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VIBRATION-ISOLATING ASSEMBLIES BASED ON STANDARD ELEMENTS

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The advantages of using vibration-isolating assemblies based on standard elements are discussed in this paper. Composite assemblies made up of the same type components allow to meet the specific requirements for attachment of ship's equipment: protection against excessive motion, required rigidity, increasing of free displacement ets. It is convenient to use prism-shaped and ring-shaped components for various users. Shock-absorbing assemblies of two-stage design have improved vibration isolation.

Shock-mounts of various load-carrying capacity ranging from several to dozens kilograms are used in shipbuilding practice for vibration isolation of instruments, small mechanisms and those of up to dozens of tons are used for installation of main engines. The most typical range of masses of equipment to be shock-mounted is from 100 kg to 10 t, shock-mounts either of different designs or of the same type but of different sizes being utilised. That is not convenient both from the point of view of a manufacturer (manufacture of various moulds and press tools for fittings) and a user (necessity to have spare shock-mounts for each standard size). It seems to be advisable that ship's shock-mounts should be formed for a wide range of loads from 100 kg to 3...4 t (per piece) by assembling standard uniform rubber-metal components varying their number in an assembly. That will allow not only to reduce the number of spare components but to get the following advantages: a) Normally rubber products have relatively large spread in characteristics, particularly in rigidity, caused by technology features. Since for vibration isolation of

a ship's mechanism all shock-mounts should be of the same rigidity because a designer proceeds from this when carrying out calculations and any deviations are fraught with complications. During the installation of shock-mounts it is required to check the rigidity of every shock-mount and to select them when placing in position so that the rigidity deviation for symmetrically installed shock-mounts would be minimised. In composite shock-mounts even with spread in characteristics of individual components as a result of summation the characteristics of the shock-mount as a whole are averaged and their spread becomes less even without special selection. In case of component selection one can equalise the rigidity characteristics of shock-mounts perfectly.
b) The rigidity of shock-mounts structurally depends on the free surface area of rubber. The less the component dimensions , the higher is the surface to volume ratio. When arranging a large shock-mount out of small components, the relative free surface of rubber is considerably more than for a shock-mount of the same load-carrying capacity but made of an integral rubber mass. Thus, one can manage to achieve lower rigidity for composite shock-mounts with the same quantity of rubber that increases their efficiency (the ratio of mechanism rotational speed to frequency of free oscillations on shock-mounts is increasing).
c) A special arrangement of components in a composite shock-mount makes it possible to provide protection of equipment against excessive motion without special stoppers. That simplifies the designing of shock-mounting for various types of mechanisms.
For various users different qualities of shock-mounts are required, therefore 2 basic types of components have been designed: prism-shaped and ring-shaped components (fig.1).

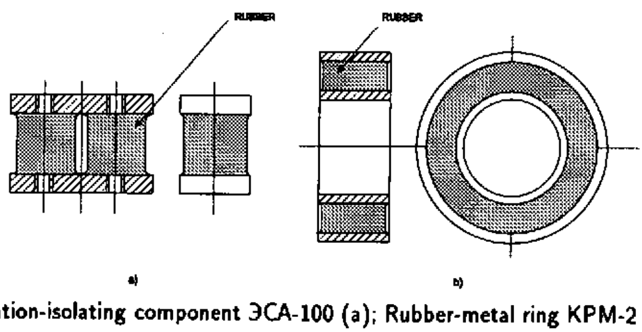

Fig.1. Vibration-isolating component ЭСА-100 (a); Rubber-metal ring KPM-2 (b)

To reduce the rigidity of a ring-shaped component a modification with rubber mass cut into separate segments has been developed.
As a basic component to compose a shock-mount, elements have been selected with relatively small load-bearing capacity of 100 to 250 kg and low rigidity.
Using these components one can compose standard size ranges of composite shock-mounts covering range of load-bearing capacity.
The shock-mounts Type 1 through 4 are made up of components ЭCA-100, Type 5 through 8 - of components KPM. Their load-bearing capacity is determined by number of these components.
The drawback of shock-mounts Type 1 through 4 is the nonuniformity of characteristics for X, Y, Z axes and absence of protection against excessive motion.
To avoid this and to achieve more uniform characteristics for axes (in different directions) and protection against excessive motion under dynamic action new ways of arranging the components are suggested.

Description of shock-mount	Load-bearing capacity, kg	Natural frequency, Hz
Type 1	400	10...12
Type 2	800	10...12
Type 3	1200	10...12
Type 4	1700	10...12
Type 5	900...1500	12...17
Type 6	1000...1500	8...10
Type 7	6000	14
Type 8	9000	14

If ring-shaped components are being utilised where the protection against excessive motion is provided by component's design already, then it is possible to increase free travel of a shock-mount (that is very important under dynamic actions) by means of series arrangement, i.e. as if using a shock-mount with an intermediate mass.
At the same time the lowest frequency of mounting is going down and what is very important for some cases in practice the vibration isolation is going up for medium and high frequencies. Let us consider a shock-absorbing assembly with series connection of ring-shaped components (fig.2).
If rings KPM-2 are utilised, then a one-stage shock-mount will have a minimum frequency $f_{0_{min}} = 15$ to 16 Hz. For a two-stage arrangement a minimum frequency will go down to $f_{0_{min}} = 10$ to 11 Hz. And a partial frequency of oscillations of an intermediate shaft for ar-

rangement shown in fig.2b with rings KPM-2 which have vibrational rigidity of C_{ring}=5400 kN/m will be f_{interm}=213 Hz.

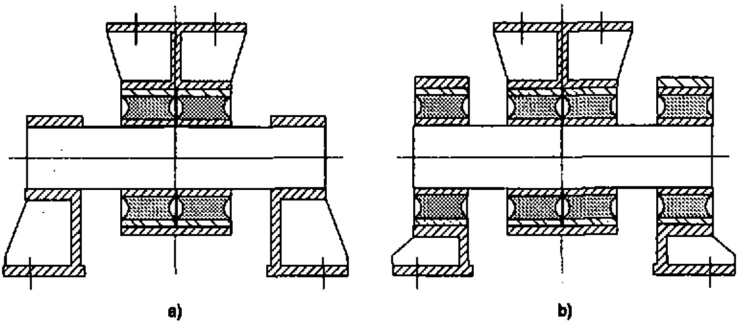

Fig.2. Composite shock-mount Type 5 (one-stage) (a). Composite shock-mount Type 6 (two- stage) (b)

The increase in vibration isolation equals 6 dB in frequency range of 5 to 250 Hz and increase in vibration isolation in frequency range above 200 Hz equals to

$$\Delta L = 40\lg f_{interm} - 20\lg \eta + 6$$

where η= 0.1 - loss factor for rubber used in these shock-mounts. The calculated characteristic is well correlated with values of vibration isolation obtained under actual conditions in frequency range of up to 500 Hz.
The utilisation of rings with reduced rigidity makes it possible to obtain much more effective shock-mounts.

SUMMARY

1. Shock-absorbing composite assemblies made up of the same type components allow to meet the specific requirements for attachment of ship's equipment : protection against excessive motion, required rigidity in different directions, etc.

2. The design simplicity of vibration-isolating components ensures the stability of characteristics and relatively low costs for their manufacturing.

3. Shock-absorbing assemblies which have two-stage design have improved vibration isolation. Experimental tests verify calculated parameters.