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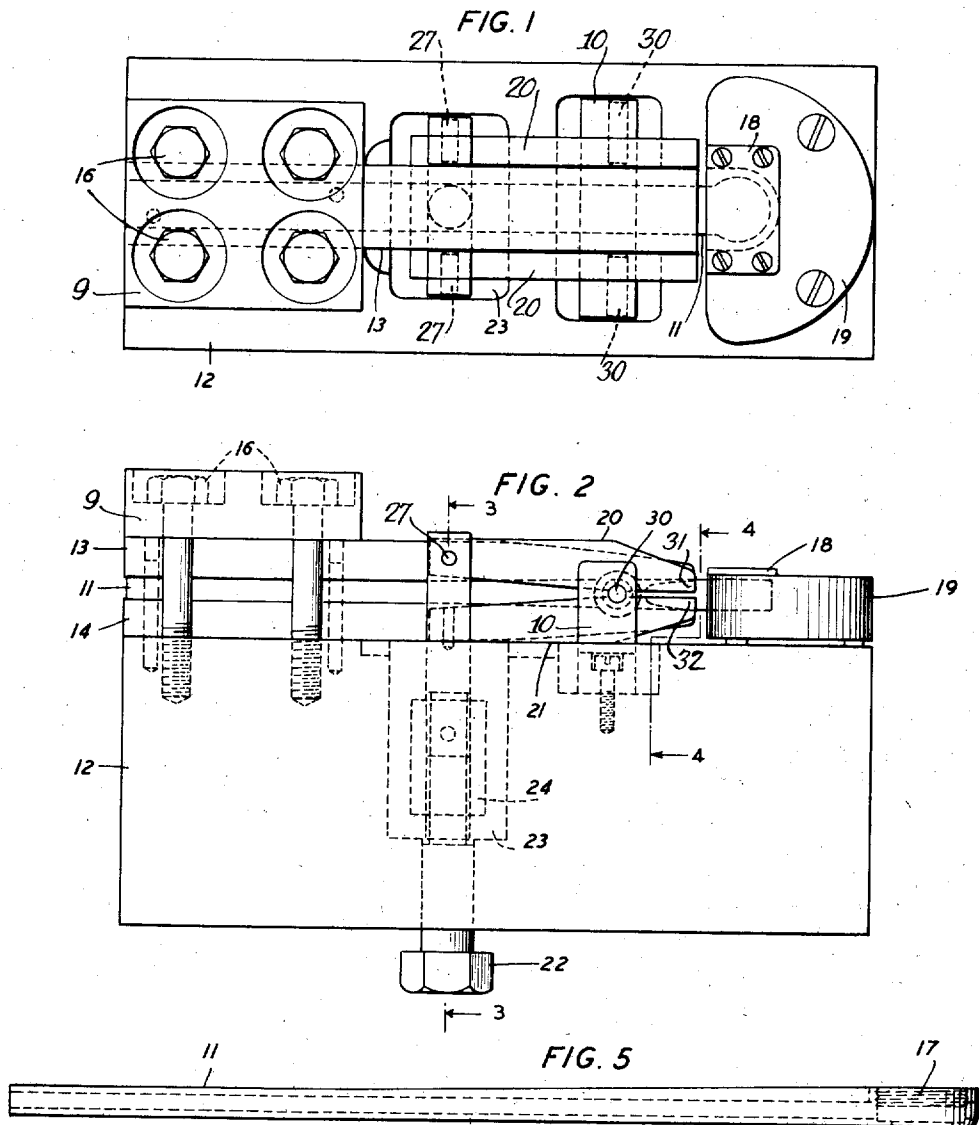
T. AAMODT

2,030,421

TUNED VIBRATING SYSTEM

Filed April 4, 1933

2 Sheets-Sheet 1



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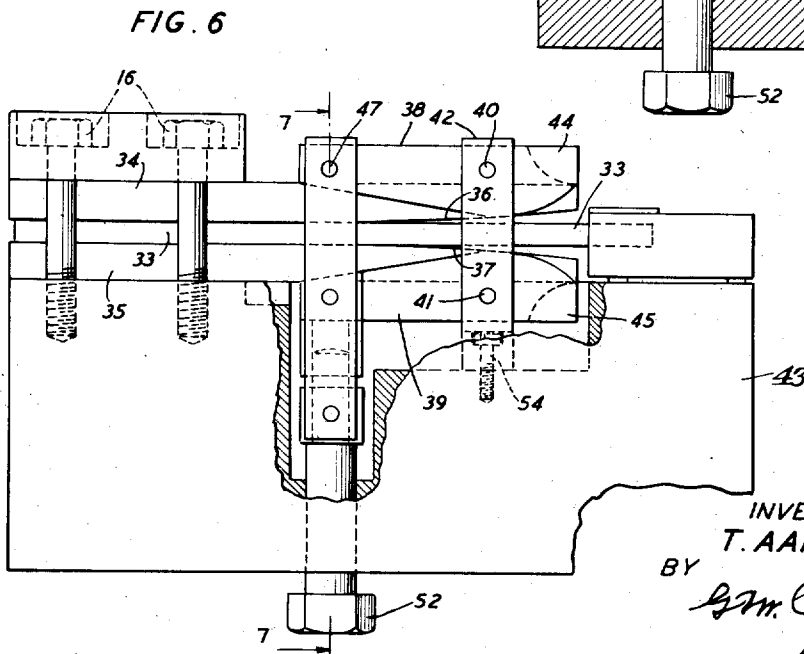
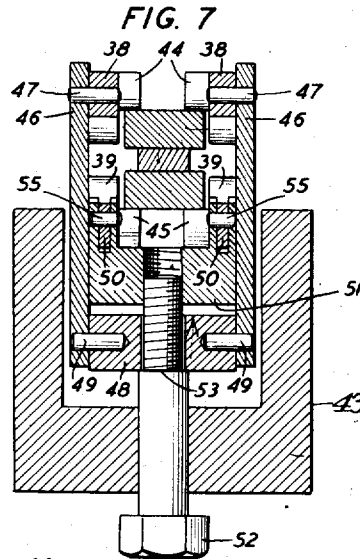
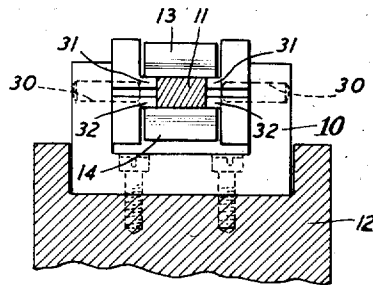
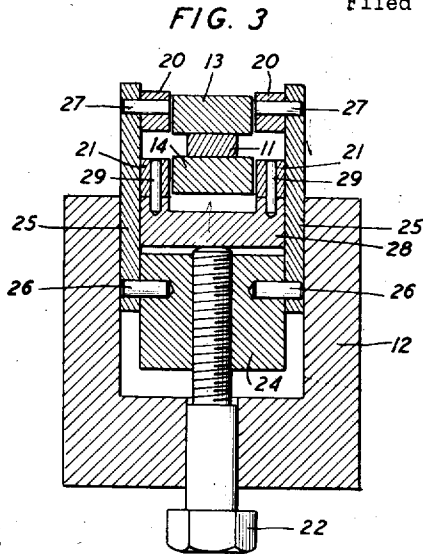
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FIG. 4 Sheets-Sheet 2



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TUNED VIBRATING SYSTEM

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12 Claims. (Cl. 84-408)

This invention relates to mechanical vibrating systems and the object of the invention is to provide convenient, practical and sensitive mechanism for tuning such systems to any desired frequency within a very wide range.

It frequently happens particularly in testing work that mechanical systems must be vibrated successively at a number of different frequencies and this is most readily accomplished by successively tuning the system to the different driving frequencies employed. A number of ways of accomplishing this result are already known in the art. For example, the vibrating member may be a tuning fork with a sliding weight for adjusting its resonant frequency, but this and various other known schemes are unsuited for many purposes in that among other reasons a sufficiently wide tuning range with a practical structure is not readily obtained.

In the preferred embodiment of this invention the member to be vibrated is a bar fixed at one end and held between clamps by pressure applied to the ends of the clamps adjacent the fixed end of the bar. This tunes the bar to its highest resonant frequency and lower frequencies are obtained by progressively forcing the clamps out of contact with the bar by forces applied to their free ends. The progressive increase in the free length of the bar to tune it to the lower frequencies is conveniently attained according to the invention, preferably by making the clamp faces flat and contouring the corresponding bar surfaces to the deflection curves of the clamps as cantilever beams under a suitably distributed load. The radius of curvature of all points along such a curve will be greater than would be obtained by applying a concentrated load of the same magnitude to the end of the clamp. The application of sufficient force at the free ends of the clamps will therefore progressively reduce the portion of their length in contact with the bar thereby increasing its free length and lowering its resonant frequency. In the preferred embodiment the bar is contoured to the deflection curves of the clamps when under a parabolically distributed load but it will be understood that the scope of the invention includes curves of other non-linear load distributions.

In an alternative construction the bar surfaces may be made flat and the clamp faces contoured instead, in which case the free ends of the clamps are forced together into contact with the bar and the concentrated force is progressively reduced to increase the free length of the bar.

The invention may be used for various pur-

poses but by way of illustration it will be described with reference to an embodiment suitable for use with an impedance meter of the type disclosed in an application of P. B. Flanders, Serial No. 664,308, filed April 4, 1933, now Patent No. 2,008,857, dated July 23, 1935.

In the drawings, Fig. 1 is a plan view and Fig. 2 an elevation of a bar and its associated tuning mechanism according to the invention. Figs. 3 and 4 are sectional views taken as indicated in Fig. 2. Fig. 5 shows the contoured bar used in this embodiment and Figs. 6 and 7 show an alternative arrangement using a flat bar and contoured clamps.

The bar 11 of Fig. 5 is securely clamped to the heavy base block 12 between the clamps 13, 14 by the machine screws 16 in the top piece 9. The faces of the clamps are ground flat but, as stated above, the upper and lower sides of the bar are contoured to the deflection curves of the clamps when under a distributed load. If the bar shown in Fig. 5 is considered as fixed at its left end, the upper face represents the deflection curve of the clamp when the load is applied upwardly, and the lower face the curve when the load is applied downwardly. Before the screws 16 are tightened, the clamps 13, 14 will be in contact with the bar only at their ends, but tightening the screws gradually forces the flat clamps to assume the contour of the bar and they are finally brought into contact throughout their length.

Under this condition the free length of the bar is a minimum and it will resonate at its highest frequency. By suitably proportioning the bar this frequency may be fixed at any desired value such as 11,000 cycles per second, according to the requirements of the particular case. In the free end of the bar there is a threaded opening 17 adapted in this case to receive the dynamic and electrostatic voltage generating elements used in the mechanical impedance measuring system referred to above. It will be understood that this construction of the end of the bar is merely illustrative and that it will vary according to the use to which the invention is to be put. The bar may be vibrated in any convenient manner such as by means of an alternating potential applied between it and the electrostatic driving plate 18 which is mounted on the U-shaped insulator block 19.

The mechanism for operating the clamps 13, 14 to progressively increase the free length of the bar and lower its resonant frequency, comprises jaw members 20, 20 and 21, 21 operated by means of the screw 22. In the rectangular

cavity 23 in the base 12 the block 24 is threaded to receive the machine screw 22 and is connected to the upper set of jaws by the straps 25, 25 and the dowel pins 26, 26 and 27, 27. The end of the screw 22 contacts the bottom of the member 28 which is connected to the lower jaws by dowel pins 29, 29 and is adapted to move vertically between the straps 25. The screw makes a sliding fit in the base block 12 and when it is forced against the member 28, the ends of the lower jaws 21 are moved upwardly and at the same time the movement of the screw through the block 24 pulls downwardly on the straps 25 and the ends of the upper jaws 20. With this arrangement the forces applied to the upper and lower jaws will always be equalized. The jaws 20 and 21 have projections 31 and 32 extending between the clamps 13 and 14 as shown in Fig. 4 and the clamps by engagement with these projections hold the jaws in contact with pivots 30 in the U-shaped support 10. As the left-hand ends of the jaws are pulled together by the screw 22 in the manner already described, the jaws will rotate on the pivots 30 and open the right-hand ends of the jaws. In opening, the projections 31—32 on the jaws will force the clamps 13—14 apart. It will be noted that these projections are tapered toward the pivots 30 as shown dotted in Fig. 2 so that they contact the clamps only at their extreme ends. As the jaws turn on the pivots 30 and the clamps are forced apart the force is therefore always applied to the end of the clamps as a concentrated load. When this concentrated force becomes great enough the clamps will be deflected with a radius of curvature less than the radius of curvature produced in the clamps by being held in contact with the bar 11 by the screws 16 so that contact between the clamps and the bar is broken progressively along the bar to progressively decrease its resonant frequency.

The bar 11 may be proportioned so that with the clamps 13, 14 fully spread the bar resonates below 300 cycles so that the invention therefore provides a member conveniently and accurately tunable to any frequency within a very wide range. If still higher or lower frequencies are required, the bar may be proportioned accordingly and where necessary to cover an unusually wide range of frequencies a series of interchangeable bars may be provided each of which is capable of being tuned to a portion of the desired range. From the foregoing description it will be clear that the procedure in using the invention is first to clamp the bar to resonate it at its highest frequency and then to obtain any desired lower frequencies by means of the set screw 22.

In the alternate form shown in Fig. 6 the bar 33 has flat faces or in other words it is of uniform cross-section throughout its length. The clamps 34 and 35 have their faces 36, 37 contoured in the same manner as the faces of the bar 11 in the embodiment already described except that in this case the contours are the deflection curves of the bar instead of the curves of the clamps. When screws 16 are tightened and no force is applied to the other ends of the clamps, they will be held out of contact with the bar as shown in Fig. 6. Under this condition the bar will resonate at its lowest resonant frequency.

The mechanism for forcing the clamps into contact with the bar to raise its resonant frequency comprises two sets of jaw members 38, 39 and operating mechanism therefor as shown in Fig. 7. The jaws are pivoted on rods 40, 41 ex-

tending between the standard 42 and another standard on the other side of the other set of jaws, these standards being mounted on the base block 43 by screws 54. The jaws are provided with projections 44, 45 engaging the clamps and contoured so that the force is always applied at the ends of the clamps as shown in Fig. 6.

The other ends of the top jaws 38 are connected by dowels 47 to the straps 46 which are secured to the member 48 by dowels 49. The other ends of the lower jaws 39 are of reduced thickness 50 and are held in pivotal relation to the U-shaped member 51 by dowels 55. The screw 52 has a sliding fit in the base block 43 and when turned in a clockwise direction, the shoulder 53 forces the block 48 and the straps 46 upwardly thereby rotating the upper jaws 38 about the pivot 40 and forcing the surfaces 36 of the clamps 34 into contact with the bar 33. Simultaneously the motion of the screw 52 in the member 51 draws this member downwardly and with it the ends of the lower jaws 39. The contra-clockwise rotation of these jaws about the pivot 41 forces the surfaces 37 of the clamps 35 into contact with the lower face of the bar. Since the whole structure moved by the screw is free-floating with respect to the stationary structure, the forces applied to the clamps will always be equal and as in the other embodiment the resonant frequency of the bar may be varied at will.

While the invention has been described with reference to particular embodiments suitable for use with a mechanical impedance meter, it will be understood that the invention is in no sense limited to this particular application or to the particular forms in which it is disclosed, for example, one or more of these variably tunable bars may be used as elements in a mechanical filter for selecting or suppressing any desired frequency or bands of frequencies. For some uses it may be desirable to use a construction in which the bar is clamped at both ends, each end being provided with a clamping mechanism of the type already described and the bar being adapted to be driven at its unclamped central portion.

What is claimed is:

1. A tuned vibrating system comprising a contoured vibrating bar, two clamp members along a portion of opposite sides of the bar having a normal radius of curvature different from the bar, means for supporting the bar and the clamps at one end, means for forcing the clamps into intimate contact with the bar throughout their lengths, and means for gradually deflecting the free ends of the clamps to vary progressively the effective free length of the bar.

2. A tuned vibrating system comprising two flat faced clamps, a vibrating bar contoured on opposite surfaces to the deflection curves of the clamps when they are subjected to a non-linearly distributed load, means for supporting the bar at one end between the clamps, means adjacent the supported end of the bar for deflecting the clamps into contact with the contoured surfaces, and means for applying a variable concentrated load to the other ends of the clamps.

3. In a tuned vibrating system, a vibrating bar, two clamp members on opposite sides of a portion of the bar, means for supporting and clamping the bar between the members at one end and means for progressively deflecting the other ends of the members to vary the resonant frequency of the bar.

4. In a tuned vibrating system, flat faced clamps, a vibrating bar, means for supporting

the bar at one end between the clamps as a cantilever beam, said bar increasing in thickness toward its free end, the upper and lower surfaces of the bar being contoured in accordance with the deflection curves of the clamps when they are subjected to a non-linearly distributed load, means for forcing the clamps into contact with the contoured surfaces of the bar, pivoted jaws engaging the ends of the clamps, and means for simultaneously rotating the jaws in opposite directions to move the clamps out of contact with the bar.

5. In a tuned vibrating system, flat faced clamps, a vibrating bar fixed at one end between the clamps as a cantilever beam and increasing in thickness toward its free end, the upper and lower surfaces of the bar being contoured in accordance with the deflection curves of the clamps when they are subjected to a non-linearly distributed load, a base block, means for forcing the clamps into contact with the contoured surfaces of the bar and securing one end of the bar and the clamps to the block, upper and lower pivoted jaws engaging the other end of the clamps and extending toward their fixed ends, a threaded member connected to the upper jaw, a thrust member connected to the lower jaw and a set screw cooperating with said members.

6. In a variably tunable vibrating system, the combination with a vibrating bar and clamping members therefor, the members being contoured to the deflection curve of the bar when said bar is subjected to a non-linearly distributed load, of means for fixing one end of the bar between the members and means for progressively varying the proportion of the clamping members in contact with the vibrating bar.

7. In combination, a vibratable bar, clamp members on opposite sides of the bar having clamping surfaces of a normal radius of curvature greater than that of the clamped surfaces of the bar, means for fixing the bar at one end between the members, and means for varying a concentrated force applied to the ends of the members to vary the proportion of their length in contact with the bar.

8. In combination, a vibratable bar, clamp members on opposite sides of the bar having clamping surfaces of a normal radius of curvature greater than that of the clamped surfaces

of the bar, means for fixing one end of the bar between the members, pivoted jaws engaging the other ends of the members, and means for applying equal and opposite forces to the jaws.

9. In combination, a vibratable bar and clamp members on opposite sides thereof, the opposed clamping surfaces of the bar and the members being contoured to different radii of curvature, means for fixing one end of the bar between the clamps and means for applying equal and opposite concentrated forces to the ends of the members to vary the radius of curvature of their clamping surfaces with respect to the radius of curvature of the surfaces of the bar and to change the proportion of the length of the clamps in contact with the bar.

10. In combination, a vibratable bar, clamping members on opposite sides thereof, a stationary block, and means for securing one end of the members to the block, pivoted jaws engaging the other ends of the members, and means free-floating with respect to the block for rotating the jaws in opposite directions about their pivots.

11. In combination, a base block, a lower clamp, a flat faced vibratable bar and an upper clamp, means for securing the clamps and the bar to the block, the surfaces of the clamps adjacent the bar being flared away therefrom in accordance with the deflection curves of the bar when it is subjected to a non-linearly distributed load, and means for progressively increasing the proportion of the length of the clamps in contact with the bar comprising jaws engaging the free ends of the clamps, and means for applying equal and opposite forces to the jaws.

12. In combination, a base block, a lower clamp, a flat faced vibratable bar and an upper clamp, means for securing the clamp and the bar to the block, the surfaces of the clamp adjacent the bar being flared away therefrom in accordance with the deflection curve of the bar when it is subjected to a non-linearly distributed load, and means for progressively increasing the proportion of the length of the clamp in contact with the bar comprising pivoted jaws engaging the free ends of the clamps and extending toward the fixed end of the bar, and means free-floating with respect to the block for operating the jaws.

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