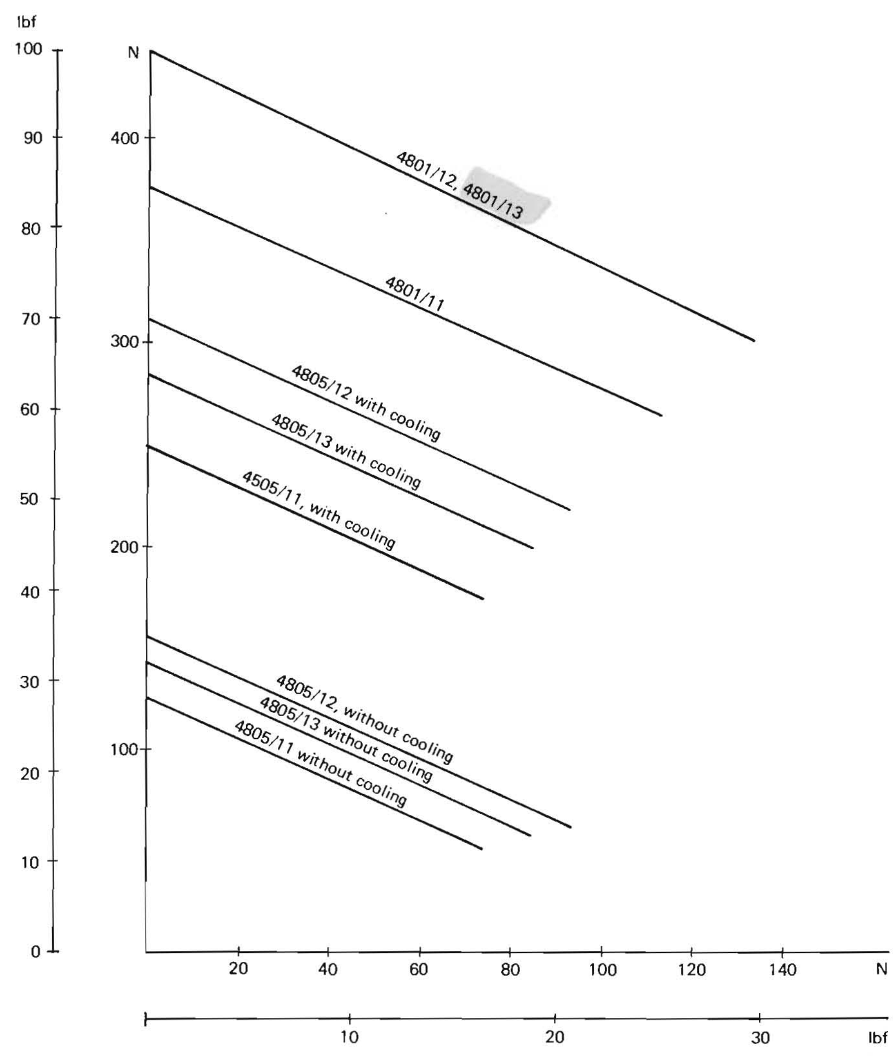


Fig. 3.5. Effect of using the static force on the available force

However, it should be recognized that this current passing through the drive coil is a part of the total allowable current and therefore reduces the dynamic force rating of the shaker by reducing the amount of alternating current which may be run through the coil.

At frequencies above 150 Hz the dynamic rated force is reduced by 2,5% if half of the available static force is used and is reduced by 10% if the full static force is used. At frequencies below 150 Hz the dynamic rated force is reduced by 15% if half of the available static force is used and is reduced by 30% if the full static force is used.

Fig.3.5 shows the effect on the available force using the static centring force.

It is here that the third controlling factor enters into the allowable dead weight calculation, i.e., the test conditions. The test object will be run at a certain acceleration level, which limits not only the weight, but how much of the force may be used up in centring the table. Also, the test will be conducted over a certain frequency range, and the displacement at the low end of this test range will affect the available amplitude.

The two plots in Figs.3.4 and 3.5 can be used to determine how much of the dead weight can be taken up by the static force and how much by the flexures, for a given test.

Examples:

1. In Fig.3.6 is shown an arrangement for vibration testing an electronic instrument on a 4801 Body and 4813 Head. The mass of the instrument to be tested is 16,8 kg (37 lb), and that of the fixture is 6,7 kg (14,7 lb). The total mass to be driven, including the mass of the moving element, is therefore 24,2 kg (53 lb).

Question: Can this arrangement be driven at 10 m/s^2 in the frequency range 20 Hz to 1 kHz?

At least 237 N (53 lbf) is needed to drive the system at 10 m/s^2. If the full static force is used, there will still be 70% of the full dynamic force available, or 312 N (70 lbf).

The rest of the weight will be taken up by the flexures. The downward force exerted on the flexures by the remainder of the weight is 96,5 N (21,7 lbf). From Fig.3.4, it can be seen that the remaining available displacement is 1,75 mm (0,07 in). 10 m/s^2 acceleration equals 1,75 mm at 12 Hz, so the 20 Hz lower limit of the test is well within the capability of this arrangement.

2. A manufacturer of electrical connectors wants to test a set of connectors weighing 500 g at 100 m/s^2, from 20 to 2000 Hz, using a 4805 Body and a 4812 Head.

Question: What is the largest possible mass which the fixture can have?

100 m/s^2 at 20 Hz corresponds to 13 mm double displacement, i.e. the full displacement of the 4812 Head. Therefore, the mass of fixture and test object must be raised with the static centring.

A study of the lines in Fig.3.5 will show that they have a slope of —1, i.e., one may say that: Force Available = Maximum Specified Force-Lifting Force. The lifting force will be the force necessary to lift the test object and fixture, in this case,

$$F_{LIFT} = (0,5 + m_F)\,10 = 5 + 10\,m_F$$

Fig.3.6. Vibration testing of an electronic measuring instrument

where m_F is the mass of the fixture and $10\,m/s^2$ is approximately the gravitational acceleration. The force necessary to drive the test object, fixture and moving element is:

$$F_{DRIVE} = (0,5 + 0,45 + m_F)\,100 = 95 + 100\,m_F$$

The maximum specified force available for the 4805/4812 combination is 312 N. The drive equations can therefore be stated as:

$$F_{DRIVE} = 312 - F_{LIFT} = 312 - 5 - 10\,m_F$$

Combining the two equations,

$$307 - 10\,m_F = 95 + 100\,m_F$$

$$110\,m_F = 212$$

$$m_F = 1{,}93\,kg$$

3.9. PUSH RODS

Since the Mode Study Head has a central point through which all its force is directed and since it is usually more convenient to have the driving point a short distance from the

Head, a push rod is generally used to transfer the force. This can also be used to provide external protection for the Head. The dimensions and stiffness of the rod should be designed in such a way that side loads and moments result in bending of the rod rather than rubbing of the side load pads.

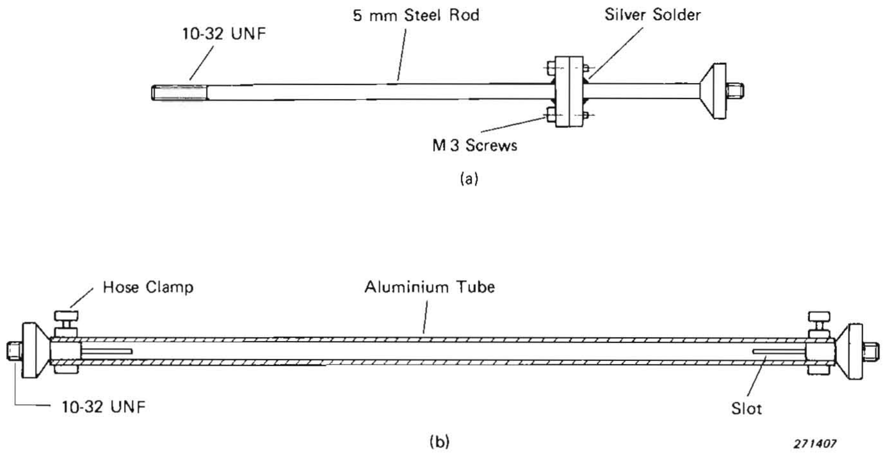


Fig. 3.7. Push rods for use with the Mode Study Head

Fig.3.7 shows sketches of two types of push rods for use with the Type 4814 Head. In a) the two halves are screwed tight to the Exciter Head and the object, then locked together by means of the four centre screws. In b) a slotted aluminum tube is slipped over the two 10 — 32 UNF screws, then clamped in place with small hose clamps. This is only suitable for applications at frequencies below 500 Hz.

3.10. START-UP PROCEDURE

This section assumes the Exciter system is powered by the 2707 Power Amplifier driven by a suitable signal source. Before the Exciter is turned on, all actions discussed in sections 3.1 to 3.8 should have been completed. Set the CURRENT LIMIT and DISPLACEMENT LIMIT controls according to the characteristics of the Head employed. For the 4805 without cooling, the CURRENT LIMIT on the power amplifier should be set to half the value stated on the Head. The AMPLIFIER GAIN control should be in its "Reset" position. EXCITER INTERLOCK should be "In".

To turn on the Exciter, turn the POWER switch on the Power Amplifier clockwise to "Power On", and after a one second pause, further clockwise to "Load On". The "Power On" position turns on the power supplies in the Power Amplifier and the Field Supply and Blower Motor in the Exciter Body Type 4801. The "Load On" position connects the driver coil of the Exciter Head. The one-second pause prevents starting-transients from causing motions of the moving element.

Confirm that the signal source connected to the input to the Power Amplifier is correctly adjusted.

Turn the AMPLIFIER GAIN control from the "Reset" position slowly clockwise until the desired amplitude of vibration is reached. A counter-clockwise turn and click to the "Reset" position resets the protective circuits and connects the signal source to the Power Amplifier if some abnormal use has tripped off one of the protective circuits.

3.11. "EXCITER" LAMP INDICATION

A lamp labelled EXCITER is mounted on the front panel of the Power Amplifier Type 2707. Lighting of this lamp indicates that something is wrong at the Exciter. Drive to the Exciter Head is removed when this lamp is lit.

a) Make sure that the Exciter Head is properly mounted on the Exciter Body.

b) Make certain that the Exciter Cable is connected both to the Power Amplifier and to the Exciter Head.

c) Check if dirt or a piece of paper blocks the Field Supply Air Inlet Screen. If so, clean, allow 20 minutes for the Exciter to cool, and turn on again.

d) Check the MOTOR fuses (see Fig.2.5). If any of these are blown, turn off the POWER switch on the Power Amplifier, clean the Field Supply Air Inlet Screen, replace the fuse, wait 20 minutes for the motor to cool down and turn on. If the fuse blows again see "Care and Maintenance", Chapter 8.

3.12. OPERATION IN HIGH AMBIENT TEMPERATURES

3.12.1. 4801 Body

The cooling system for the 4801 is designed to limit component temperatures to normal values for ambient temperatures as high as 104°F (40°C). Operation with ambient temperatures as high as 122°F (50°C) is possible if input power to the Driver Coil is reduced by limiting Driver Coil currents slightly.

For ambient temperatures of 104°F to 122°F (40°C to 50°C) reduce the setting of the CURRENT LIMIT control by 1% for each 2°F above 104°F (1% for each 1°C above 40°C). The available force is reduced in proportion to the reduction in current.

3.12.2. 4805 Body

The above rules also apply to the Type 4805 when adequate cooling is provided (see section 2.3). However, if there is no cooling, then the CURRENT LIMIT should be set to half of the value shown on the back of the Head and reduced proportionately for increased ambient temperatures.

3.13. REDUCTION OF RESIDUAL MOTION

The residual motion is the motion of the moving element when the input signal to the Power Amplifier is zero. The residual motion of the system consisting of the Power Amplifier Type 2707, the Exciter Body Type 4801, and a matching Exciter Head is typically about 0,05 mms^{-2} . This low level of background motion is insignificant for most applications.

It is traceable to Amplifier noise and fan motor residual unbalance. The proportion of the latter depends on whether the Amplifier OUTPUT IMPEDANCE is set to "Low" or "High". This is because the suspension provides some isolation of the table from vibrations of the Exciter Body, and the amount of vibration isolation is influenced by the impedance in the drive coil electrical circuit.

4. DESCRIPTION OF 4801 EXCITER BODY

Fig.4.1 is an exploded view of a Type 4801 Exciter Body, showing the major parts. These can be divided into two groups, the Magnet Assembly and the Field Supply and Cooling Assembly.

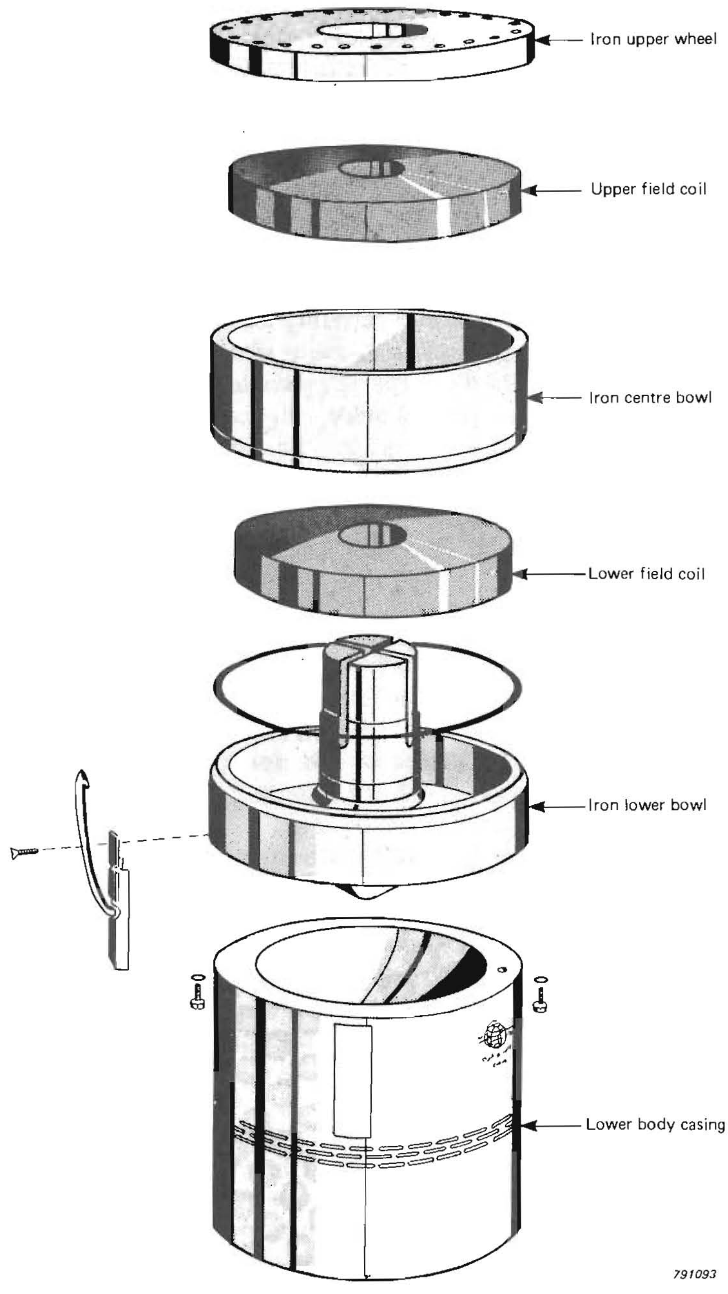


Fig.4.1. Exploded view of the Exciter Body 4801

4.1. THE MAGNET ASSEMBLY

The magnetic system is double-ended, having two magnetic circuits supplying magnetic flux to a single air gap. Except for the Split Hub, which is part of the Exciter Head, the magnetic system is contained in the Exciter Body. The Magnet Assembly has two field coils, two Secondary Bands, and three iron parts, the Stem, the Centre Bowl and the Upper Wheel.

4.1.1. Field Coils

The Lower Coil is clamped between the Stem and the Centre Bowl. The Upper Field Coil is clamped between the Centre Bowl and the Upper Wheel. Rubber spacers are fitted above and below each field coil. These spacers provide a stiff, heavily damped support for the field coils, allowing for thermal expansion yet restricting relative motion due to vibration.

4.1.2. Secondary Bands

An Inner Secondary Band surrounds the inner post of the Stem just inside of the Driver Coil. An Outer Secondary Band is mounted on the inner surface of the lower part of the Centre Bowl just outside of the Driver Coil. These are copper rings which are soldered in place and nickel plated.

Induced currents in these shorted Secondary Bands keep the impedance of the Driver Coil low. If these Secondary Bands were omitted, the voltage needed to drive the exciter at high frequencies would be greatly increased and a much larger amplifier would be needed.

4.1.3. Stem

The Stem is the lower part of the Magnetic Assembly, the inner surface of the magnetic air gap, and the guiding surface for the Split Hub. It contains the lower field coil. Slots are cut into the center post of the Stem to provide clearance for the ribs of the moving element skeleton. The lower magnetic circuit is formed by the bowl shaped part of the Stem, the lower part of the post of the Stem, and the lower part of the Centre Bowl.

4.1.4. Centre Bowl

The Centre Bowl is the middle part of the Magnetic Assembly, the outer surface of the magnetic air gap, and contains the upper field coil. The bottom of the Centre Bowl is common to both the lower and upper magnetic circuits. The upper magnetic circuit is formed by the Centre Bowl, the upper part of the post of the Stem, the Split Hub, and the Upper Wheel.

4.1.5. Upper Wheel

The Upper Wheel is the upper part of the Magnetic Assembly, and forms the top of the upper magnetic circuit. The Exciter Head is held rigidly to the upper surface of the Upper Wheel by both magnetic forces and by hold-down clamps.

4.2. THE FIELD SUPPLY AND COOLING ASSEMBLY

The Field Supply and Cooling Assembly consists of the Head and Field Cooling Fan, the Blower Motor and the Field Supply.

4.2.1. The Head and Field Cooling Fan

The Head and Field Cooling Fan draws air through the Exciter Coils and past the Driver Coil. The air is exhausted through an air duct. The fan is a centrifugal fan driven by the Blower Motor mounted directly below on the Motor and Field Supply mounting plate. Fig.4.2 shows the path taken by the cooling air. The cooling air flows downward through the Exciter. The air enters the Exciter through perforations around the top of the Exciter Head. It is drawn through the Magnet Assembly by the Head and Field Cooling Fan and exhausts at the lower rear of the exciter.

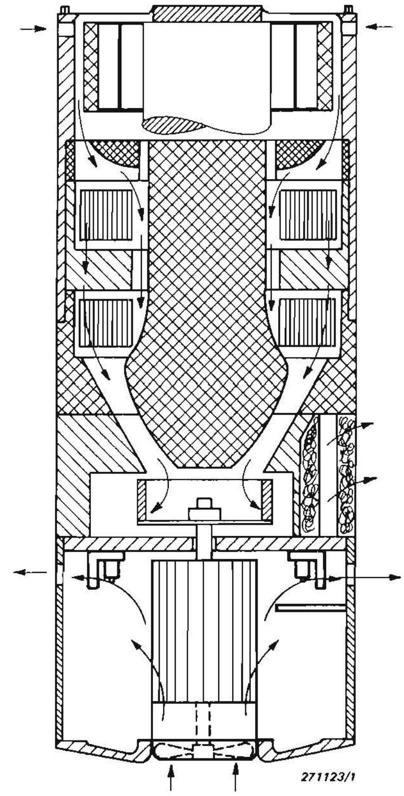


Fig.4.2. Sectional view of an Exciter Body and Head showing direction of cooling air flow

In the Magnet Assembly the air flows through two parallel paths. The outer path is through openings in the Upper Wheel, through the annular passages in the Upper Field Coil, through openings in the Centre Bowl, through the annular passages in the Lower Field Coil, and then through openings in the lower part of the Stem. The inner path is through the openings in the Upper Wheel, radially inward to the post of the Stem, downward along the inner and outer surfaces of the driver Coil and the inner and outer Secondary Bands, and then to the openings in the lower part of the Stem. Rubber seals between the Field Coils and the Centre Bowl keep the inner and outer air paths separate and prevent "short circuiting" the Driver Coil cooling.

Air through the outer path cools the Upper and Lower Coils. Air through the inner path cools the Driver Coil and the Secondary Bands.

The motor-cooling fan is mounted directly on the lower end of the motor drive shaft. It takes in air from below the Exciter and exhausts through side vents.

4.2.2. Blower Motor

An AC Blower Motor drives the Head and Field Cooling Fan. Since the motor speeds up to a max. of 2900 RPM when the mains frequency is increased (to 440 V, 60 Hz), increased cooling is provided when the Field Coil dissipation is increased.

4.2.3. Safety Circuit and Field Supply

The three-phase power supply for the field supply is fed to the rectifiers located on the safety circuit board in the base of the Exciter Body. The safety circuit provides the following protective functions:

a) Checks that all three phases are connected.

b) Checks that the cooling motor fuses mounted on the safety circuit board are intact.

c) Checks that the phases are connected correctly to ensure against the cooling fan rotating backwards.

d) Checks field coil temperature with the help of a sensor in the field coils.

e) Checks that the exciter head is mounted on the body.

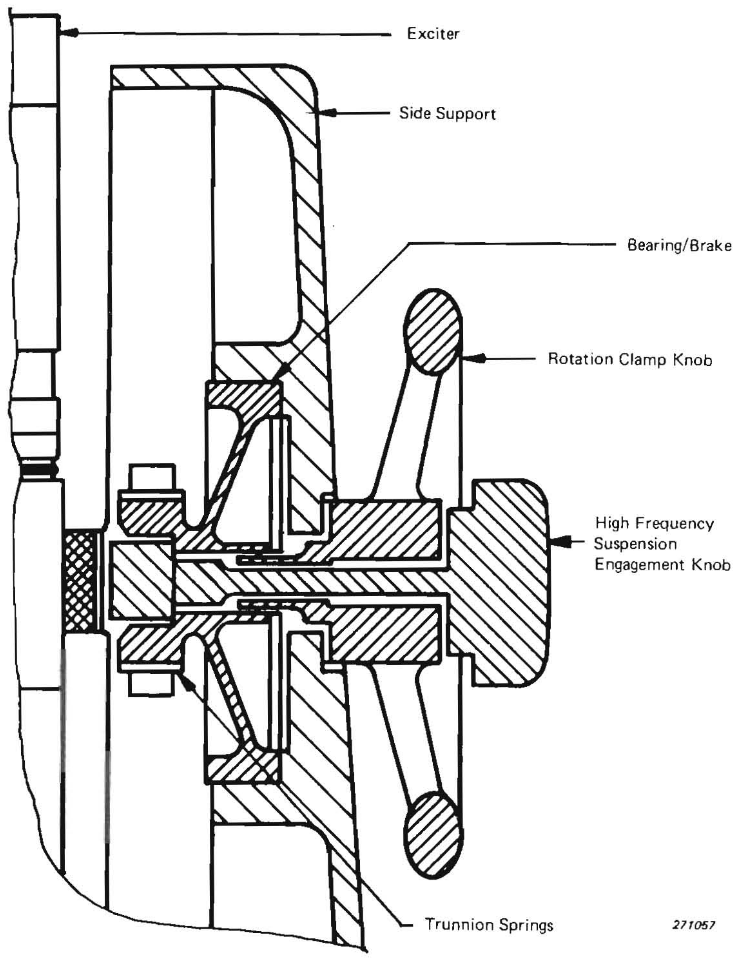


Fig. 4.3. Cross-section of the Exciter Support

If any of these malfunctions is detected the Exciter protection circuit operates, cutting off the drive coil power and field coil power. The indicator lamp "Exciter" on the front panel of the Power Amplifier will be lit to indicate that the malfunction is confined to the shaker.

4.3. EXCITER SUPPORT

The Exciter Support consists of three large parts, the Base and the two Side Supports, and a number of smaller parts associated with the connection of the Side Supports to the Magnet Assembly of the Exciter Body.

4.3.1. Base

The Base, with the two Side Supports, provides the frame for the exciter. 15 mm (0,59 in) holes are provided in each corner of the Base on a 305 mm (12 in) square (see Fig.2.4). These holes typically may be used to attach the exciter to a reaction mass to reduce Exciter Body motion, or alternatively, to hang the exciter upside-down from shock cords for structural testing.

4.3.2. Side Supports

The Side Supports are bolted to the Base. These Side Supports provide the bearing surface for the exciter trunnion assembly and act as a protective cover for the trunnion springs.

4.3.3. Trunnion Springs

The Trunnion Springs permit relative motion along the axis of the exciter, but restrict motion radially. When the exciter is used with slip tables, it is important that the table location is accurately repeatable. The high radial stiffness satisfies this requirement. In the axial direction, the resonance frequency of the unloaded exciter on the Trunnion Springs is about 14 Hz.

4.3.4. High Frequency Suspension Engagement Knob

The smaller of the two knobs in the top centre of each Side Support (Fig.4.3) is the High Frequency Suspension Engagement Knob. When both of these control knobs are at their counterclockwise limit, the low frequency suspension is engaged. At the clockwise limit a highly damped high frequency suspension is engaged.

These knobs should both be either fully clockwise or fully counterclockwise at all times. There is no advantage to be had by leaving them in an intermediate position.

NOTE: The knobs should always be fully clockwise during transport.

4.3.5. Rotation Bearing/Brake

The Rotation Bearing/Brake is a four segment wide rimmed wheel that acts both as a bearing and as rotational brake. As a bearing, it rotates freely in a brass liner in the Side Support.

4.3.6. Rotation Clamp Knob

The larger of the two knobs in the top center of the Side support is the Rotation Clamp Knob. When this knob is rotated clockwise, the Rotation Brake expands and rotation of the exciter relative to the Side Support is prevented. This knob should always be in the clockwise tight position when the exciter is operated.

4.4. 4801 (S)

A steel plate base, without suspension system or trunnion mechanism, is available for the 4801 Exciter Body. See Fig.4.5. The Exciter Body Type 4801 fitted with the fixed base is designated Type 4801 S.

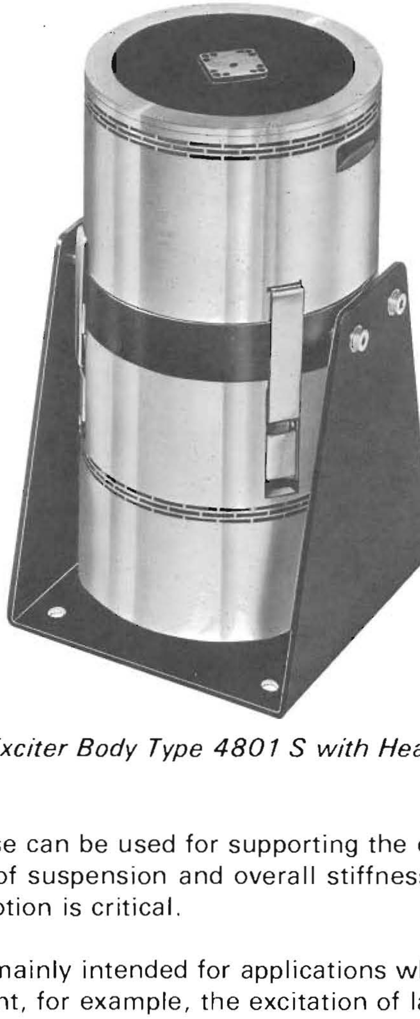


Fig.4.4. Exciter Body Type 4801 S with Head Type 4811

This simplified base can be used for supporting the exciter body in the normal way on the floor but the lack of suspension and overall stiffness makes it unsuitable for applications where purity of motion is critical.

The fixed base is mainly intended for applications where the suspension/trunnion system would be redundant, for example, the excitation of large structures to determine resonant modes, mechanical impedance or transmissibility. Here the exciter is often slung from ropes. Where the exciter is to be used on a seismic block of low resonant frequency, the suspension system integral with the standard base is not necessary.

For customers who initially purchase the Exciter body fitted with the Fixed (S) base and later wish to convert to the standard base (T), this is available as a separate item (KS 0031) on request.

5. PERMANENT MAGNET BODY, TYPE 4805

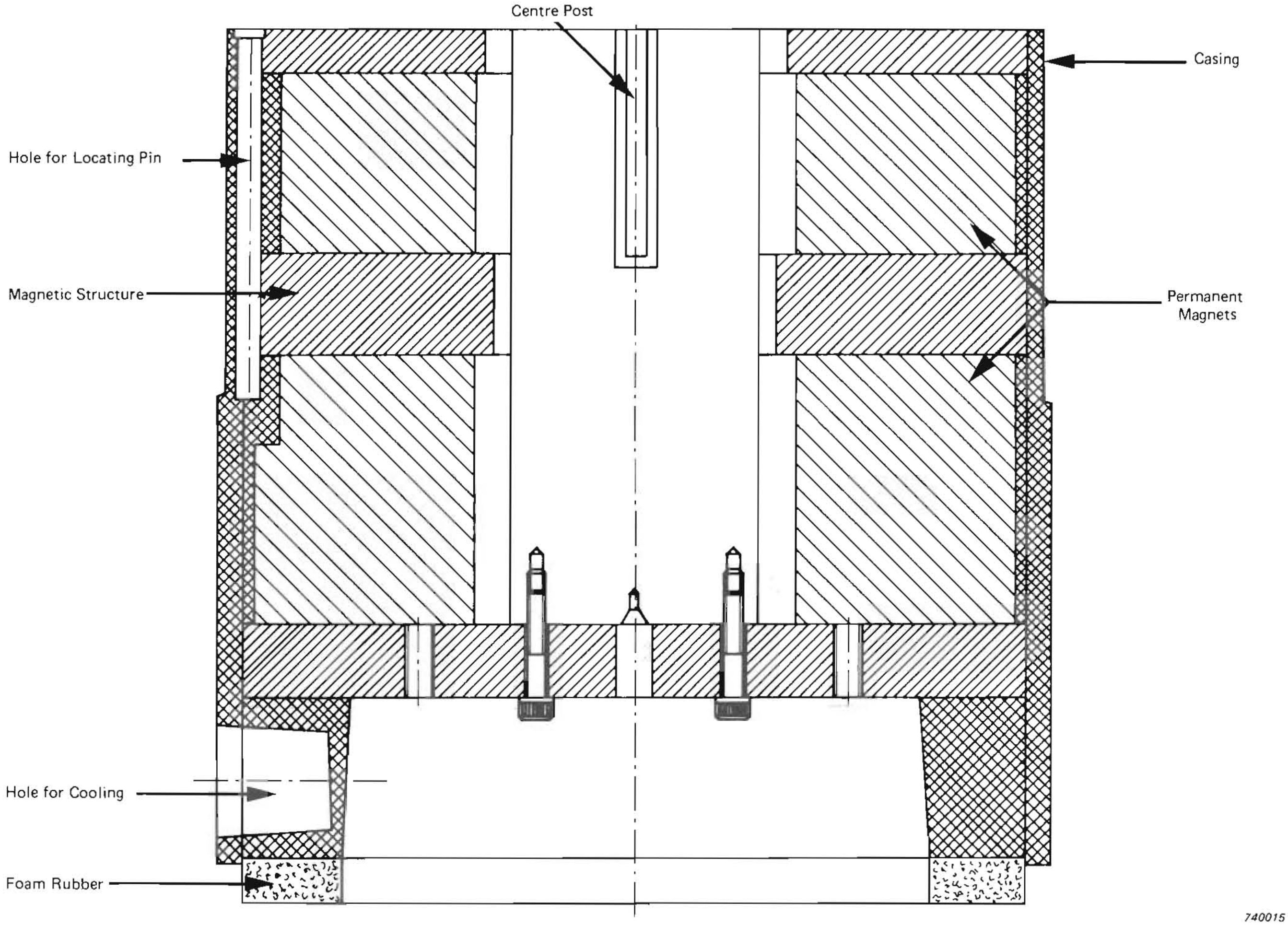


Fig.5.1. Cross-sectional drawing of the Permanent Magnet Body

Fig.5.1 shows a cross-sectional drawing of the Permanent Magnet Body. The magnetic field is supplied by a stack of annular magnets held in position by a cast iron magnetic structure, which also serves to contain the magnetic field in the Exciter Body as much as possible. The stainless steel center post is basically the same as that of the Type 4801 in order that all the Heads may fit. The 10 mm mounting holes are also shown. A foam rubber annulus at the base serves to isolate the Shaker from its surroundings.

NOTE: Users working around the 4805 are advised to remove wristwatches. Even when the Head is mounted, there is a strong field down the side of the Body, at just about the point where one might wrap one's arms around it to lift it.

6. DESCRIPTION OF EXCITER HEADS

6.1. HEADS WITH SQUARE TABLES: TYPES 4811, 4812, 4813

Figs.6.1, 6.2 and 6.3 show the Types 4811, 4812 and 4813 respectively with their rubber boots and protective cans removed. A description of their major features follows.

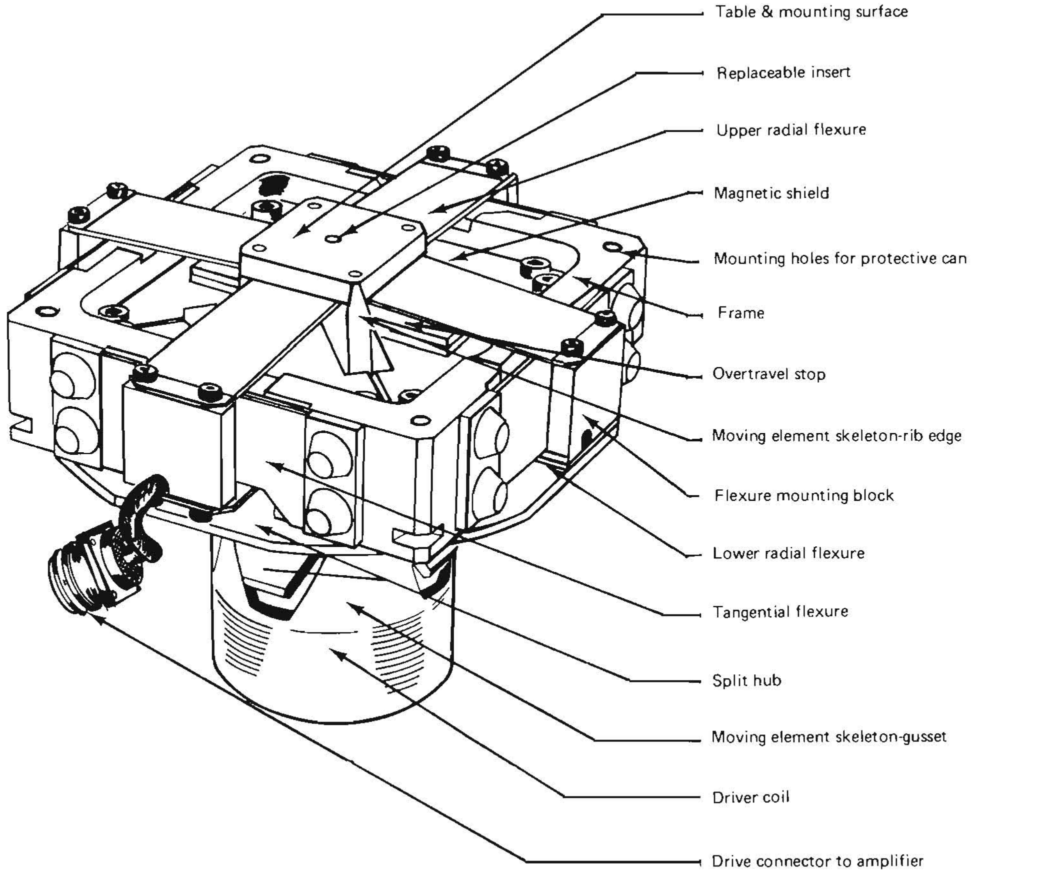


Fig.6.1. Head 4811 with rubber boot and protective can removed

6.1.1. Table and Mounting Surface

All three of these Heads have square tables with dimensions as shown in Table 3.2. The mounting surface is hardened and anodized. At the center of the table and at the four corners are threaded holes. The threads are NOT to be used to mount fixtures directly. They are intended for the special inserts supplied with the Head. See Section 3.4.

6.1.2. Flexure System

Eight radial flexures, four upper and four lower, and four tangential flexures form a strong guidance system for the moving element. The moving element moves easily along

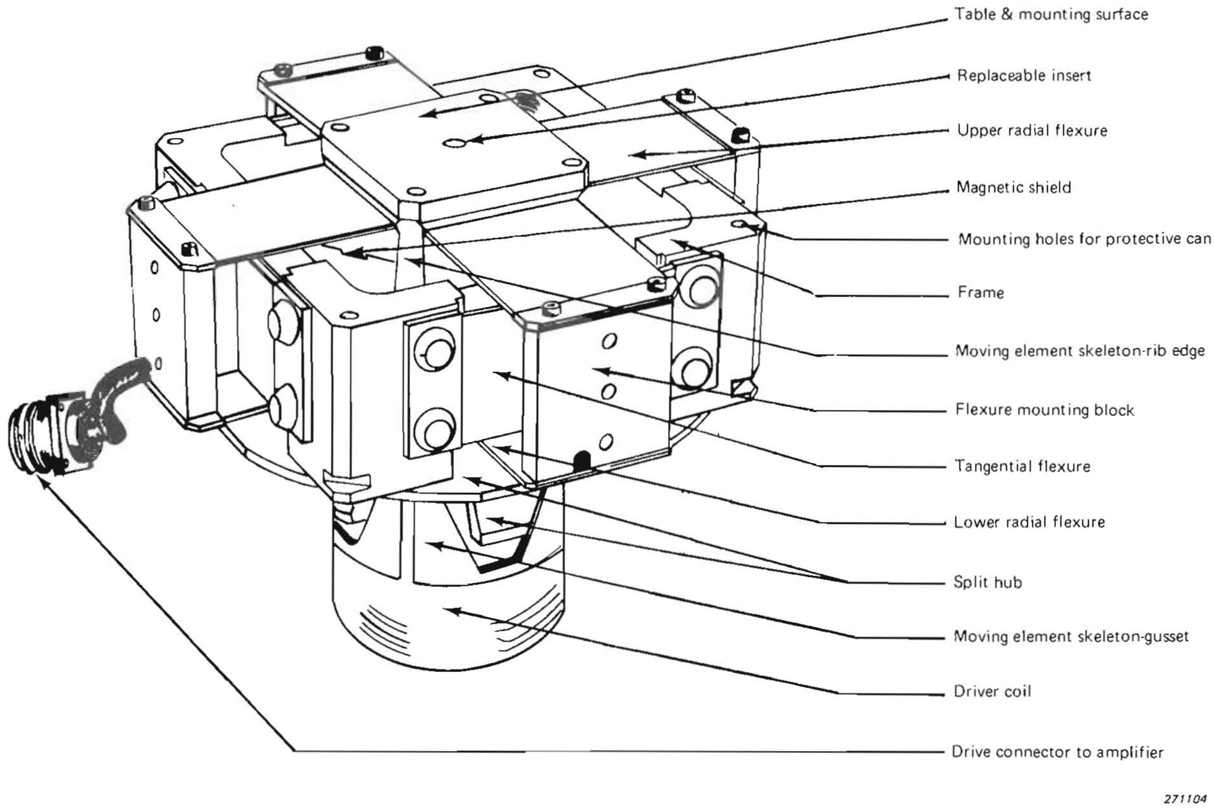


Fig.6.2. General Purpose Head 4812

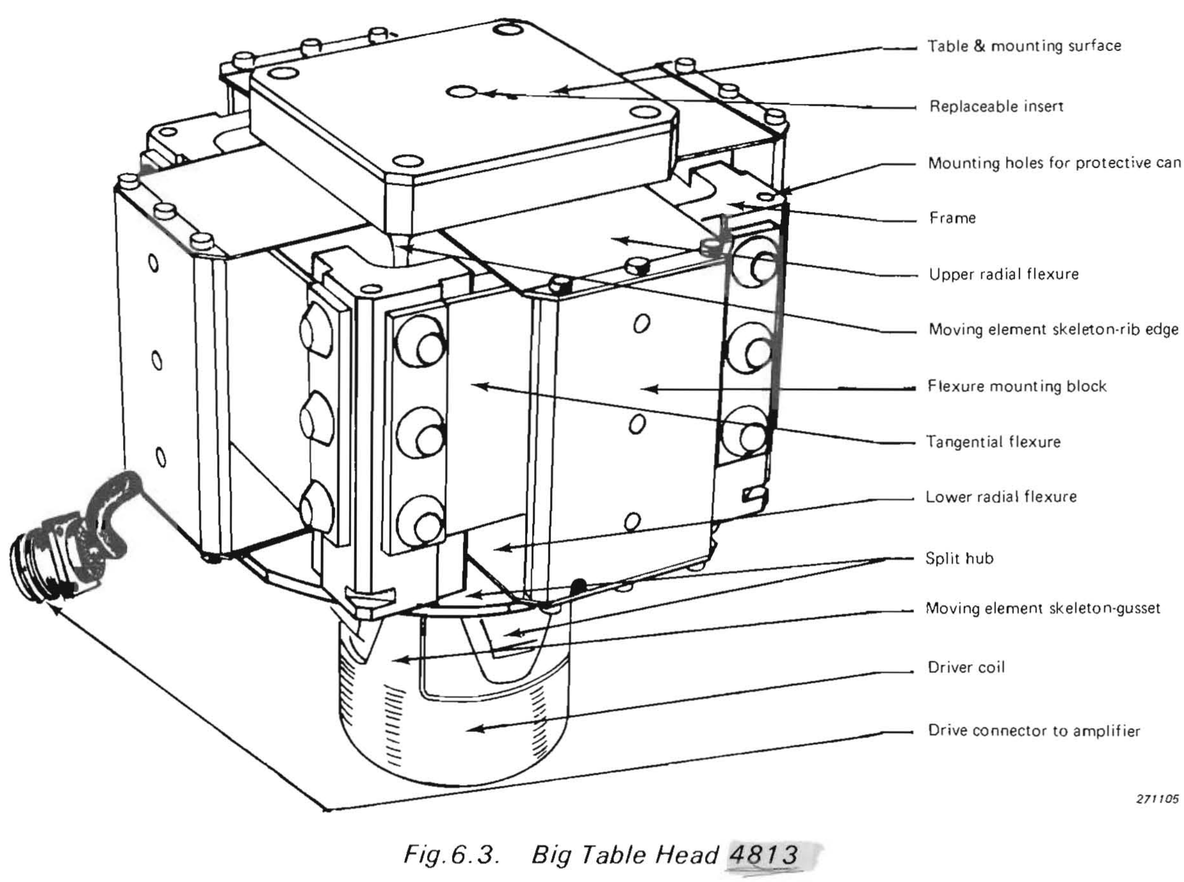


Fig.6.3. Big Table Head 4813

its axis but is prevented from moving sideways or rotating in any direction. The inner ends of the radial flexures are attached to the moving element skeleton. The outer ends of the radial flexures are mounted in pairs to flexure mounting blocks. The flexure mounting blocks are mounted on the tangential flexures. The tangential flexures are mounted on the frame.

As the moving element moves up or down, the eight radial flexures bend as a double cantilever beam. The outer ends of the radial flexures, the flexure mounting blocks, and the tangential flexures all move inward as the moving element moves either upward or downward, and therefore vibrate at twice the frequency of the table motion.

A side force applied to the top of the table normal to the main axis tends to deflect the radial flexures as beams, but little deformation results since the beams are very stiff in this direction. Motion of the outer ends of the radial flexures is resisted by the high torsional stiffness and high lengthwise stiffness of the tangential flexures.

Each flexure is a sandwich of metal and rubber bonded together. The design is such that a very high degree of damping is provided for the resonant modes of the flexure.

6.1.3. Stray Magnetic Field

Magnetic shields are provided to reduce the flux density above the table top. In Figs.6.4 and 6.5 are shown plots of typical steady state flux density as a function of distance above the table top. The alternating flux density is negligible.

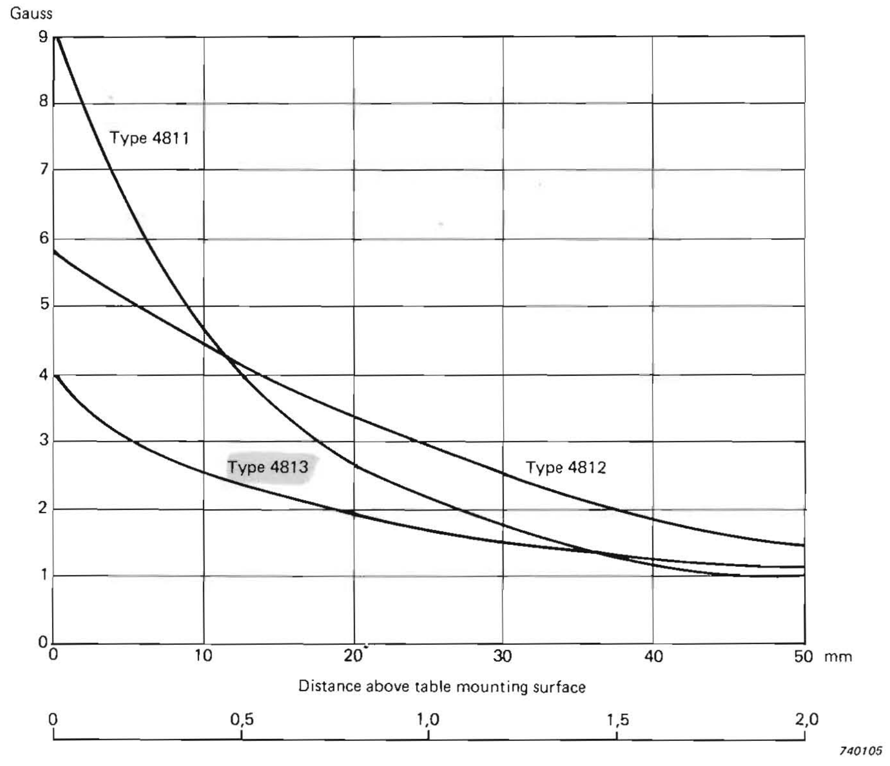


Fig.6.4. Magnetic flux density above table top. Types 4811, 4812, 4813 with Type 4801 Body

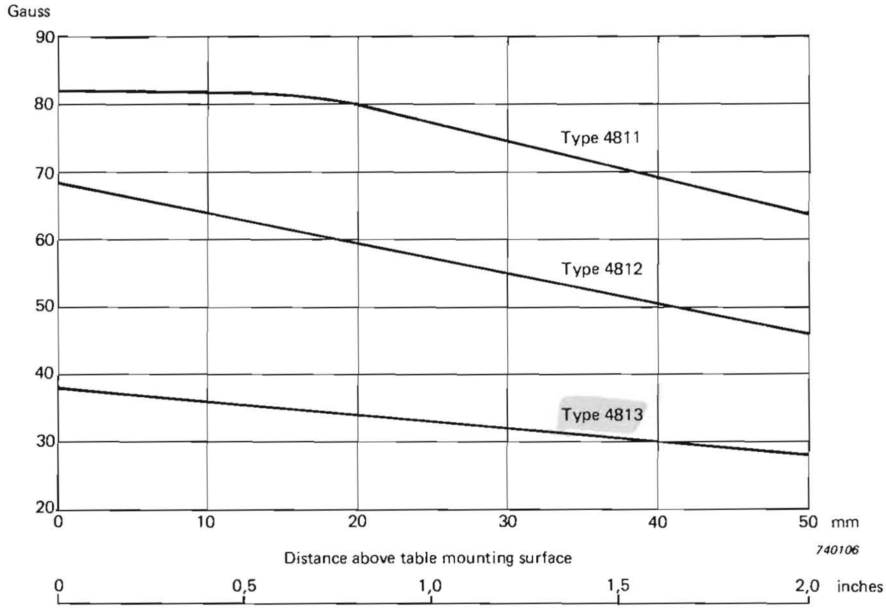


Fig. 6.5. Magnetic flux density above table top. Types 4811, 4812, 4813 with Type 4805 Body

6.1.4. Mechanical Over-travel Stops

Over-travel stops are provided on the upper and lower surfaces of the magnetic shields. These stops permit a total peak-to-peak travel of at least 12,7 mm (0,5 in).

The over-travel stops are intended for emergency use only. The stops are designed to absorb the energy of an occasional high velocity impact. Neither the moving element nor the resilient pads are designed for frequent impacts, and such impacts should be avoided since forces of thousands of newtons and decelerations of many thousands of g can be generated, possibly causing damage to both the Exciter Head and to the specimen.

6.1.5. Split Hub

The split hub is made up of four identical pieces, each machined from a pure iron casting. The upper part of each piece is a segment of a circle lying in a similar plane to the table itself. The lower part approximates a tapered quarter cylinder and is concentric with the vertical axis of the Shaker Base.

The split hub has a dual purpose. It is a part of the upper magnetic circuit of the field and is made a part of the Exciter Head to provide an opening into the center of the magnetic assembly through which the driver coil can be inserted as the Exciter Head is mounted. The lower part of the split hub is machined to a fine tolerance fit to the center post. This provides a concentricity guide during mounting, preventing the driver coil from rubbing as It is slid over the centre post into the air gap. It also ensures the correct positioning of the driver coil in the air gap during operation.

6.1.6. Driver Coil

The Driver Coil is formed as a double layer of rectangular, high purity wire, one layer wound on the outside of the cylindrical part of the skeleton and one wound on the inside. The wire used for the Types 4812 and 4813 is copper, while that used in the Type 4811 is aluminum to keep the mass of the moving element as low as possible. The wire has a very thin high temperature insulation which takes up as little space as possible, thereby reducing the generated heat by allowing a larger wire size to be used.

6.1.7. Side Overload Pads

On each side of the ribs of the skeleton, just above the drive coil, is located a small raised area (see Fig.6.6). These are the side overload pads, whose function is to protect the driver coil from rubbing against the centre post. These pads should not be permitted to rub for any length of time. When unusually heavy side loads or specimens with possibly excessive side moments are mounted on the table, the acceleration waveform should be monitored on an oscilloscope.

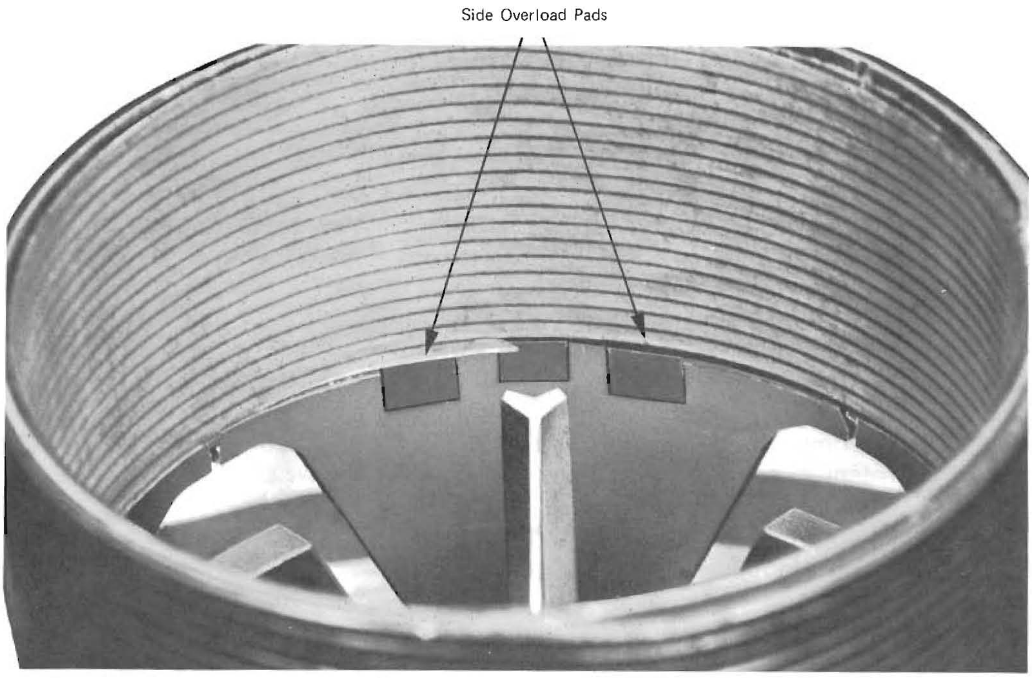


Fig.6.6. Side overload pads

6.1.8. Moving Element Skeleton

The moving element skeleton is a high strength aluminum alloy structure that attaches all of the parts of the moving element together. It is designed to provide the best possible coupling of the force generated by the driver coil at one end to the test object attached to the table at the other end within the limitation set by the allowable weight of the moving element.

The driver coil is attached to the lower end of the skeleton. The force transmitted to the skeleton from the driver coil passes upward through four triangular shaped load distributing gussets into the four ribs of the skeleton and into the four rib edge stiffeners. The ribs and rib edge stiffeners pass the force upwards to the table. The centre insert of the table is a continuation of the intersection of the ribs. The outer four inserts are continuations of the rib edge stiffeners. The design is such that approximately equal stiffness exists between the driver coil and each of the inserts, so that deformation, or "diaphragming" of the table top surface is small, thus minimizing any damage to the test object that might be caused by base bending.

The upper radial flexures are attached to the lower surface of the table by a combination of bolts and high strength adhesive at the outer edge. The lower radial flexures are attached by bolts and high strength adhesive to a stiff platform formed integral with the skeleton.

The skeleton is machined from a single piece of aluminum. A closely controlled machining process causes the moving element to have a high resonant frequency and very little unbalanced mass to cause cross motion problems.

6.1.9. Boot

The boot is a rubber diaphragm bonded to the outer skirt of the table and extending out to the protective can. It prevents dirt and debris from falling into the exciter. A clamping ring holds the outer edge of the boot to the protective can.

6.1.10. Protective Can and Guidance Pins for the Head

The protective can for the Head provides a stable base for the Exciter Head when the Exciter Head is not on the Exciter Body. It also protects the driver coil and the moving element. Set in the supporting ring of the protective can are three guidance pins, which serve to line up the Head as it is being placed on the Body and keep the drive coil from being bumped against the sides of the opening during placement and removal.

6.2. THE MODE STUDY HEAD TYPE 4814

Fig.6.7 shows an illustration of the Mode Study Head Type 4814 with its rubber boot and protective can removed.

The construction of the Type 4814 Head is basically the same as that of the previous three, with the following differences:

1. The Type 4814 is provided with a 19 mm (0,75 in) diameter table with one centrally located mounting point.

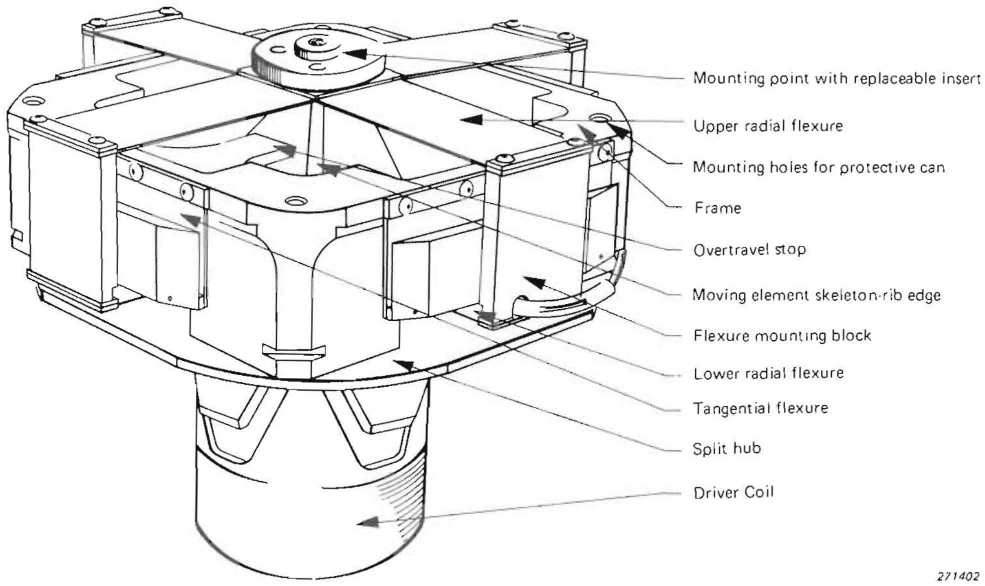


Fig.6.7. Mode Study Head Type 4814

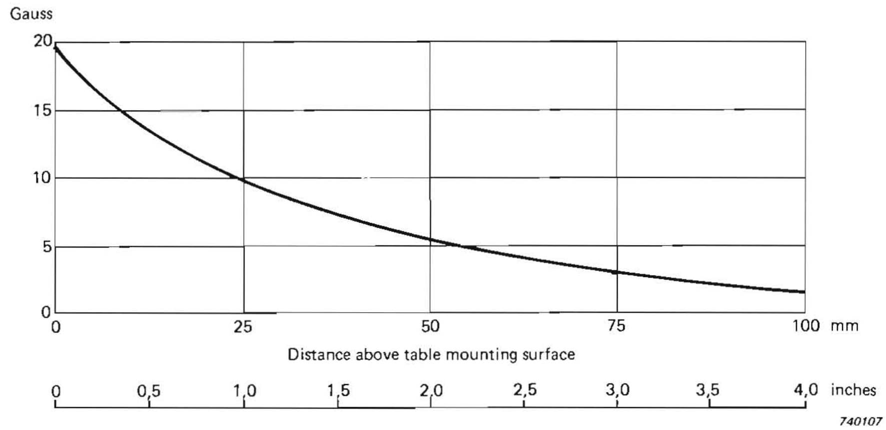


Fig.6.8. Magnetic flux density above table top. Type 4814 with 4801 Body

2. The upper radial flexure is one piece.

3. There are no magnetic shields on the Mode Study Head. As the Head is generally coupled to the test object by a pushrod, the influence of the steady state magnetic field due to the field coils is considerably diminished. The alternating flux is negligible. As can be seen on the graphs in Figs.6.8 and 6.9, the magnetic flux density 100 mm from the table top is small.

4. The mechanical overtravel stops permit a total peak-to-peak travel of at least 25,4 mm (1,0 in).

The driver coil is wound with aluminum wire.

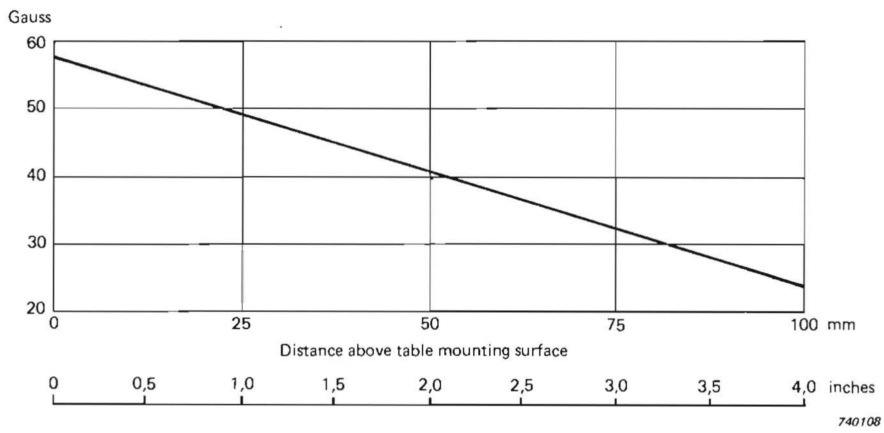


Fig.6.9. Magnetic flux density above table top. Type 4814 with 4805 Body

6.3. THE CALIBRATION HEAD TYPE 4815

Fig.6.10 shows an illustration of the Calibration Head Type 4815 with its rubber boot and protective can removed. A description of its major features follows.

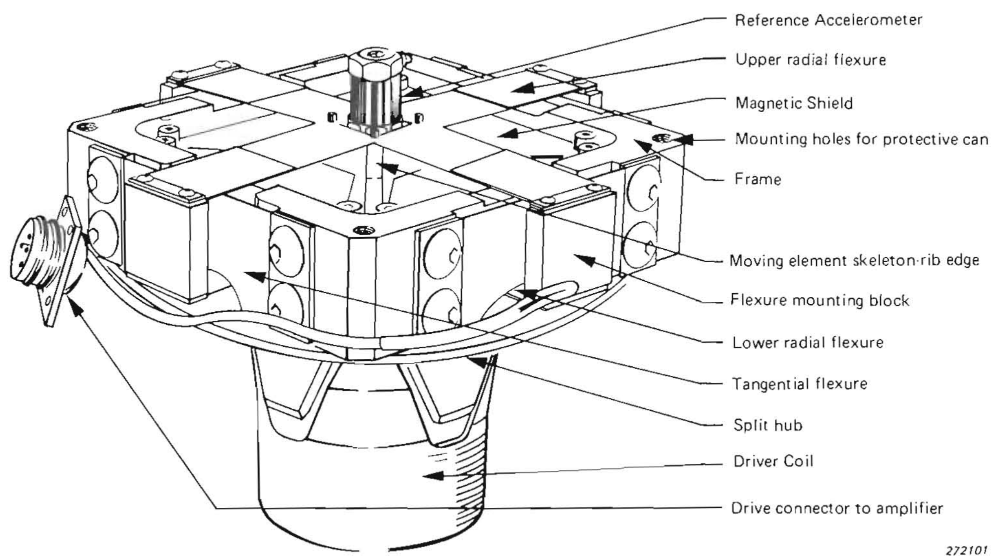


Fig.6.10. Calibration Head 4815

6.3.1. Reference Accelerometer

The accelerometer built into the Type 4815 Head is a Standard Accelerometer Type 8305. It has been designed particularly for the precise calibration of transducers by the back-to-back comparison method. Careful design resulted in very low transverse and base strain sensitivities, assuring a high degree of accuracy in comparison measurements.

Long term stability and low sensitivity to temperature changes are obtained by using a piezoelectric element of quartz. A sectional drawing of the accelerometer is shown in Fig.6.11. Construction is of the inverted single ended compression type, and a full discussion of its characteristics is contained in the "Accelerometers" Instruction Manual.

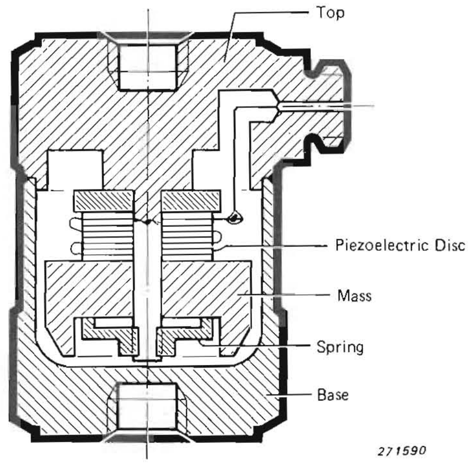


Fig.6.11. Cross-sectional view of the Type 8305 Accelerometer

On a 4815, as delivered from the factory, the accelerometer is already mounted. However, in case it should be necessary at any time to remove the accelerometer from the 4815 Head, the following mounting instructions are included.

6.3.2. Mounting the Accelerometer

The Reference Accelerometer sits on a hard ceramic block, which provides electrical isolation and therefore helps to avoid ground loops. The Accelerometer is inverted as shown in Fig.6.12 and the block is fastened by its single 10— 32 UNF screw. This screw should be fastened as tight as it is possible to do it with an ordinary hexagonal wrench by hand.

After the Accelerometer is fastened to the block, the block in turn is fastened to the skeleton by means of 4 x 2,5 mm screws in the manner shown in Fig.6.13. Again, the screws should be as tight as it is possible to get them by hand.

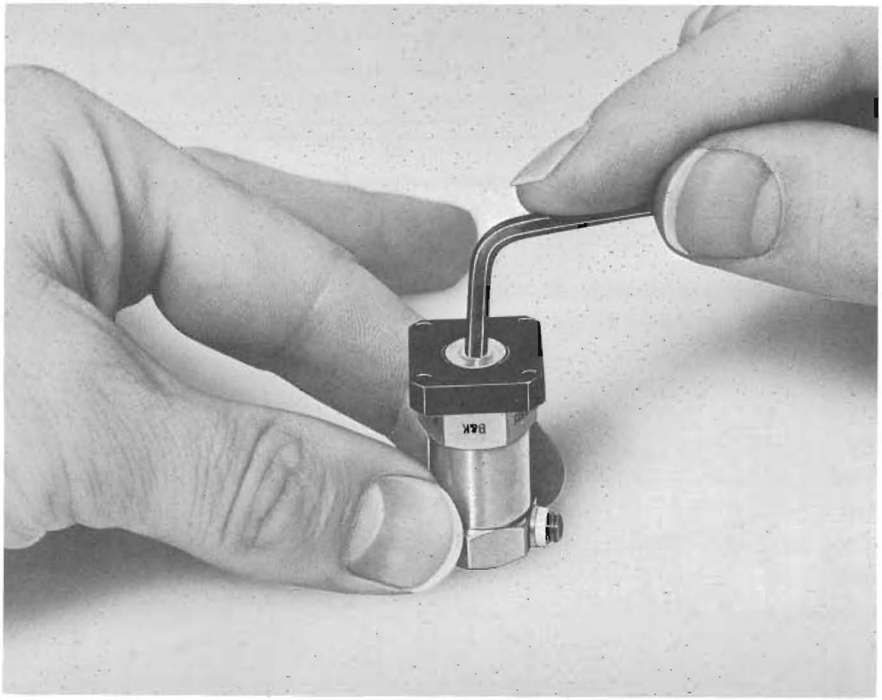


Fig.6.12. Fastening the Accelerometer to the Isolating Block

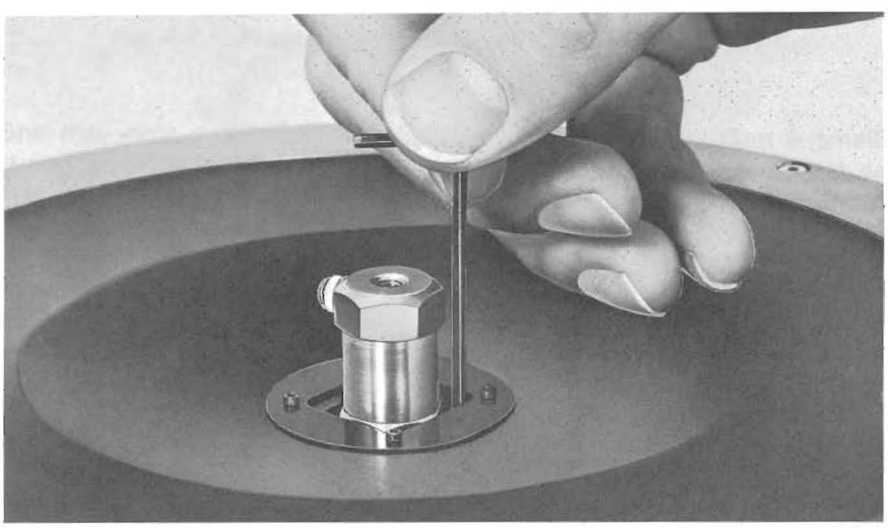


Fig.6.13. Fitting the block to the Head

6.3.3. Other Features Specific to the Type 4815

The construction of the Type 4815 is similar to that of the Type 4814 in that the force produced in the Driver Coil is directed to a single mounting point in the center, the upper radial flexure is one piece and the Driver Coil is formed of aluminum wire. However, the total peak-to-peak travel is only 12,7 mm (0,5 in).

Magnetic shields are provided to reduce the flux density above the table top. Figs.6.14 and 6.15 are plots of typical steady state flux density as a function of distance above the table top. The alternating flux density is negligible.

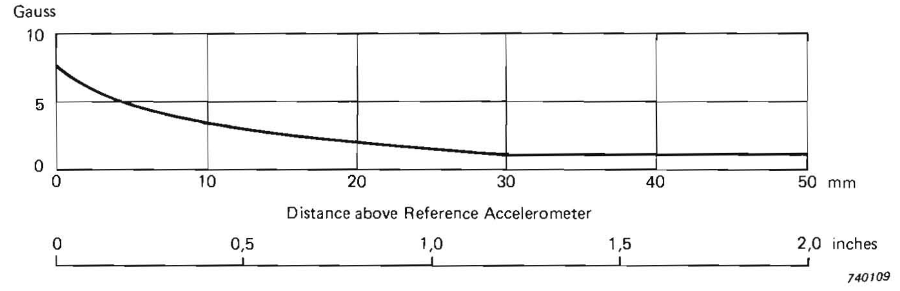


Fig.6.14. Magnetic flux density above the reference Accelerometer. Type 4801 Body

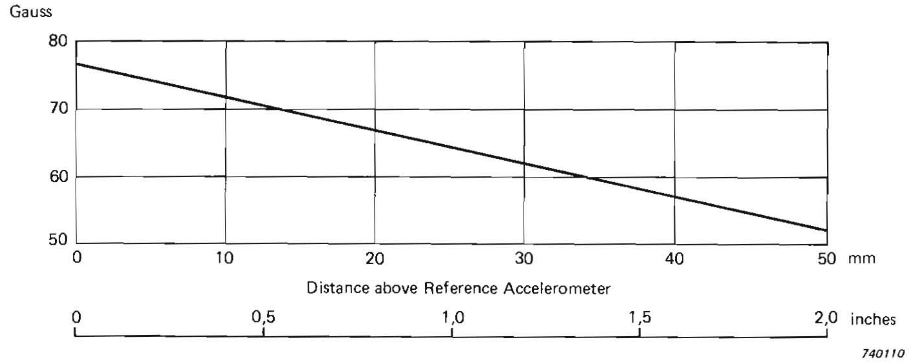


Fig.6.15. Magnetic flux density above the reference Accelerometer. Type 4805 Body

7. CHARACTERISTICS

7.1. SQUARE TABLE HEADS

The three Square Table Heads, as might be expected, have similar frequency response and loading characteristics. They are grouped together in this section for comparison.

Since frequency response and resonance are characteristics of the Heads alone, the curves shown in Figs.7.1, 7.2, 7.3, 7.7 and 7.9 apply to both 4801 and 4805 Bodies.

7.1.1. Frequency Response and Resonance

In Fig.7.1 is shown a plot of the frequency response of an Exciter Head Type 4811. The acceleration in g is plotted with respect to frequency for a constant voltage.

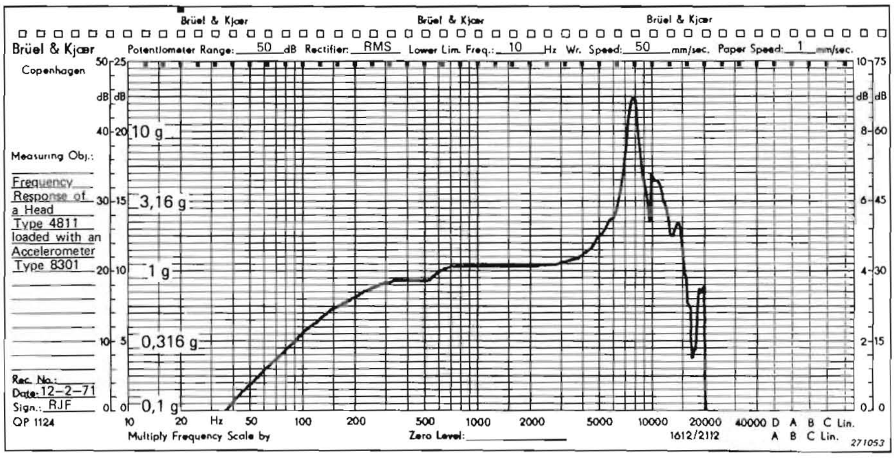


Fig.7.1. Frequency response of a High g Head 4811

One may note a levelling off at slightly above 300 Hz, then a small step upwards between 500 and 700 Hz. At this point the mass of the flexures is de-coupled from the mass of the skeleton and table. This reduces the dynamic mass, and hence there is a slight increase in acceleration for the same voltage.

After 700 Hz the acceleration remains at the same level until about 3 kHz at which point it begins to rise to the peak at 8 kHz. This peak is the first major resonance peak of the moving element itself.

Fig.7.2 shows the frequency response of the Type 4812 Head. Here there is a smaller decoupling step in the curve, since the mass of the flexures is smaller with respect to the mass of the moving element.

The acceleration remains level between 400 Hz and 3 kHz and rises to a resonance peak at about 7,2 kHz.

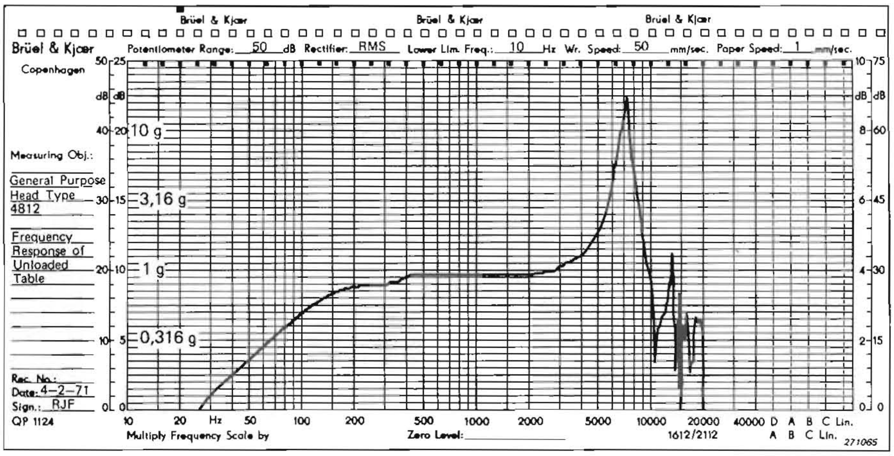


Fig. 7.2. Frequency response of a General Purpose Head 4812

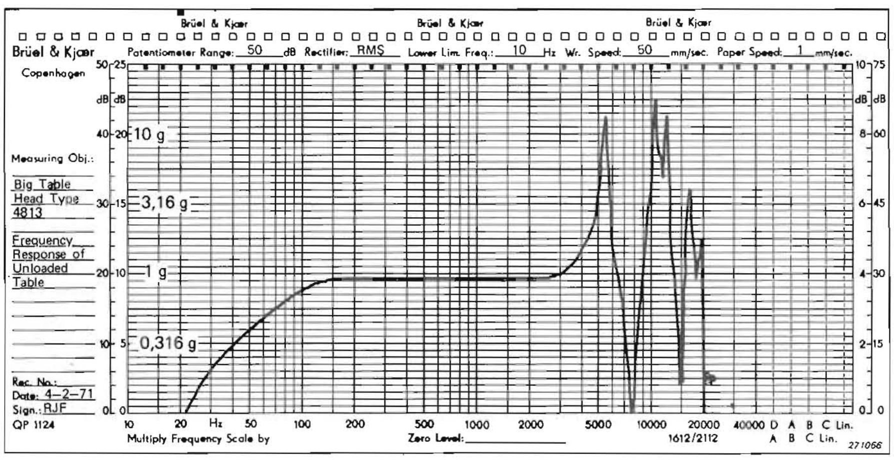


Fig. 7.3. Frequency response of a Big Table Head 4813

Shown in Fig. 7.3 is the frequency response of the Type 4813 Head. Here there is no significant de-coupling step and the acceleration remains level from 150 Hz to 3 kHz. The resonance is at 5,4 kHz.

It can be readily seen in all three cases that the Exciter can be operated in the region where the acceleration curve is flat without the use of a compressor loop to control the oscillator.

7.1.2. Rated Force and Limits

When it is desired to vibrate a test object of mass m with an acceleration a, the required force is:

$$F = (m + m_e)\, a$$

where m_e is the mass of the moving element. In this way, the maximum shaker playload for a given acceleration level can be computed.

For example:

$$m = \frac{F}{a} - m_{el}$$

For 981 m/s² (100 g) acceleration level and 0,18 kg moving element mass (Type 4811).

$$m = \frac{380}{981} - 0{,}180 = 0{,}207\ \text{kg}$$

Fig.7.4 shows a diagram of bare table acceleration limits with respect to frequency for the Type 4811 High g Head mounted on a 4801 Body and a 4805 Body with and without cooling. Power is supplied in all cases by a Type 2707 Power Amplifier. Above 400 Hz it can be seen that the limits are based solely on the amount of force available, as in the preceding example. At lower frequencies, however, other factors must be considered. The displacement, for example, must be held below 13 mm (0,5 in) in order to avoid hitting the overtravel stops. At 10 Hz, therefore the acceleration is limited to 2,6 g. At 32 Hz the limit has risen to 27 g. At this point a velocity limit of 1,27 m/s (50 in/s) begins to control. This is due to a limitation on the voltage which can be obtained from the Power Amplifier. A further limitation appears from 150 Hz to 400 Hz caused by the power limit of the amplifier. If it were necessary to exceed these limits for high g, low frequency operation, a Type 2708 Power Amplifier could be used, because of its higher voltage capability. However, caution should be exercised when operating outside the specification limits.

Fig.7.5 shows a plot of maximum acceleration vs. load for the 4811 Head mounted on the different bodies. To find the maximum acceleration possible for a particular combination, find the TOTAL mass, including test object, fixture and moving element, on the abscissa, then move vertically upward to the intersection with the applicable curve. The acceleration can be found on the ordinate opposite.

Fig.7.6 shows bare table acceleration limits with respect to frequency for the 4812 Head. Above 120 Hz, the limits are based on force available. Between 29 Hz and 120 Hz, the velocity is limited to 1,14 m/s (45 in/s). Below 29 Hz, the displacement limit of 13 mm (0,5 in) controls.

Fig.7.7 shows a plot of maximum acceleration vs. load for the 4812 Head mounted on the different bodies.

Fig.7.8 shows bare table acceleration limits with respect to frequency for the 4813 Head. The displacement limit controls to 26 Hz and the velocity limit to 90 Hz.

Fig.7.9 shows a plot of maximum acceleration vs. load for the 4813 Head mounted on the different bodies.

7.2. MODE STUDY HEAD

Fig.7.10 shows the frequency response of the Mode Study Head Type 4814. The resonance peak is at 6,4 kHz.

The loading limits diagram is shown in Fig.7.11. In this case force is used as the ordinate instead of acceleration, as the Mode Study Head is usually force-controlled. Displacement and velocity (proportional to voltage) limits still apply, in this case 25,4 mm (1 in) and 1,01 m/s (40 in/s).

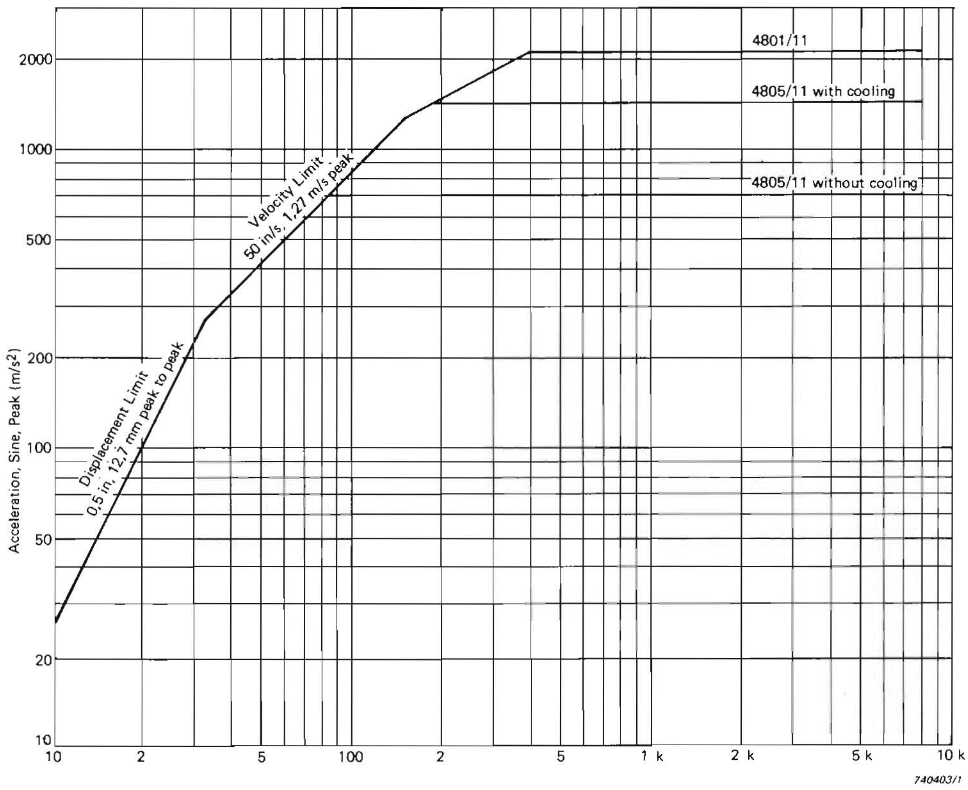


Fig.7.4. Bare table acceleration limits for the Type 4811

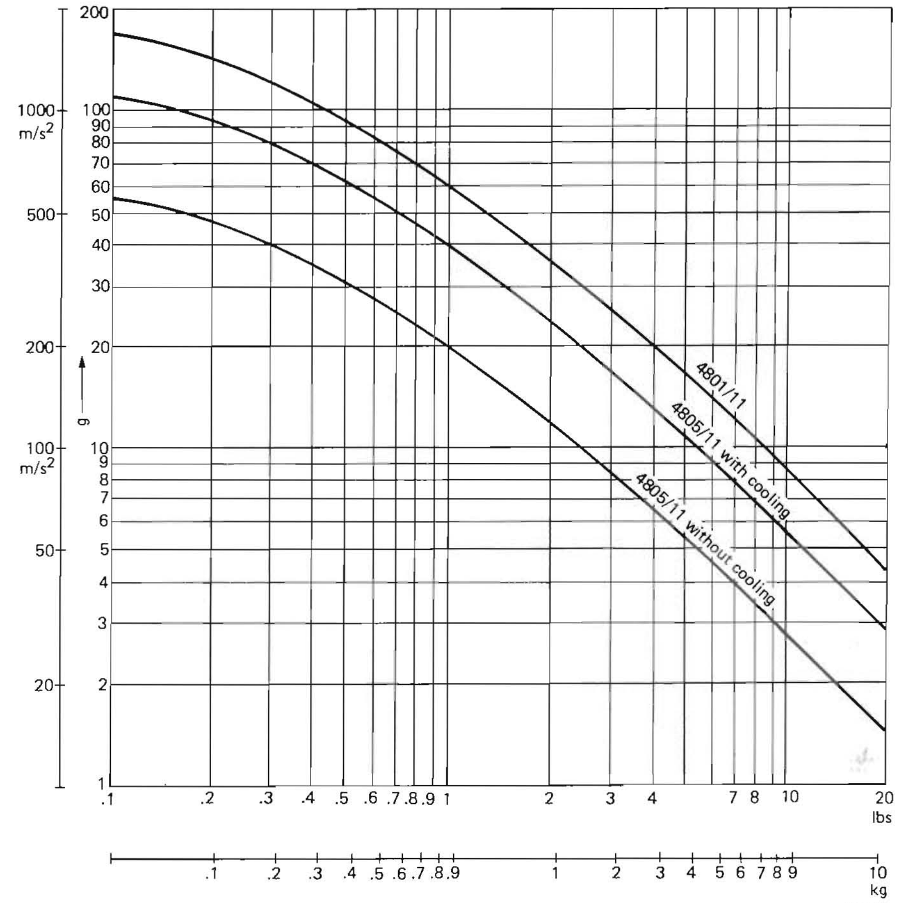


Fig.7.5. 4811. Maximum acceleration vs. load

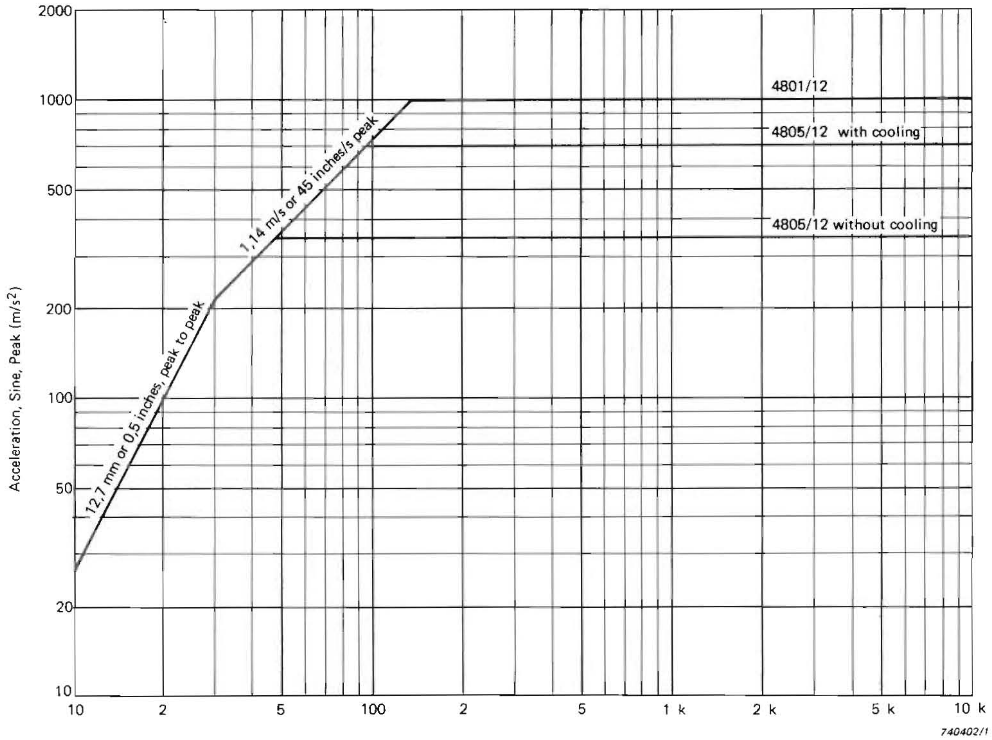


Fig. 7.6. Bare table acceleration limits for the Type 4812

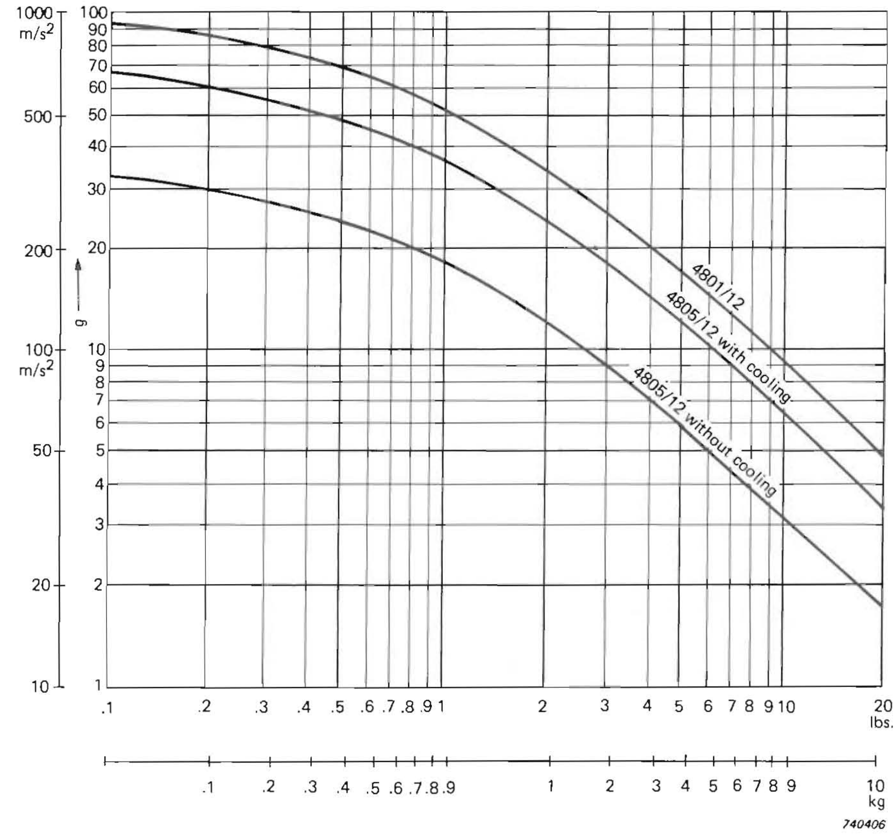


Fig. 7.7. 4812. Maximum acceleration vs. load

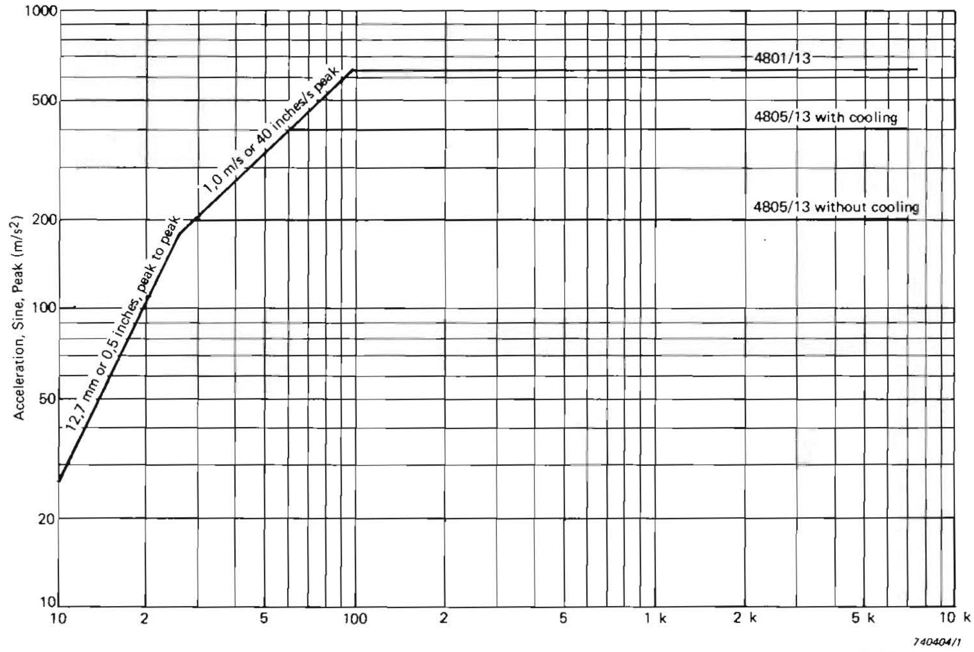


Fig. 7.8. Bare table acceleration limits for the Type 4813

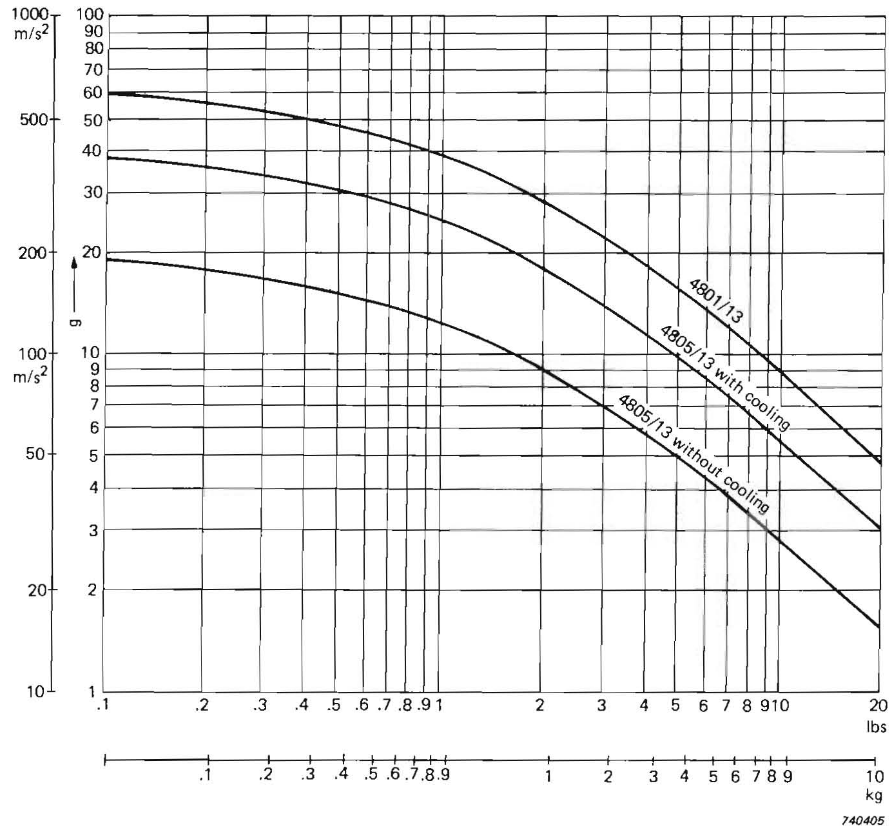


Fig. 7.9. 4813. Maximum acceleration vs. load

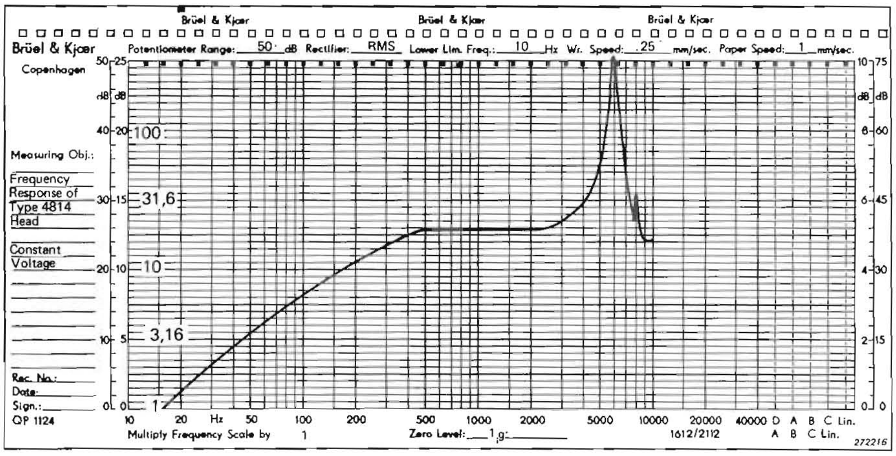


Fig.7.10. Frequency response of a typical Mode Study Head

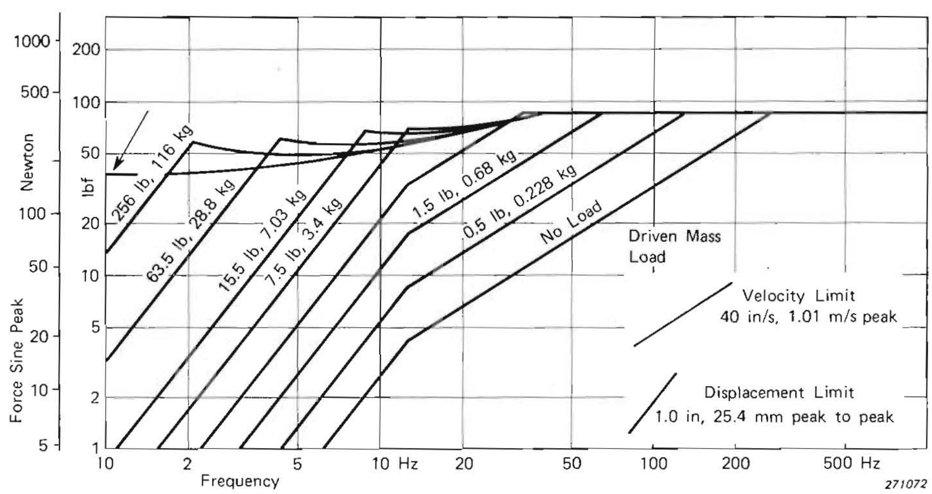


Fig.7.11. Loading limits for the Mode Study Head

7.3. CALIBRATION HEAD TYPE 4815

7.3.1. Frequency Response of the Head

Fig.7.12 shows a plot of the frequency response of the Type 4815 Calibration Head.

There are three curves shown, each for a different loading. They all have the same general shape, with a levelling off at about 500 Hz, a constant level to 3 kHz, and finally, a climb to a resonance peak. As the moving mass increases, the resonance frequency drops. This, in turn, narrows the frequency limits of the flat part of the curve.

From this it can be seen that it is not practical to operate the exciter from a constant voltage source if the full possibilities of its range are to be exploited. Instead, it is more common, especially in the case of accelerometer calibration, to operate with a compressor circuit. In a compressor circuit (automatic gain control circuit), the signal from the accelerometer is fed back to the generator, where it is used to regulate a voltage controlled amplifier. In the lower frequencies, where the level drops off, the gain of the amplifier is increased and more power is supplied to the exciter. In the higher frequencies, as the resonance is reached, the gain is decreased. In this way, a constant level of acceleration is maintained throughout the frequency range which can be accommodated by the dynamic range of the compressor circuit.

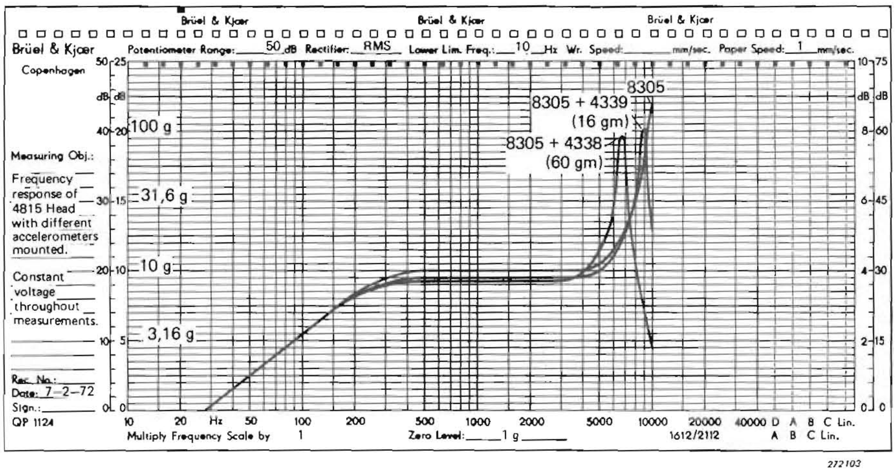


Fig. 7.12. Frequency response of the Type 4815

7.3.2. Frequency Response of the Standard Accelerometer Type 8305

If the Standard Accelerometer were removed from its case and inverted, as shown in Fig.7.13 it would show a typical accelerometer response, with a 35 dB peak at 35 kHz, which is the natural frequency of the spring-mass system of the accelerometer. In the calibration procedure of an unknown accelerometer using 4815 and 8305, the acceleration level of the Standard Accelerometer is held constant. In this case, the Exciter characteristics and the resonance of the steel case have no influence. However the screw which connects the two accelerometers is effectively a spring whose influence is particularly felt at high frequencies. This spring, with the mass of an accelerometer above it, has a resonance at about 20 kHz, opposite in direction to that of the mass-spring system of the Type 8305. The two effects just about cancel out, and the result is an almost flat frequency response (see calibration chart for Type 8305, Fig.7.14). The larger the accelerometer being calibrated, the more the resonance curve flattens out.

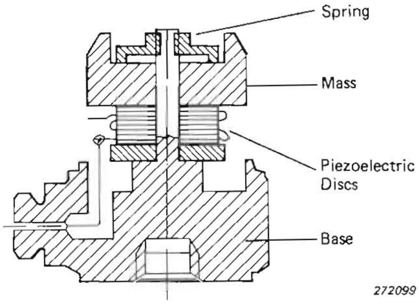


Fig. 7.13. Accelerometer 8305 removed from its case and inverted

7.3.3. Acceleration vs. Load

Fig.7.15 shows the relationship of the possible acceleration level to the mass of the accelerometer being calirated. Accelerometers weighing up to 60 g present no problem. However, it should be noted that addition of mass on top of the reference accelerometer increases the cross-motion and testing of large transducers (200 + grams) could cause base bending of the accelerometer and subsequent error in its output.

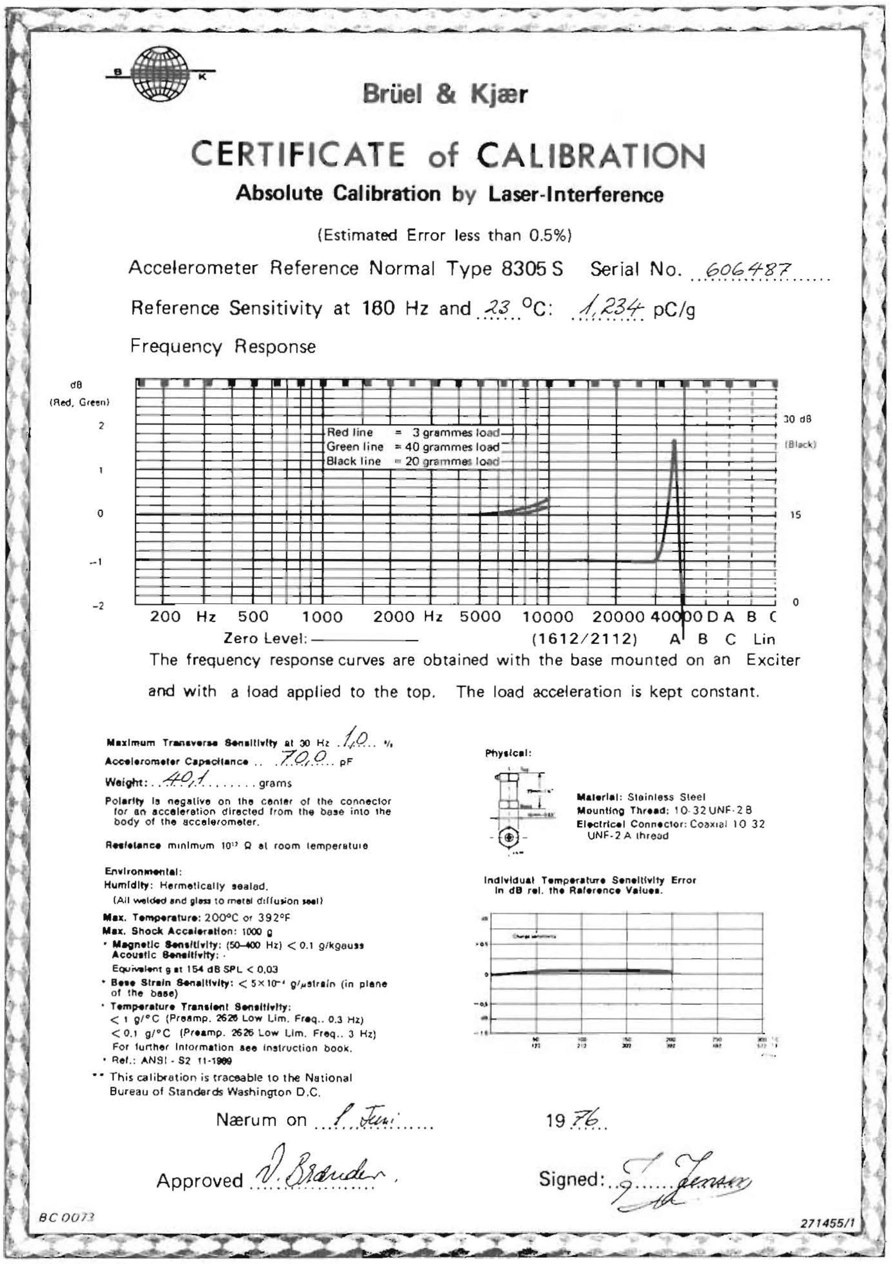


Fig.7.14. Calibration chart for an Accelerometer 8305

7.3.4. Cross-Motion

Although a great deal of effort has been put into making the motion of the Type 4815 Head rectilinear, it would be impossible to eliminate all the cross-motion.

Fig.7.16 shows plots of cross-motion vs. frequency in two mutually perpendicular directions for a typical Type 4815 Head. The cross-motion is less than 3% up to 2 kHz and, with the exception of one sharp peak at 3,5 kHz it remains below 10% for the rest of its range.

7.3.5. Errors in Calibration

The important question which comes up when using a calibration standard concerns the error introduced by the standard itself. If a compressor loop is used, the frequency re-

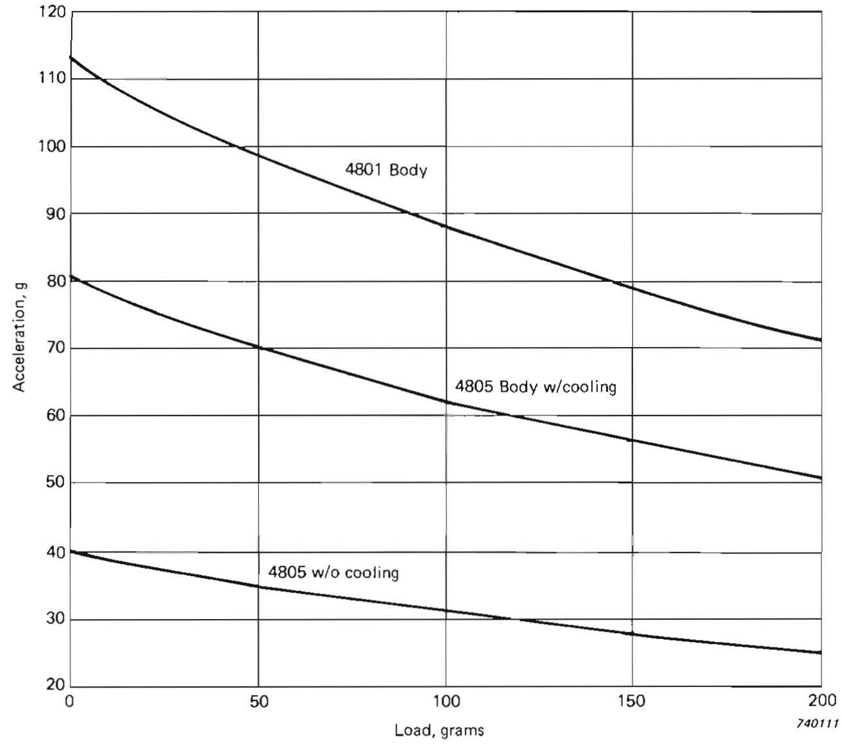


Fig. 7.15. Relationship of acceleration to load, Type 4815

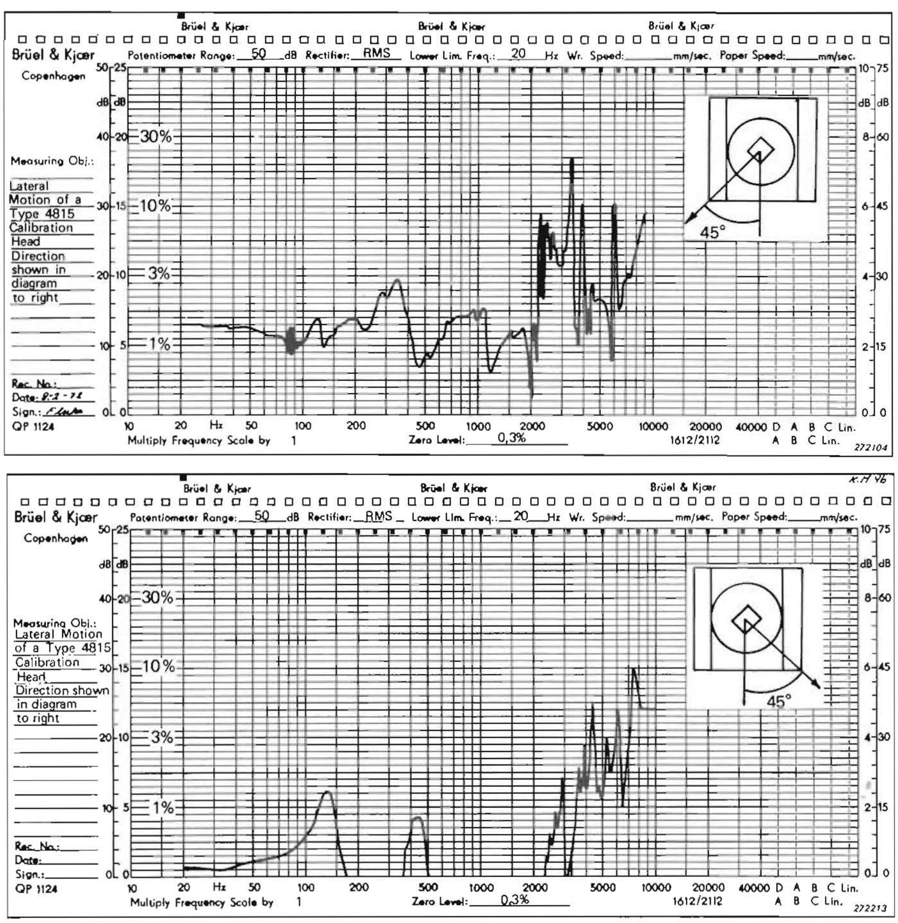


Fig. 7.16. Lateral motion of a Type 4815 Head

sponse of the Head itself is eliminated as a source of error. The next consideration is the response of the Standard Accelerometer. Below 5 kHz this response is independent of frequency. Above 5 kHz there is a slight upward swing to a maximum of + 0,5 dB (6%) at 10 kHz. If a calibration is to be run at these high frequencies, it is a simple matter to adjust the sensitivity setting on the preamplifier to compensate for the increased output, by reference to the accelerometer calibration chart. The influence of test level on sensitivity is so small as to be not measurable over the dynamic range of the 4815.

The final consideration is the cross-motion of the Head. If, for example, this is taken as 2%, the contribution to the measured acceleration level is dependent on the difference in transverse sensitivity between the Standard Accelerometer and the test accelerometer. For example, if the Exciter is running at 100 g at 1 kHz, there is a transverse acceleration of about 2 g. If the Standard Accelerometer has a transverse sensitivity of 1,7% it will be reading 2 x 0,017 g high, i. e. 100,034 g. If the test accelerometer has a transverse sensitivity of 3%, it will be reading 2 x 0,03 high, or 100,060 g. Since the calibration of the test accelerometer is based, not on what the absolute acceleration level is, but on what the Standard Accelerometer measures, there will be an error of + 0,026 g introduced. If both accelerometers had the same maximum transverse sensitivity and were aligned in the direction of greatest sensitivity, there would be no error introduced by cross-motion.

8. CARE AND MAINTENANCE

The V System requires but a minimum of care for trouble-free performance. A few suggestions are given in the following paragraphs.

8.1. PERIODIC CLEANING

Long, trouble-free service can be enhanced by following a routine maintenance schedule. The Daily, Weekly, and Monthly cleaning activities listed below are appropriate for an "Average" vibration laboratory. If the environment where the V System is located is cleaner than "average", the periods can be lengthened. If the environment is dirty, the periods should be shortened.

With the 4805 Exciter Body and with the Exciter Heads, cleaning problems are limited to the obvious cleaning of accessible surfaces. The 4801 Body, however, requires more particular care, as follows:

Daily: Each day, before starting, inspect the Field Supply Air Inlet Screen. Remove paper and debris both from the screen and from the area immediately around the screen.

Weekly: Brush off the Field Supply Air Inlet Screen with a soft brush.

Monthly: (1) Blow or brush any accumulated dirt out of the Rotation Bearing/Brake Assembly.

(2) Vacuum clean the upper surface of the Field Coils. The Exciter Head may be removed but the iron Upper Wheel should be left in place.

(3) Vacuum clean the Field Supply Air Inlet Screen.

If in the monthly inspection and cleaning any severe accumulation is noticed, a thorough cleaning of the region in isopropyl alcohol is recommended. The Field Coils present a special problem and are discussed further in section 8.2.3.

8.2. CARE OF EXCITER BODY 4801

8.2.1. Exciter Body Cover

If an Exciter Body is to be left for more than a few minutes without an Exciter Head mounted in place, a cover should be placed over the Exciter Body. Although the flat top surface of the Exciter Body looks like a convenient table, it is very dangerous to leave it uncovered, since small objects may fall into the Exciter Body. Loose objects in the Exciter Body may cause distortion on the acceleration waveform, may short out a Field Coil or the Driver Coil, or may jam the Head/Field Cooling Fan. Iron particles are particularly dangerous, since they tend to collect in the magnetic air gap where they rub on the Driver Coil and eventually destroy the coil.

8.2.2. Cleanliness of Exciter Body

The air inlet screen at the bottom of the Exciter Body should be inspected daily and cleaned when necessary. It is possible for loose pieces of paper and other light debris to be drawn up against the air inlet screen. A periodic inspection schedule is recommended.

The top of the Exciter Body should be inspected prior to mounting an Exciter Head, or if one Exciter Head is being used continuously, the head should be removed periodically for inspection. The upper surface of the Field Coil is visible through the openings in the iron. If the surface is dirty, and particularly if any of the air passages look blocked or obstructed, the field coils should be vacuumed clean. If vacuuming does not open the passages, see section 8.2.3.

Dirt, especially sand or other gritty dirt, should be kept out of the Rotation Bearing/Brake assembly. If the exciter has been exposed to such dirt, the dirt in this area should be blown out with a jet of air, or if severe, washed out with a mild solvent, before the Exciter Body is rotated.

8.2.3. Field Coil Cleaning

The field coils each have many annular passages for cooling air. These passages should be kept clean.

The high velocity air flowing through the field cooling passages normally prevents a serious accumulation of dirt in these passages. However, the user is advised to inspect the upper surface of the Upper Field Coil at regular intervals. Since the air flows downward through the passages, the worst accumulation of dirt is at the top. The upper surface of the Upper Field Coil is exposed when the Exciter Head is removed.

If it should be necessary to clean the field coils, a strong vacuum cleaner will remove most dirt from the top. For guidance on dealing with more persistent dirt, consult your B & K representative.

8.3. CARE OF EXCITER HEAD

A B & K Exciter Head will provide long service if it is not abused. Although most care is just "Common Sense" careful treatment, a few suggestions may be useful.

8.3.1. Removal of Cable

Before an Exciter Head is removed from the Exciter Body, the cable from the Power Amplifier should be disconnected from the Head. This serves two purposes: (1) It prevents inadvertent application of power to the Exciter Head while it on is the workbench without cooling, thus burning out the Driver Coil, and (2) If the cable from the Power Amplifier were still connected to the Exciter Head, it would be hanging over the side of the workbench. It would be easy to step on such a cable and pull the head off the table onto the floor, possibly causing severe damage.

8.3.2. Cleaning of Exciter Head

An Exciter Head should normally require very little cleaning. It is advisable to wipe away any accumulated grease, dirt, or grime off the Driver Coil just before installing the Exciter Head each time. If the head is unusually dirty, it may be immersed for a short time in isopropyl alcohol or freon and agressively agitated to dissolve any grease and dislodge any foreign particles.

8.3.3. Clean Workbench Surface

The Exciter Head should be placed only on smooth clean surfaces. It is convenient to have the Exciter Head on a workbench while making a fixture to attach a test object to the exciter table or when preparing instrumentation for a vibration test. If a sharp object were on the workbench underneath the Driver Coil, the Driver Coil might get damaged when the moving element deflects downwards.

8.3.4. Care of Mounting Surface

The user should be very careful to keep the mounting surface of the table clean. The surface is hardened and anodized aluminum, but it could still be scratched if, for example, sand got in between the table and the fixture. Hence, to prevent scratching the mounting surface, the table and the lower surface of the fixture should be cleaned before they are joined.

The lower surface of the test object mounting fixture should be smooth and flat. Whenever possible, grind this lower surface. A smooth, flat surface minimizes localized stresses in the mounting surface and provides good vibration coupling from the moving element to the test object.

8.3.5. Exciter Head Inspection and Repair

If something appears to be wrong with the Exciter Head, inspect the coil and the screws holding the lower flexures to the Moving Element Skeleton by looking into the bottom of the Head Protective Can.

For major repairs the Exciter Head should be sent to B & K, Nærum, Denmark, since precision alignment fixtures are necessary.

8.4. CARE OF EXCITER BODY 4805

The most important thing with the 4805 is to either have a Head or a cover on at all times. Since it is a permanent magnet, the magnetic field is always "On" and anything ferrous that comes within the field will be drawn into the gap.

9. SPECIFICATIONS

9.1. EXCITER BODY 4801

9.1.1. Type 4801 T

Exciter Rotation: ± 180°. Can be locked at any position

Exciter Body Suspension: The low frequency suspension has a resonant frequency between 10 and 15 Hz. The high frequency suspension has a resonant frequency between 30 and 50 Hz

Power Requirements: 380 V ± 10% 50 Hz (900 VA) or 440 V ± 10% 60 Hz (112 VA) three-phase AC mains (including neutral). Ratings, valid for nominal supply voltage, exclude up to 20% over-current at switch on

Cooling: Blower-cooled by ambient air

Size: Base: 381 × 381 mm (15 × 15 in) overall
Height: 405 mm (16 in) without Exciter Head. See also Fig.9.1
Exciter Heads add 50 to 130 mm (2 to 5 in)

Weight: 80 kg. (176 lb)

Accessories Supplied:

1	AG 0005	Safety trigger cable, 2 conductor, 0,75 mm^2 each, 5 m long
1	AG 0007	Mains cable, 5 conductor, 1,5 mm^2 each, 5 m long
1	AQ 0026	Driver coil cable, 5 conductor, 1,5 mm^2 each, 5 m long
1	QA 0049	Hexagonal wrench, 2,5 mm
2	YV 3575	Screw, 5 m diameter, 0,8 mm pitch
6	VF 0013	1 A slow-blow fuse

9.1.2. Type 4801 S

The Exciter Body Type 4801 S differs from the Type 4801 T only in its suspension. Therefore its specifications are the same except for the following:

Exciter Rotation: None. Can only be used in upright position on its suspension

Exciter Body Suspension: The suspension has a resonant frequency of about 10 Hz

Size: Base: 254 × 254 mm (10 × 10 in). See also Fig.9.2
Height: 370 mm (14,5 in) without Exciter Head
Exciter Heads add 50 to 130 mm (2 to 5 in)

Weight: 75 kg (165 lb)

9.2. EXCITER BODY 4805

Dimensions: Diameter 236 mm (9,25 in) approx. Height 246 mm (9,7 in). See also Fig.9.3

Weight: 40 kg (90 lb)

Cooling: For full force output, a cooling air flow of 0,42 m^3/min. at a pressure of 0,008 kg/cm^2 is necessary

9.3. EXCITER HEADS

The following specifications apply when the Exciter is powered by a Power Amplifier Type 2707.

9.3.1. High g Head Type 4811

Rated Force: 380 N (85 lbf) when mounted on the 4801 Body
248 N (56 lbf) when mounted on the 4805 Body
See also Fig.7.4 for acceleration, velocity and displacement limits

Static: 120 N (27 lbf)

Acceleration Limit: (bare table) 210 g (2060 m/s^2) when mounted on 4801
140 g (1370 m/s^2) when mounted on 4805

Current Limit: 20 A RMS with cooling
10 A RMS without cooling

Displacement Limit: 12,7 mm (0,5 in), continuous
14 mm, (0,55 in) between stops

Velocity Limit: 1,27 m/s (50 in/s)

Moving Element Dynamic Mass: 0,18 kg (0,4 lb)

Resonance Frequency Unloaded Table: 8,5 kHz

Stray Magnetic Field: See curves, Figs.6.4, 6.5

Mounting Surface: Hardened anodized aluminum

Mechanical Fuse Inserts: Centre insert plus four outer inserts equally spaced on a 50,8 mm (2,00 in) diameter circle. Side of square 35,9 mm (1,414 in)

Cross Motion: Less than 10% of the axial motion to 3,5 kHz

Flexure Stiffness: 17,5 N/mm, (100 lbf/in)

Side Load Capability: A mass of 2,3 kg, (5 lb), with centre of gravity 50 mm, (2 in) above the centre of the table, can be vibrated in the horizontal direction over the full frequency range

Head Constant: 69 mm/Vs (2,7 in/Vs)

Bolt Torque Limit:	2,3 Nm, (20 lbf in)
Dimensions:	235 mm (9,3 in) dia × 160 mm (6,3 in) high
Weight:	6,5 kg, (15 lb)
Accessories Supplied:	
10 x YS 0621	4 mm diameter, 0,7 mm pitch internal thread inserts
10 x YS 0620	8 — 32 NC inserts
1 bottle QS 0003	Thread locking cement, LOCTITE screw lock
1 x QA 0060	Insert mounting tool

9.3.2. General Purpose Head Type 4812

Rated Force:	
Dynamic:	445 N (100 lbf) when mounted on the 4801 Body 310 N (70 lbf) when mounted on the 4805 Body See also Fig.7.5 for acceleration, velocity and displacement limits
Static:	135 N (30 lbf)
Acceleration Limit: (bare table)	981 m/s^2 when mounted on 4801 685 m/s^2 when mounted on 4805
Current Limit:	23 A RMS with cooling 11,5 A RMS without cooling
Displacement Limit:	12,7 mm (0,5 in) continous 14 mm, (0,55 in) between stops
Velocity Limit:	1,14 m/s (45 in/s)
Moving Element Dynamic Mass:	0,454 kg (1,0 lb)
Resonance Frequency Unloaded Table:	7,2 kHz
Stray Magnetic Field:	See curves, Figs.6.4, 6.5
Mounting Surface:	Hardened Anodized Aluminum
Mechanical Fuse Inserts:	Centre insert plus four outer inserts equally spaced on a 76,2 mm, (3,00 in) diameter circle. Side of square 53,9 mm, (2,12 in)
Cross Motion:	Less than 15% of the axial motion to 3 kHz
Flexure Stiffness:	21 N/mm (120 lbf/in)
Side Load Capability:	A mass of 5,5 kg, (12 lb) with centre of gravity 75 mm, (3 in) above the centre of the table, can be vibrated in the horizontal direction over the full frequency range
Head Constant:	58 mm/Vs (2,3 in/Vs)
Bolt Torque Limit:	3,4 Nm, (30 lbf in)

Dimensions:	235 mm (9,3 in) dia x 178 mm (7,0 in) high
Weight:	8 kg, (18 lb)
Accessories Supplied:	
10 x YS 0810	5 mm diameter, 0,75 mm pitch internal thread inserts
10 x YS 0811	10 — 32 UNF inserts
1 x QA 0003	Bottle of thread locking cement, LOCTITE screw lock
1 x QA 0061	Insert mounting tool

9.3.3. Big Table Head Type 4813

Rated Force:	
Dynamic:	445 N (100 lbf) when mounted on the 4801 Body 283 N (64 lb) when mounted on the 4805 Body See also Fig.7.6 for acceleration, velocity and displacement limits
Static:	135 N, (30 lbf)
Acceleration Limit: (bare table)	615 m/s^2 when mounted on 4801 390 m/s^2 when mounted on 4805
Current Limit:	22 A RMS, with cooling 11 A RMS without cooling
Displacement Limit:	12,7 mm, (0,5 in) continuous 14 mm, (0,55 in) between stops
Velocity Limit:	1,0 m/s, (40 in/s)
Moving Element Dynamic Mass:	0,725 kg, (1,6 lb)
Resonance Frequency Unloaded Table:	5,4 kHz
Stray Magnetic Field:	See curves, Figs.6.4, 6.5
Mounting Surface:	Hardened Anodized Aluminum
Mechanical Fuse Inserts:	Centre insert plus four outer inserts equally spaced on a 114 mm, (4,50 in) diameter circle. Side of square 81 mm, (3,18 in)
Cross Motion:	Less than 15% of the axial motion to 2 kHz
Flexure Stiffness:	21 N/mm, (120 lbf/in)
Side Load Capability:	A mass of 15 kg, (33 lb) with centre of gravity 100 mm (4 in) above the centre of the table, can be vibrated in the horizontal direction over the full frequency range
Head Constant:	58 mm/Vs (2,3 in/Vs)
Bolt Torque Limit:	5,64 Nm, (50 lbf in)
Dimensions:	235 mm, (9,3 in) dia × 230 mm (9,1 in) high

Weight:	8,9 kg, (19,5 lb)
Accessories Supplied:	
10 x YS 0809	6 mm diameter, 1,0 mm Pitch internal thread inserts
10 x YS 0808	0,25 in — 20 UNC internal thread inserts
1 x QS 0003	Thread locking cement, LOCTITE screw lock
1 x QA 0062	Insert mounting tool

9.3.4. Mode Study Head Type 4814

Rated Force:	
Dynamic:	380 N (85 lbf) when mounted on the 4801 Body 267 N (60 lbf) when mounted on the 4805 Body
Static:	120 N (27 lbf)
Acceleration Limit Peak: (bare table)	1180 m/s^2 when mounted on 4805 1670 m/s^2 when mounted on 4801
Current Limits:	20 A RMS, with cooling 10 A RMS, without cooling
Displacement Limit peak-to-peak:	25,4 mm, (1,0 in) continuous 26,7 mm, (1,05 in) in between stops
Velocity Limit, peak:	1,0 m/s (40 in/s)
Moving Element Dynamic Mass:	0,23 kg, (0,50 lb)
Resonance Frequency Unloaded Table:	6,4 kHz
Stray Magnetic Field:	See curves, Figs.6.8, 6.9
Mechanical Fuse Insert:	Centre insert in 19 mm, (0,75 in) diameter table
Cross Motion:	Less than 10% of the axial motion to 2 kHz
Flexure Stiffness:	3,5 N/mm (20 lbf/in)
Side Moment Capability:	1,1 Nm (10 lbf-in) applied moment
Head Constant:	69 mm/Vs (2,7 in/Vs)
Insert Torque Limit:	0,35 kgm, (30 lbf in)
Dimensions:	235 mm (9,3 in) diameter, 180 mm (7,1 in) height
Weight:	6,0 kg, (13,1 lb)
Accessories Supplied:	
10 x YS 0810	5 mm diameter, 0,75 mm pitch internal thread inserts
10 x YS 0811	10 — 32 inserts
1 bottle QS 0003	Thread locking cement, LOCTITE screw lock
1 x QA 0061	Insert mounting tool

9.3.5. Calibration Head Type 4815

Rated Force:	
Dynamic:	380 N (85 lbf) when mounted on the 4801 Body 267 N (60 lbf) when mounted on the 4805 Body
Acceleration Limit: **(bare table)**	1190 m/s^2 when mounted on the 4801 Body 785 m/s^2 when mounted on the 4805 Body
Current Limit:	20 A RMS, with cooling 10 A RMS without cooling
Displacement Limit:	12,7 mm, (0,5 in) continuous 14 mm, (0,55 in), between stops
Velocity Limit:	1,0 m/s, (40 in/s)
Moving Element Dynamic Mass:	0,34 kg, (0,75 lb)
Resonance Frequency Unloaded Table:	12,5 kHz
Stray Magnetic Field:	See curves, Figs.6.14, 6.15
Mounting Surface:	Stainless steel Reference Accelerometer, 15,8 mm, (0,622 in) diameter, tapped for 10— 32 mounting stud. Electrically isolated from Head
Cross Motion:	Less than 3% of the axial motion to 2 kHz. See also Fig.7.13
Flexure Stiffness:	5,2 N/mm, (30 lbf/in)
Head Constant:	69 mm/Vs (2,7 in/Vs)
Dimensions:	235 mm (9,3 in) dia, 157 mm (6,2 in) high excluding Type 8305
Weight:	6,7 kg, (14,9 lb) excluding Type 8305

Accessories Supplied:

1 Type 8305 Accelerometer	
1 x DC 0174	Mounting block
1 bottle QS 0003	Thread locking cement, LOCTITE screw lock
1 x QA 0009	Hexagonal wrench, 1/8"
1 x QA 0043	Hexagonal wrench, 2 mm
1 x QA 0065	Hexagonal wrench, 1,27 mm
4 x YQ 0723	Screw, 1,4 mm diameter, 0,3 pitch
4 x YQ 0927	Screw 2,5 mm diameter, 0,45 pitch

9.4. NOTES TO SPECIFICATIONS

1. Specifications valid for 1) Mains voltages within + 5%. 2) Altitude from sea level to 500 m (1600 ft). 3) Ambient Temperature not higher than 40°C (104°F). 4) Zero static force for table centring. 5) Standard base (T) only.

   For ambient temperature T_A above 40°C (104°F), and/or altitudes exceeding 500 m above sea level, the rated dynamic force (and drive current limit) is reduced by multiplying by the following factor for the Exciter Head in use:

$$\frac{1}{22}\sqrt{(100 - T_a)\ 8{,}07\ \frac{\rho_A}{\rho_{SL}}}$$ (Exciter Heads 4812 and 4813)

$$\frac{1}{20}\sqrt{(100 - T_a)\ 6{,}67\ \frac{\rho_A}{\rho_{SL}}}$$ (Exciter Heads 4811 and 4814)

where ρ_A = ambient air density
ρ_{SL} = air density at sea level

2. Dynamic rated force is reduced if the mains voltage is —5% to —15% of nominal.

3. At frequencies above 150 Hz the dynamic rated force is reduced by 2,5% if half of the available static force is used and is reduced by 10% if the full static force is used. At frequencies below 150 Hz the dynamic rated force is reduced by 15% if half of the available static force is used and is reduced by 30% if the full static force is used.

4. The system V exciters will normally be operated by Power Amplifier Type 2707 rated at 220 VA. To attain higher performance characteristics the exciter may be intermittently driven by Power Amplifier Type 2708, rated 1200 VA. This permits a higher dynamic range to be achieved with, for example, random signals. However, the maximum RMS ratings (e.g. current) must not be exceeded. The 4801 and 2708 are fully compatible with respect to supply and interlock connections.

9.5. EXTERNAL DIMENSIONS

The external dimensions of the 4801 T and 4801 S are given in Figs.9.1 and 9.2 respectively.

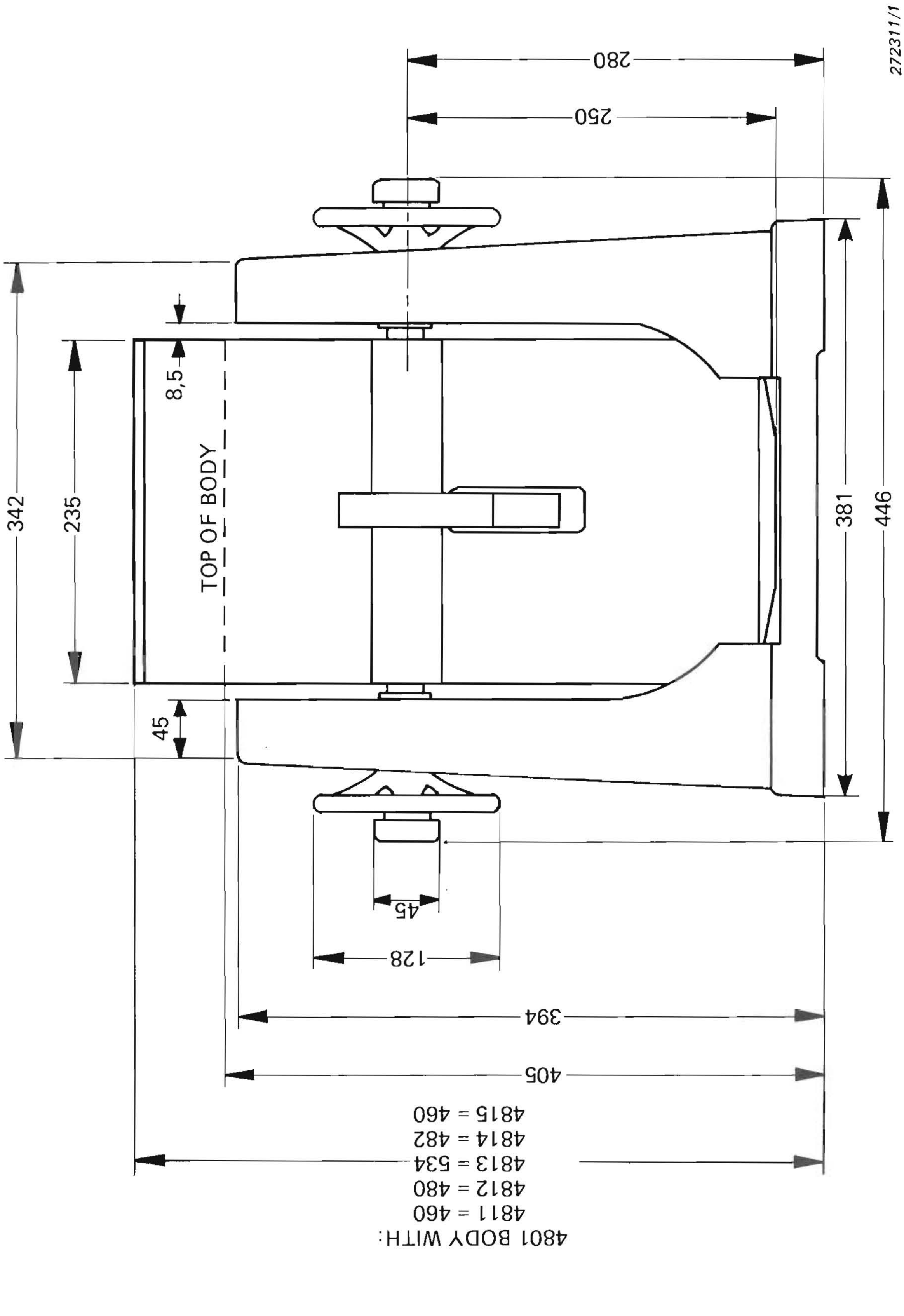


Fig.9.1. External dimensions of 4801 T

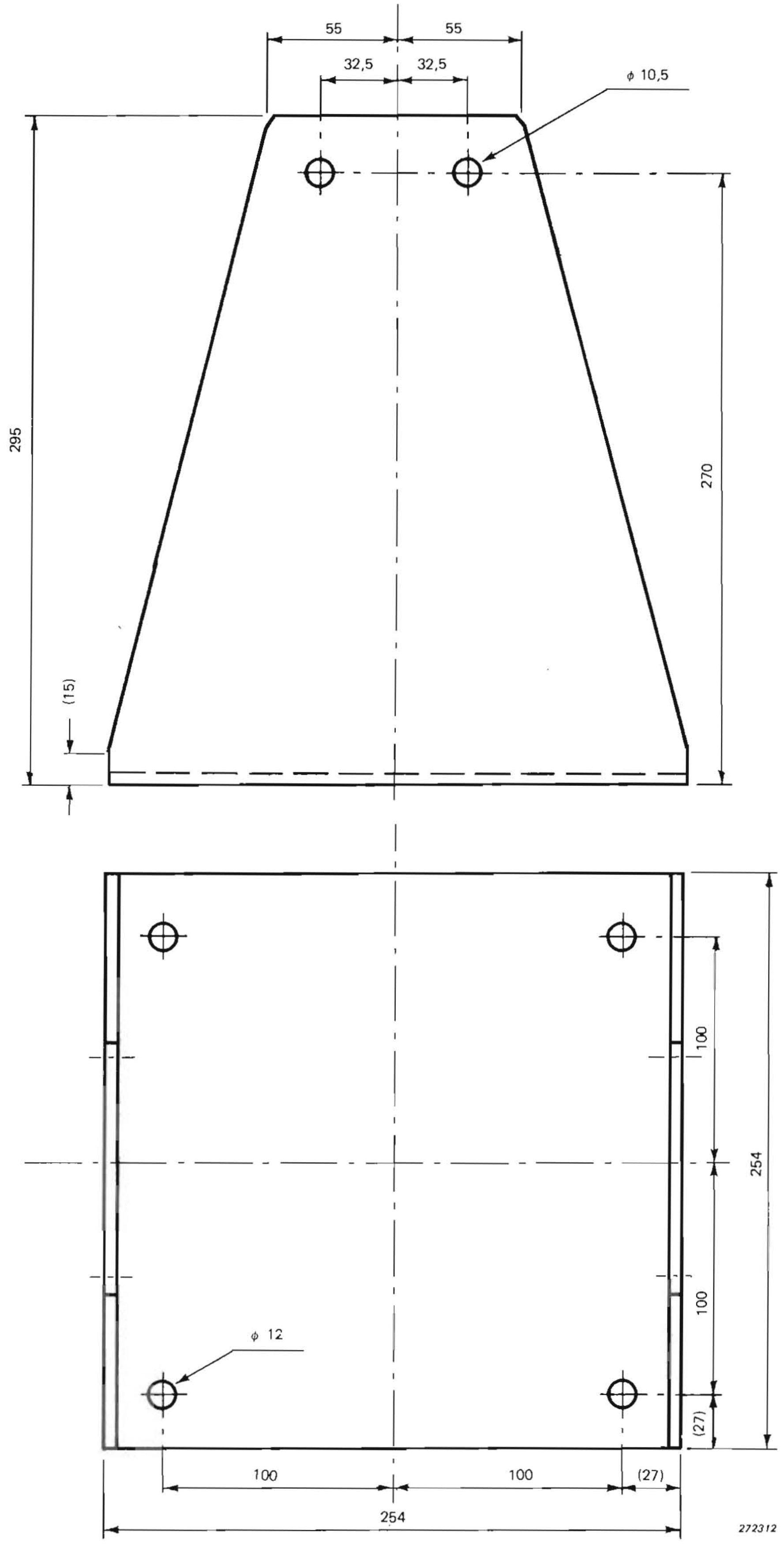


Fig.9.2. External dimensions of 4801 S

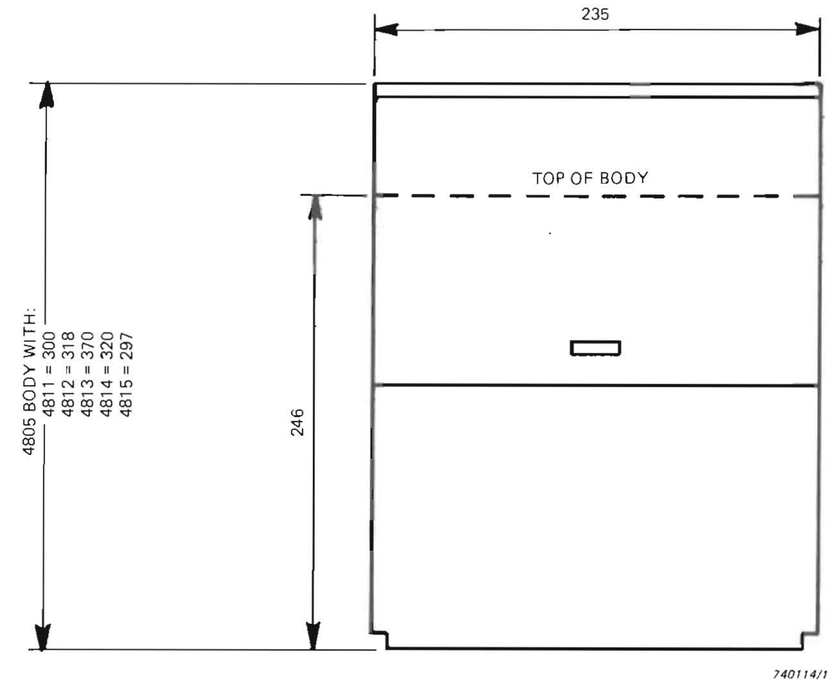


Fig.9.3. External dimensions of 4805

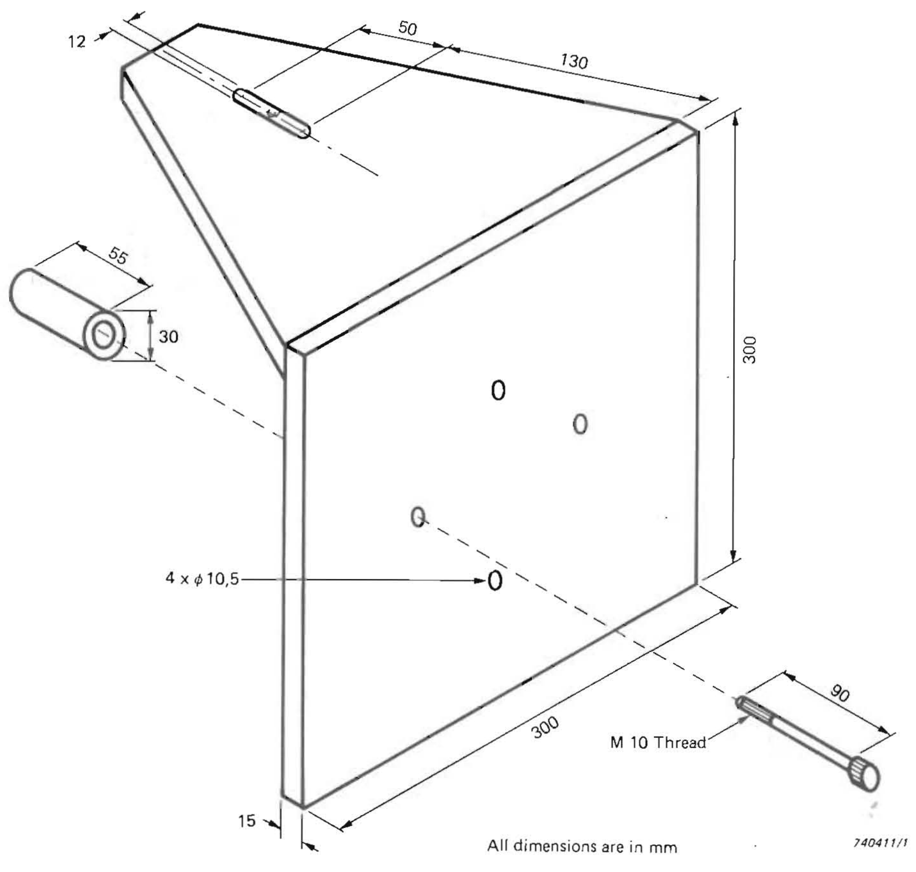
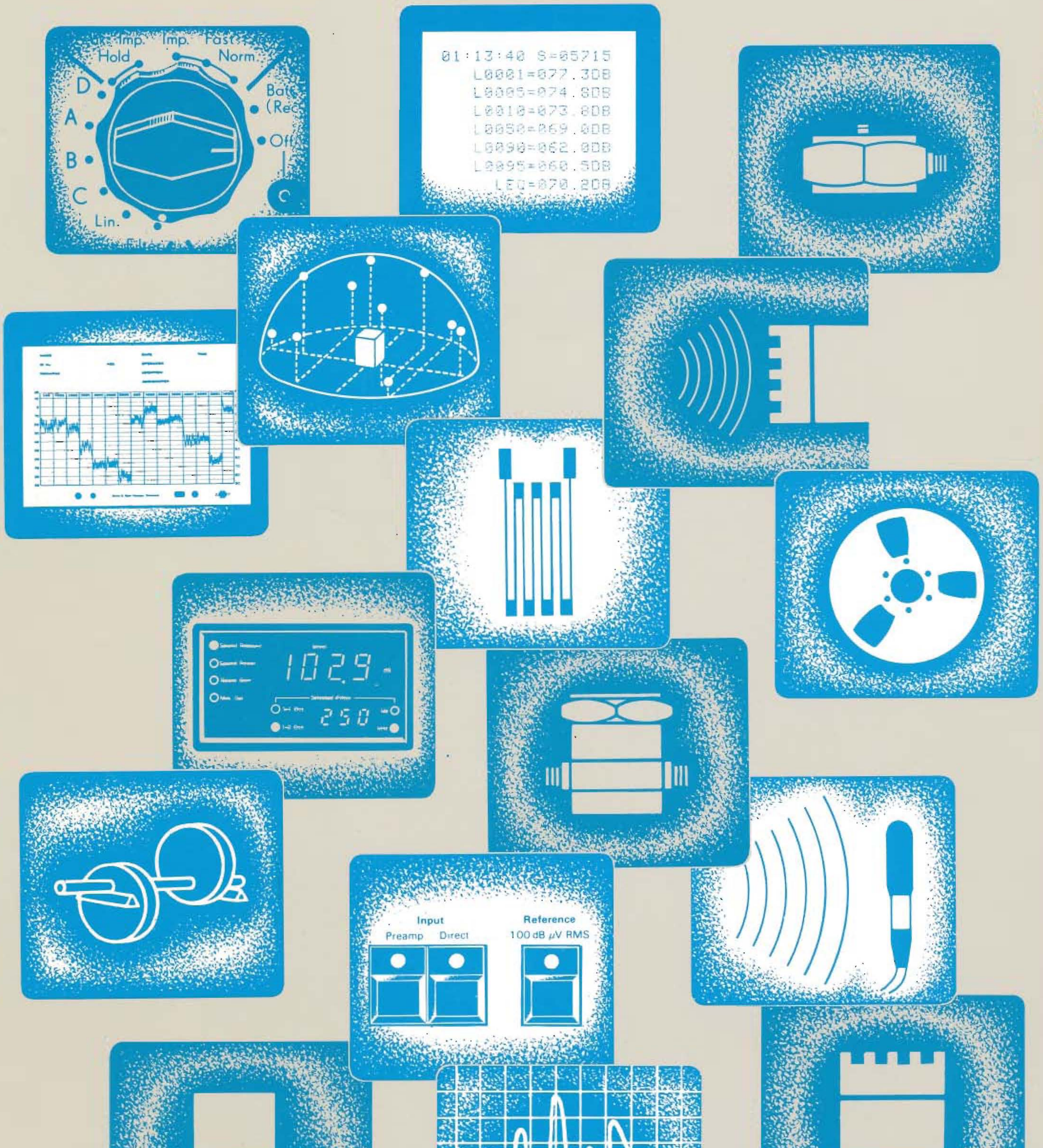


Fig.9.4. Exploded view of attachments for hanging 4805 (see section 3.7)



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