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(54) Titre : OUTIL ROTATIF EXTERNE AYANT UNE PARTIE DE COUPE AVEC UN MECANISME D'AMORTISSEMENT ALLONGE TRANSVERSAL
(54) Title: EXTERNAL TURNING TOOL HAVING A CUTTING PORTION WITH A TRANSVERSE ELONGATED DAMPING MECHANISM

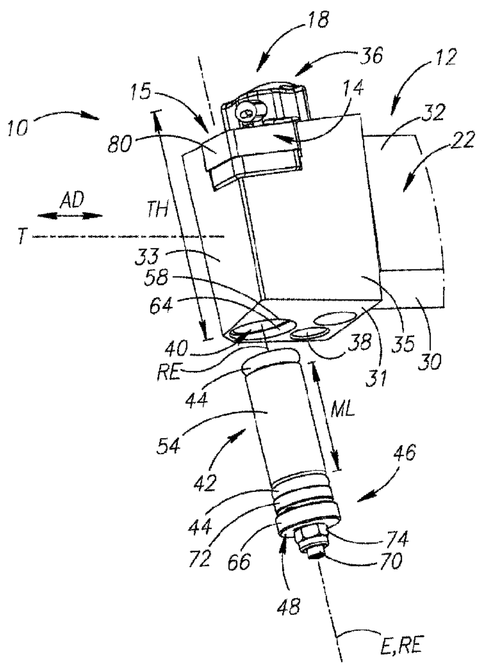

FIG.1

(57) Abrégé/Abstract:
An external turning tool includes an elongated tool body with opposite clamping and cutting portions which define an axial direction therebetween. The cutting portion includes a damping mechanism with an elongated damping member which defines an elongation axis. The elongation axis forms a non-zero damping member angle with the axial direction.

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(54) Title: EXTERNAL TURNING TOOL HAVING A CUTTING PORTION WITH A TRANSVERSE ELONGATED DAMPING MECHANISM

(57) Abstract: An external turning tool includes an elongated tool body with opposite clamping and cutting portions which define an axial direction therebetween. The cutting portion includes a damping mechanism with an elongated damping member which defines an elongation axis. The elongation axis forms a non-zero damping member angle with the axial direction.

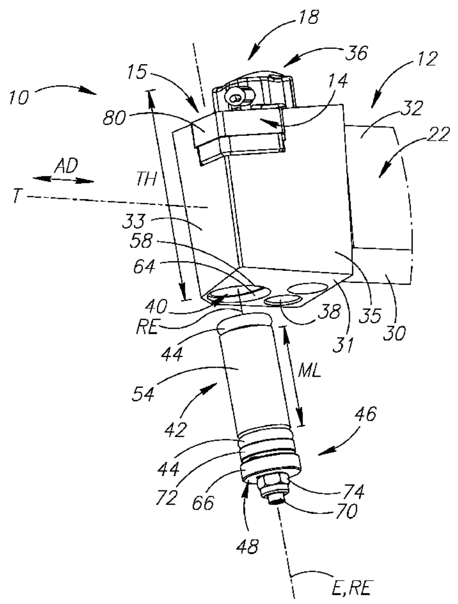

FIG.1

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EXTERNAL TURNING TOOL HAVING A CUTTING PORTION WITH A TRANSVERSE ELONGATED DAMPING MECHANISM

FIELD OF THE INVENTION

[001] The subject matter of the present application relates to external turning machining tools which include a vibration damping mechanism. More particularly, the subject matter of the present application pertains to turning tools having a non-blade-shaped cutting portion, instead of blade-shaped cutting portions of the sort commonly found in grooving and/or parting tools.

BACKGROUND OF THE INVENTION

[002] In the current field it is known that the damping effect, or vibration suppression, created by a damping mechanism in a turning tool is influenced mainly by three parameters: A) Damping member weight; B) Distance between a damping member center of mass and the clamping portion which is secured in a CNC machine; and C) Turning tool stiffness. To maximize the damping effect, these parameters are optimized/chosen per the machining application and/or turning tool geometry. In most scenarios, all three parameters are preferably maximized.

[003] Typical damped turning tools of the field have a relatively large length-to-width ratio, and have clamping and cutting portions and a tool body which extends therebetween. In a clamped position in the CNC machine, at least a portion of the clamping portion is rigidly clamped in the CNC machine, while the tool body and cutting portions are cantilevered therefrom. A typical damping mechanism includes a confined, elongated damping member which lies within a damping cavity, or damping recess, along the elongated tool body. The damping member interacts with the turning tool via a viscous and/or elastic material. To maximize the size/weight of the damping member, the required damping recess leaves the tool body with only a thin peripheral envelope. This type of damping mechanism considerably reduces tool stiffness compared to tools with a solid/full tool body which does not include a damping mechanism therein. In summary, the above described damped turning tools maximize the damping member weight, at the expense of tool, or tool body, stiffness and the distance between the damping member center of mass and the clamping portion.

[004] Generally, an effective non-damped turning tool, among other features, must have an appropriately rigid structure and should be cost-efficient. Designing such a tool becomes even more complex, when a damping mechanism is to be implemented. Specifically - finding an appropriate location, orientation and/or enough space for a sufficiently heavy damping member while both preserving tool structure rigidity and proper tool clearance. The current invention provides a vibration damping solution for external turning tools which overcomes the aforementioned problems.

SUMMARY OF THE INVENTION

[005] In accordance with a first aspect of the subject matter of the present application there is provided an external turning tool comprising an elongated tool body having opposite clamping and cutting portions defining an axial direction therebetween;

wherein:

the cutting portion comprises a damping mechanism with an elongated damping member which defines an elongation axis; and wherein the elongation axis forms a non-zero damping member angle with the axial direction.

[006] In accordance with a second aspect of the subject matter of the present application there is provided an external turning tool comprising a turning insert secured in a pocket and a tool body having opposite clamping and cutting portions defining an axial direction therebetween;

wherein

only the cutting portion comprises a damping mechanism with an elongated damping member; and wherein the damping member defines an elongation axis which forms a damping member angle with the axial direction which ranges from 45 to 135 degrees.

[007] In accordance with a third aspect of the subject matter of the present application there is provided an external turning tool having a non-blade-shaped cutting portion comprising a turning insert secured in a pocket and a tool body having opposite clamping and cutting portions defining an axial direction therebetween;

wherein:

only the cutting portion comprises a damping mechanism with an elongated damping member; and wherein the damping member interacts with the tool body via a viscous material.

[008] Any of the following features, either alone or in combination, may be applicable to any of the above aspects of the subject matter of the application:

[009] The damping member angle can range between 45 and 135 degrees.

[0010] The damping member angle can range between 80 and 100 degrees.

[0011] The turning tool has a tool axis which extends centrally within the tool body parallel to the axial direction and the damping member has a center of mass which is offset from the tool axis.

[0012] The damping member has a max member length measured between extremities of the damping member along the elongation axis; and the max member length is larger than a max member thickness measured between extremities in a direction perpendicular to the elongation axis.

[0013] The max member length is at least 1.5 times larger than the max member thickness.

[0014] The damping member is replaceable with damping members of different weights, each configured, or calibrated, for a specific, or range of damping scenarios.

[0015] The cutting portion has an elongated damping recess configured to accommodate the damping member; the damping recess has a recess elongation axis which forms a non-zero damping recess angle with the axial direction.

[0016] The cutting portion includes a turning insert, and in a top view of the turning tool, the center of mass of the damping member and the turning insert are located on opposite sides of the tool axis.

[0017] The damping mechanism can have an elastic member.

[0018] The damping mechanism can have a lid and a calibration mechanism which is configured to apply a permanent force onto the damping member against an elastic member.

[0019] The damping member can be entirely confined within the cutting portion. Thus, no portion of the damping member 42 is visible in any view of the cutting portion. Also, the damping member does not extend in a rearward direction into the clamping portion.

[0020] The damping member can have chamfers at opposite ends thereof.

[0021] The cutting portion has opposite cutting portion side surfaces, and the elongation axis can extend therebetween without intersecting the cutting portion side surfaces.

[0022] The cutting portion has opposite cutting portion top and bottom surfaces and the damping recess opens out to exactly one of the cutting portion top and bottom surfaces.

[0023] The damping member can have unitary one-piece construction.

[0024] The damping member can be cylindrical.

[0025] The turning tool further includes a turning insert which has a cutting edge formed at an intersection between an upward-facing rake surface and a forward-facing and/or side-facing relief surface.

[0026] The elongation axis can extend parallel or substantially parallel to the relief surface.

[0027] The turning tool has coolant conveyance assembly with coolant channels which extend at least through the cutting portion.

[0028] A plane perpendicular to the axial direction can intersects both the turning insert and the damping mechanism.

[0029] The cutting portion can have a different axial cross-sectional shape than that of the tool body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] For a better understanding of the subject matter of the present application and to show how the same may be carried out in practice, reference will now be made to the accompanying drawings, in which:

Fig. 1 is an exploded isometric view of a cutting portion of a turning tool with a transverse damping mechanism with a bottom opening;

Fig. 2 is a top view of the turning tool of Fig. 1 showing hidden lines;

Fig. 3 is a cross-sectional view taken along line III-III of Fig. 2;

Fig. 4 is a cross-sectional view taken along line IV-IV of Fig. 2;

Fig. 5 is a side view of the turning tool of Fig. 1;

Fig. 6 is a cross-sectional view taken along the line VI-VI of Fig. 5;

Fig. 7 is an exploded view of the damping mechanism of Fig. 1;

Fig. 8 is a top view of a second embodiment of the turning tool with damping mechanism with a top opening;

Fig. 9 is a cross-sectional view taken along line IX-IX of Fig. 8; and

Fig. 10 is a Modal test result graph showing two Frequency Response Functions (FRF) representing, respectively, the same turning tool with and without a damping mechanism.

[0031] Where considered appropriate, reference numerals may be repeated among the figures to indicate corresponding or analogous elements.

DETAILED DESCRIPTION OF THE INVENTION

[0032] In the following description, various aspects of the subject matter of the present application will be described. For purposes of explanation, specific configurations and details are set forth in sufficient detail to provide a thorough understanding of the subject matter of the present application. However, it will also be apparent to one skilled in the art that the subject matter of the present application can be practiced without the specific configurations and details presented herein.

[0033] Attention is drawn to Fig. 1. A turning tool 10 configured to suppress vibrations includes an elongated tool body 12 and a turning insert 14 secured in a pocket 15. The pocket 15 is configured to accommodate the turning insert 14. The turning insert 14 has at least one cutting edge 76 formed at a meeting between an upward-facing rake surface 78 and a forward-facing and/or side-facing relief surface 80. The turning tool 10 has, at opposite extremities of the tool body 12, a clamping portion 16 and a cutting portion 18. The cutting portion 18 further includes a damping mechanism 20. The elongated tool body 12 defines a longitudinal, or axial direction **AD**. The term longitudinal, or axial direction refers to any axis which is parallel to an elongation direction of the tool body 12. Specifically, the axial direction **AD** can be determined by a projection direction of the tool body 12 which is cantilevered from a CNC machine. The turning tool 10 is secured, or coupled into the CNC machine via the clamping portion 16. The axial direction **AD** can also be perpendicular to a rotation axis of the machined workpiece.

[0034] The tool body 12 also defines a centrally extending tool axis **T** which is parallel to the axial direction **AD** and passes centrally through the tool body 12. According to the present embodiment, the tool axis **T** and the axial direction **AD** both pass through the clamping and cutting portions 16, 18.

[0035] The clamping portion 16 is configured to be clamped in a CNC machine, and can have a square cross section taken perpendicular to the tool axis **T** (axial cross section). When clamped in the CNC machine, the clamping portion 16 is considered as a rigid, static reference point with regard to references to vibration damping in the turning tool 10.

[0036] Attention is drawn to Figs. 2, 6 and 8. The tool body 12 has a body peripheral surface 22 which extends along the axial direction **AD** between the clamping and cutting portions 16, 18. Specifically, the axial direction **AD** is parallel to the body peripheral surface 22. According to the present embodiment, the body peripheral surface 22 has opposite body top and bottom surfaces 28, 30and opposite body side surfaces 32 which extend between the body top and bottom surfaces 28, 30. The body peripheral surface 22 can have a square axial cross section taken perpendicular to the axial direction **AD**. The tool axis **T** and the axial direction **AD** are parallel to the body side surfaces 32. The tool axis **T** and the axial direction **AD** are also parallel to the body top and bottom surfaces 28, 30. The tool axis **T** can be located midway between the body side surfaces 32. The tool axis **T** can be located midway between the body top and bottom surfaces 28, 30.

[0037] Attention is drawn to Figs. 4 and 6. The turning tool 10 has a maximum tool width **TW** which is measured between outward extremities of the turning tool body 12 in a direction perpendicular to the body side surfaces 32 and in a direction perpendicular to the tool axis **T**. The turning tool 10 further has a maximum tool height **TH** which is measured between outward extremities of the tool body 12 in a direction parallel to the body side surfaces 32 and in a direction perpendicular to the tool axis **T**.

[0038] The turning tool 10 has a height to width ratio **HWR** = **TH/TW** which is smaller than 3.5 and preferably smaller than 3. According to the present embodiment, the height to width ratio **HWR** is 1. This dimension ratio relates to available volume (internal or external) in the turning tool 10 where a damping mechanism 20 can be implemented efficiently. Most, if not all blade-shaped tools have a height to width ratio of upwards of 4.5. Parting, or cut-off blade shaped tools are therefore too narrow to internally include a damping mechanism 20 according to the present invention. Specifically, an elongated damping member 42 according to the present application which has an appropriate and effective weight cannot be implemented or be accommodated internally within a blade-shaped machining tool simply because it will not fit.

[0039] Attention is drawn to Figs. 1-4. The cutting portion 18 extends from the tool body 12. The cutting portion 18 has cutting portion top and bottom surfaces 29, 31 which extend from a tool front surface 33 towards the clamping portion 16. The cutting portion 18 further has cutting portion side surfaces 35 which extend between the cutting portion top and bottom surfaces 29, 31. The cutting portion 18 includes at least one pocket 15 and a turning insert 14 secured therein. The cutting portion 18 can further include a coolant conveying assembly 36 and coolant channels 38 which extend at least through the cutting portion 18. According to the present embodiment, the cutting portion 18 has a different axial cross section shape than that of the tool body 12. According to the present embodiment, the cutting portion 18 extends in the axial direction **AD** with the pocket 15 formed at the forwardmost axial end of the cutting portion 18.

[0040] According to the present embodiments, the damping mechanism 20 includes an elongated damping recess 40, an elongated damping member 42, at least one elastic member 44, a calibration mechanism 46 and a lid 48.

[0041] Attention is drawn to Fig. 2. According to the present embodiment, the damping member 42 is entirely confined within the cutting portion 18. Stated differently, in the present example, no portion of the damping member 42 protrudes outwardly from the cutting portion 18. Thus, no portion of the damping member 42 is visible in any view of the cutting portion. Also, the damping member 42 does not extend in a rearward direction into the clamping portion 16. The damping member is made from a material with a relatively high density to achieve a high weight-to-volume ratio. The damping member 42 can be made of Tungsten. In the current example, the damping member 42 is made of a single piece of material and thus has unitary one-piece construction.

[0042] The damping member 42, and especially a center of mass **CM** thereof, is located adjacent the tool front surface 33 at a location which is farthest possible from the clamping portion 16. In the present embodiments, the pocket 15 and the damping mechanism 20 at least partially overlap in the axial direction **AD**. In other words, a plane **P** perpendicular to the axial direction **AD** intersects both pocket 15 and the damping mechanism 20.

[0043] These orientation-related features relate to advantageous design which places the damping mechanism 20 at the cutting portion 18 to avoid compromising the structural integrity and/or stiffness of the tool body 12.

[0044] Attention is drawn to Fig. 7. The damping member 42 can have first and second end surfaces 50, 52 and a member peripheral surface 54 which extends therebetween. According to the present embodiment, the member peripheral surface 54 does not include a thread. The damping member 42 has a central elongation axis **E** which passes through the first and second end surfaces 50, 52. The elongation axis **E** extends in a damping member elongation direction. The elongation axis **E** forms a non-zero damping member angle $\boldsymbol{\alpha}$ with the axial direction and with the tool axis **T** (Fig. 4). The damping member angle $\boldsymbol{\alpha}$ ranges preferably between 45 and 135 degrees. In the present example, the damping member angle $\boldsymbol{\alpha}$ is 96 degrees. The damping member angle $\boldsymbol{\alpha}$ can be determined by tool geometry, i.e., in accordance with design efforts to maximize the available space/volume for the damping member 42 and consequently - its weight. The damping member angle $\boldsymbol{\alpha}$, can also be affected by other recesses in the cutting portion 18 such as the pocket 15 and/or coolant conveying assembly 36. Furthermore, in an axial view along the tool axis **T**, the orientation of the damping member 42, and consequently the elongation axis **E** is preferably upright, as seen in Fig. 3. In other words, in the present embodiments, the elongation axis **E** extends between the cutting portion side surfaces 35 without intersecting either. In the present embodiments, as seen in Fig. 4, the elongation axis **E** is parallel, or substantially parallel to the tool front surface. According to the present embodiments, during machining, the elongation axis **E** extends parallel, or substantially parallel, to an operative relief surface 80 which extends from an operative cutting edge 76 that cuts the workpiece.

[0045] According to the present example, the member peripheral surface 54 has a cylindrical shape, the central axis of which coincides with the elongation axis **E**. The center of mass **CM** is defined by a vertex. According to the present embodiment, the center of mass **CM** lies on the elongation axis **E**. According to the present embodiments, the damping member 42 is not centered with respect to the tool body 12. In other words, in the present embodiment, the center of mass **CM** does not lie in the tool axis **T**. Specifically, in a top view of the cutting portion 18, or a plan view of the cutting portion top surface 29 (as seen in Fig. 2), a projection of the center of mass **CM** is offset from the tool axis T. This is advantageous, since the deviation, or lever arm, of the damping member 42 with respect to the tool axis **T** enables the damping member 42 to generate a suppression counter torque against torsional vibrations generated by machining forces. This is true in the present embodiments where the pocket 15 is also not centered with respect to the tool axis **T**. According to the present embodiment, in a top view of the cutting portion 18, or a plan view of the cutting portion top surface 29, as shown in Fig. 2, the center of mass **CM** and the turning insert 14 are preferably located at opposite sides of the tool axis **T**. As seen in Fig. 2, the center of mass **CM** is not located directly beneath, or under, the turning insert 14. In other words, in a plan view of the rake surface 78, the center of mass **CM** does not overlap a projection of the turning insert 14.

[0046] The damping member 42 has a maximum member length **ML** measured between extremities of the damping member 42 along the elongation axis **E**. The damping member 42 also has a maximum member thickness **MT** measured between extremities thereof in a direction perpendicular to the elongation direction. It is understood that when the damping member 42 has a cylindrical body, the maximum member thickness **MT** corresponds to the diameter of the cylindrical body. The maximum member length **ML** is larger than the maximum member thickness **MT**. The maximum member length **ML** is preferably 1.2 times larger than the maximum member thickness **MT**. In other words, the damping member 42 has a length to thickness ratio **ML/MT = LTR** > 1.2. According to the present embodiment, the length to thickness ratio **LTR** is 1.5. This ratio relates directly to optimization of the shape of the damping member 42 to the available volume and to production restrictions in turning tools having a non-blade-shaped cutting portion. Specifically, the elongated shape has a bigger rotational inertia than, e.g., a spherical or a cube shaped damping member. In addition, the elongated shape enables compactness, while avoiding various mechanisms of the turning tool 10 such as an insert clamping mechanism in the pocket 15, or coolant channels 38. In the current turning tool 10, it was found that the current position and orientation of the damping mechanism 20 is preferable in terms of maximum weight achieved in a relatively small confined volume, production efficiency and damping test results (as shown in Fig. 10). As previously mentioned, increasing the damping member 42 weight and distance from the clamping portion 16 becomes more significant as the distance between the cutting portion 18 and the clamping portion 16 increases, i.e., longer tools means larger projection from the CNC machine which leads to an increase in vibrations caused by machining.

[0047] The damping member 42 can have two chamfers 56. Each chamfer 56 extends between the member peripheral surface 54 and each of the first and second end surfaces 50, 52. In a cross section along the elongation axis **E**, the chamfer 56 can appear straight. Each chamfer 56 is configured to abut the elastic member 44.

[0048] The damping recess 40 is elongated and configured to accommodate the elongated damping member 42. According to the present embodiment, the damping recess 40 is a blind hole, or recess, i.e., includes only a single opening 58. According to the present embodiment, the damping recess 40 only opens out to, and the opening 58 is located in, the cutting portion bottom surface 31. This allows for a clean, protrusion-free, cutting portion top surface 29 which gives way for uninterrupted chip flow. Furthermore, this smooth upper surface is subjectively aesthetic, which is regarded as advantageous in terms of marketing value.

[0049] Attention is drawn to Figs. 1-4 and 9. The damping recess 40 has a recess elongation axis **RE**. The recess elongation axis **RE** forms a non-zero damping recess angle **β** with the axial direction **AD**. The damping recess angle **β** ranges preferably between 45 and 135 degrees. According to the present embodiments the damping recess angle **β** measures 96 degrees. It is understood that when the damping mechanism 20 is installed and the tool is non-operative, the damping member's elongation axis **E** and the recess elongation axis **RE** are aligned.

[0050] The damping recess 40 can have a recess wall 60 which extends from a recess base surface 62 located at an inner-most portion of the damping recess 40 along the elongation axis **RE**. The recess wall 60 can be cylindrical. The recess wall 60 can open out to the body bottom surface 30. At or adjacent the opening 58, the recess wall 60 can have a recess female thread 64 configured to receive and correspond with an external male lid thread 66 of the lid 48. The lid 48 can also have an internal female lid thread 68 which is configured to receive and correspond with an adjustment screw 70, as will further explained below.

[0051] According to the present embodiment, the damping mechanism 20 has two elastic members 44. Each elastic member 44 can abut a respective chamfer 56. Each elastic member 44 can be an elastic O-ring made of rubber.

[0052] According to the present embodiment, in an assembled position of the damping mechanism 20, the calibration mechanism 46 can include, in the following order: a pressure plate 72, the adjustment screw 70, the lid 48 and a locating nut 74. The pressure plate 72 is located between a first end of the adjustment screw 70 and the elastic member 44, the adjustment screw 70 is threaded into the internal female lid thread 68, and the locating nut 74 is threaded at a second end of the adjustment screw 70. Once the lid 48 has been firmly tightened into the recess female thread 64, the adjustment screw 70 can be turned to calibrate the damping mechanism 20, i.e., to adjust the amount of force exerted onto the respective elastic member 44 via the pressure plate 72 which spreads the forces across the elastic member 44. Once the damping mechanism 20 has been properly calibrated, i.e., the desired force has been achieved, the locating nut 74 is tightened to preserve the current calibration, or adjustment screw 70 location.

[0053] Attention is drawn to Figs. 8 and 9. According to a second embodiment, the damping recess 40 opens out only to the body top surface 28. The rest of the features of the damping mechanism 20 are similar or identical to the first embodiment disclosed above.

CLAIMS

1. A non-blade shaped external turning tool (10) comprising:

an elongated tool body (12) having opposite clamping and cutting portions (16, 18) defining an axial direction (AD) therebetween; and

a damping mechanism (20) at the cutting portion (18), the damping mechanism (20) comprising an elongated damping member (42) having an elongation axis (E);

wherein:

the elongation axis (E) forms a non-zero damping member angle (α) with the axial direction (AD).

2. The external turning tool (10) according to claim 1, wherein the damping member angle (α) ranges from 45 to 135 degrees.

3. The external turning tool (10) according to claim 1 or 2, wherein the damping member angle (α) ranges from 80 to 100 degrees.

4. The external turning tool (10) according to any one of claims 1 to 3, wherein:

the external turning tool (10) has a tool axis (T) which extends centrally within the tool body (12), parallel to the axial direction (AD); and

the damping member (42) has a center of mass (CM) which is offset from the tool axis (T).

5. The external turning tool (10) according to any one of claims 1 to 4, wherein:

the damping member (42) has a maximum member length (ML) measured between extremities of the damping member (42) along the elongation axis (E); and

the maximum member length (ML) is larger than a maximum member thickness (MT) measured between extremities in a direction perpendicular to the elongation axis (E).

6. The external turning tool (10) according to claim 5, wherein the maximum member length (ML) is at least 1.5 times larger than the maximum member thickness (MT).

7. The external turning tool (10) according to any one of claims 1 to 6, wherein the cutting portion (18) has an elongated damping recess (40) configured to accommodate the damping member (42).

8. The external turning tool (10) according to claim 7, wherein:

the cutting portion (18) has opposite cutting portion top and bottom surfaces (29, 31); and

the damping recess (40) opens out to exactly one of the cutting portion top and bottom surfaces (29, 31).

9. The external turning tool (10) according to any one of claims 1 to 8, wherein the damping mechanism (20) comprises an elastic member (44).

10. The external turning tool (10) according to any one of claims 1 to 9, wherein the damping mechanism (20) further comprises a lid (48) and a calibration mechanism (46) which is configured to apply a permanent force onto the damping member (42) against an elastic member (44).

11. The external turning tool (10) according to any one of claims 1 to 10, wherein the damping member (42) is entirely confined within the cutting portion (18), such that no portion of the damping member (42) is visible in any view of the cutting portion.

12. The external turning tool (10) according to any one of claims 1 to 11, wherein the cutting portion (18) has opposite cutting portion side surfaces (35); and wherein the elongation axis (E) does not intersect the cutting portion side surfaces (35).

13. The external turning tool (10) according to any one of claims 1 to 12, wherein the damping member (42) has unitary one-piece construction.

14. The external turning tool (10) according to any one of claims 1 to 13, wherein the damping member (42) is cylindrical.

15. The external turning tool (10) according to any one of claims 1 to 14, further comprising a coolant conveyance assembly (36) including a coolant channel (38) which extends at least through the cutting portion (18).

16. The external turning tool (10) according to any one of claims 1 to 15, wherein:

the cutting portion (18) has a different axial cross-sectional shape than that of the clamping portion (16).

17. The external turning tool (10) according to any one of claims 1 to 16, wherein the damping mechanism (42) does not extend in a rearward direction into the clamping portion (16).

18. The external turning tool (10) according to any one of claims 1 to 17, further comprising:

a turning insert (14) removably retained in a pocket (15) of the cutting portion (16).

19. The external turning tool (10) according to claim 18, wherein:

the turning insert (14) comprises a cutting edge (76) formed at an intersection between a rake surface (78) and a relief surface (80); and

the elongation axis (E) extends parallel or substantially parallel to the relief surface (78).

20. The external turning tool (10) according to claim 18 or 19, wherein a plane (P) perpendicular to the axial direction (AD) intersects both the turning insert (14) and the damping mechanism (20).

21. The external turning tool (10) according to any one of claims 18 to 20, wherein:

in a top view of the external turning tool (10), a center of mass (CM) of the damping member (42) is not located directly under the turning insert (14).

22. The external turning tool (10) according to any one of claims 18 to 21, wherein:

the external turning tool (10) has a tool axis (T) which extends centrally within the tool body (12) parallel to the axial direction (AD), and in a top view of the external turning tool (10), a center of mass (CM) of the damping member (42) and the turning insert (14) are located on opposite sides of the tool axis (T).

23. The external turning tool (10) according to any one of claims 18 to 22, wherein:

the damping member (42) is entirely confined within the cutting portion (16) such that no portion of the damping member (42) is visible in any view of the cutting portion (16); and

the damping member angle (α) which ranges from 45 to 135 degrees.

24. The external turning tool (10) according to claim 23, wherein the cutting portion (18) has a different axial cross-sectional shape than that of the clamping portion (16).

25. The external turning tool (10) according to claim 23, wherein the damping mechanism (42) does not extend in a rearward direction into the clamping portion (16).

26. The external turning tool (10) according to any one of claims 18 to 25, wherein:

the damping member (42) is entirely confined within the cutting portion (16) such that no portion of the damping member (42) is visible in any view of the cutting portion (16); and

the damping member (42) interacts with the tool body (12) via a viscous material.

27. The external turning tool (10) according to claim 26, wherein the cutting portion (18) has a different axial cross-sectional shape than that of the clamping portion (16).

28. The external turning tool (10) according to claim 26, wherein the damping mechanism (42) does not extend in a rearward direction into the clamping portion (16).

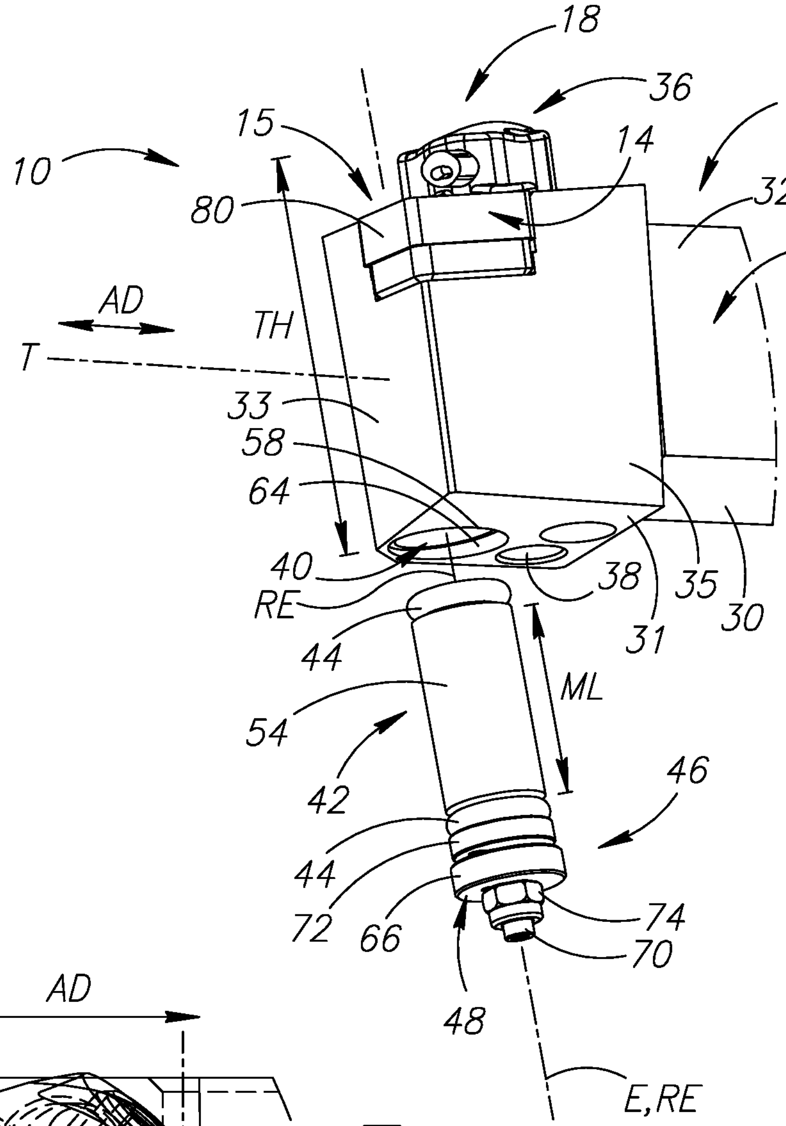
18
36
12
15
14
10
32
80
22
AD
TH
T
33
58
64
40
38
35
RE
31
30
44
ML
54
42
46
44
72
66
74
70
48
E,RE

FIG.1

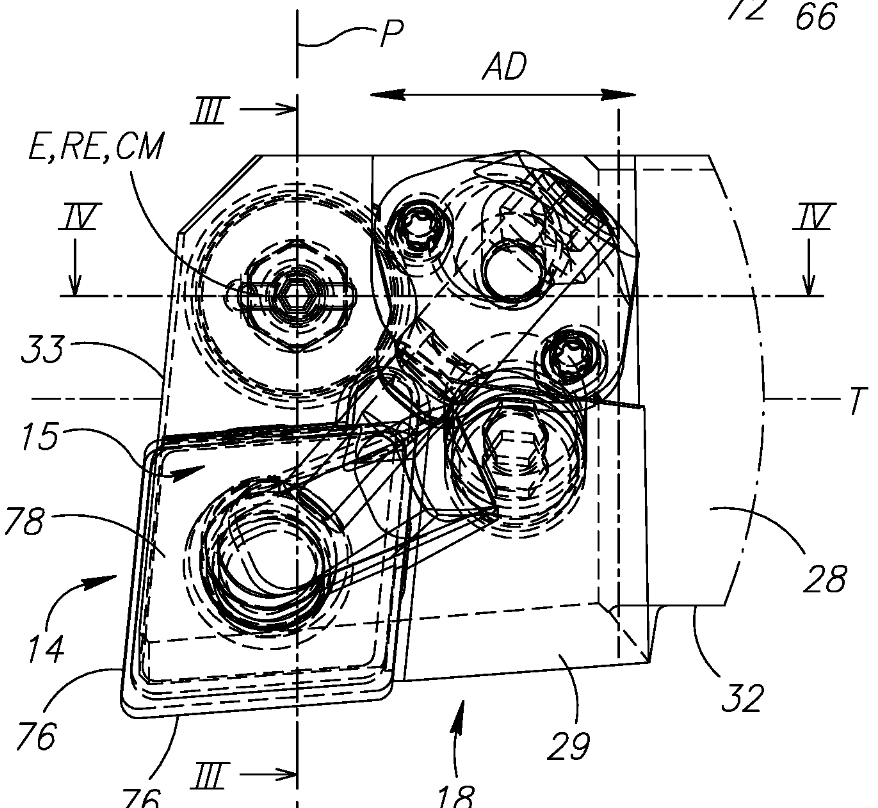
P
AD
III
E,RE,CM
IV
IV
33
T
15
78
28
14
76
32
76
III
29
18

FIG.2

2/5

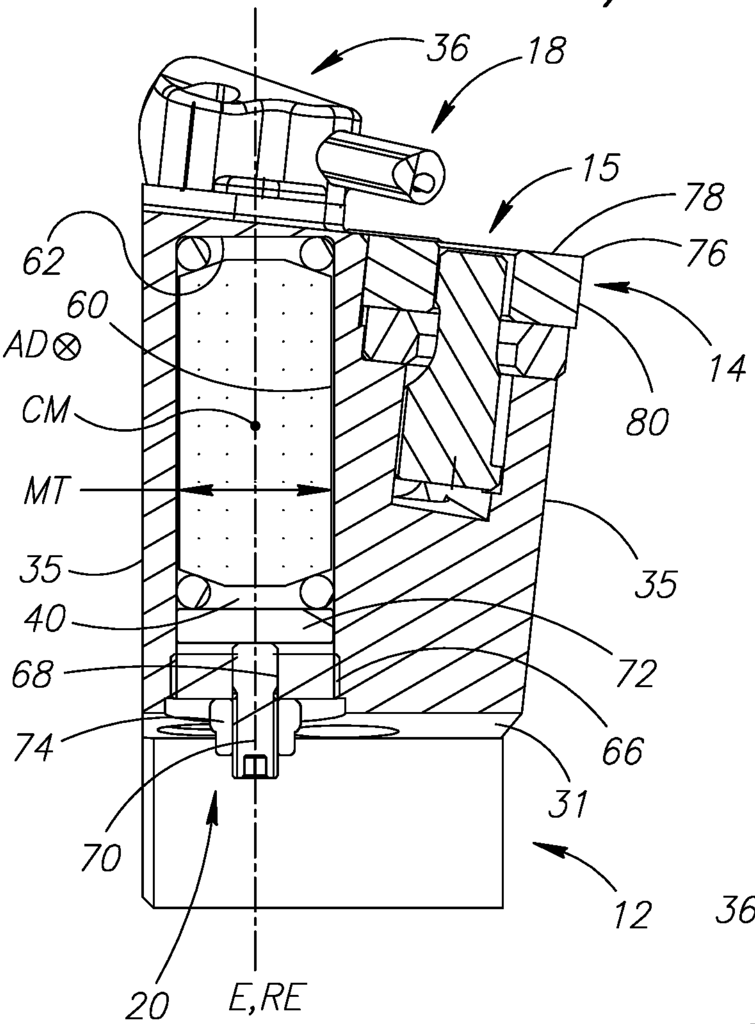
36
18
15
78
76
62
60
AD⊗
14
80
CM
MT
35
35
40
72
68
66
74
31
70
12
20
E,RE

FIG.3

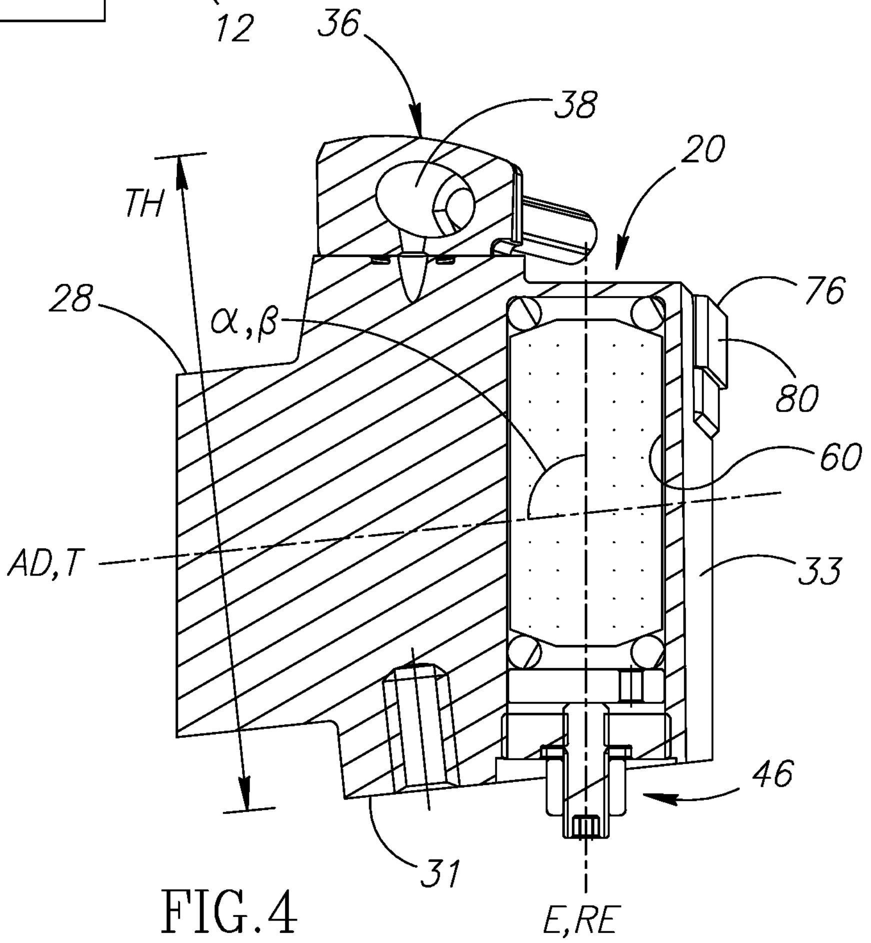
36
38
20
TH
28
α,β
76
80
60
AD,T
33
46
31
E,RE

FIG.4

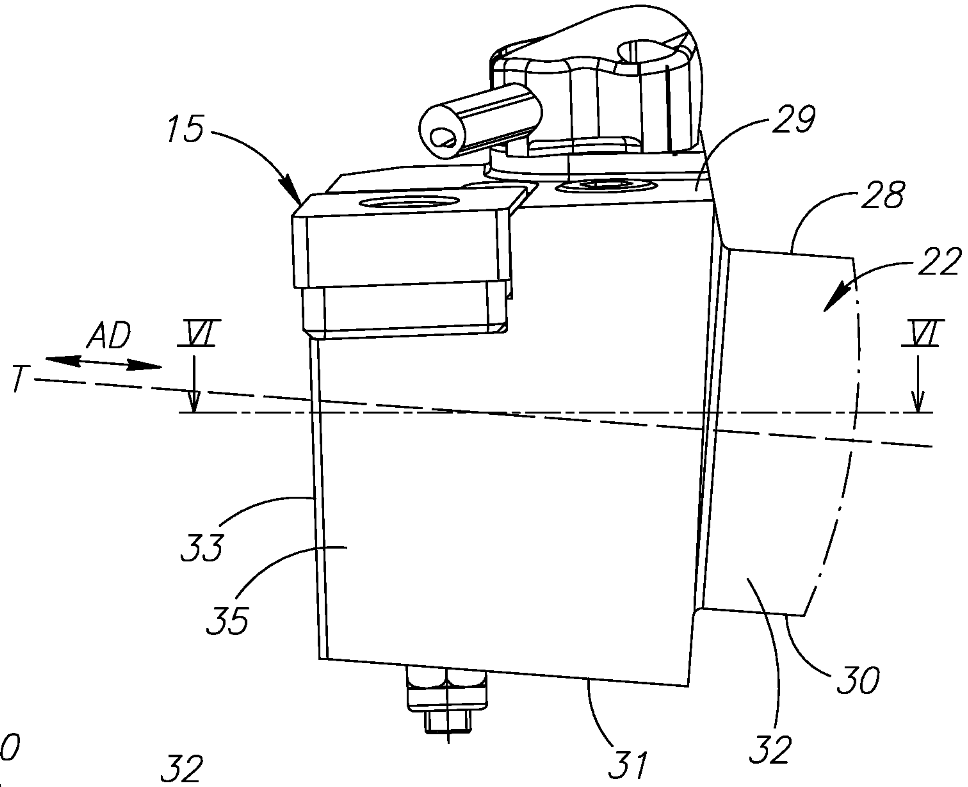

FIG.5

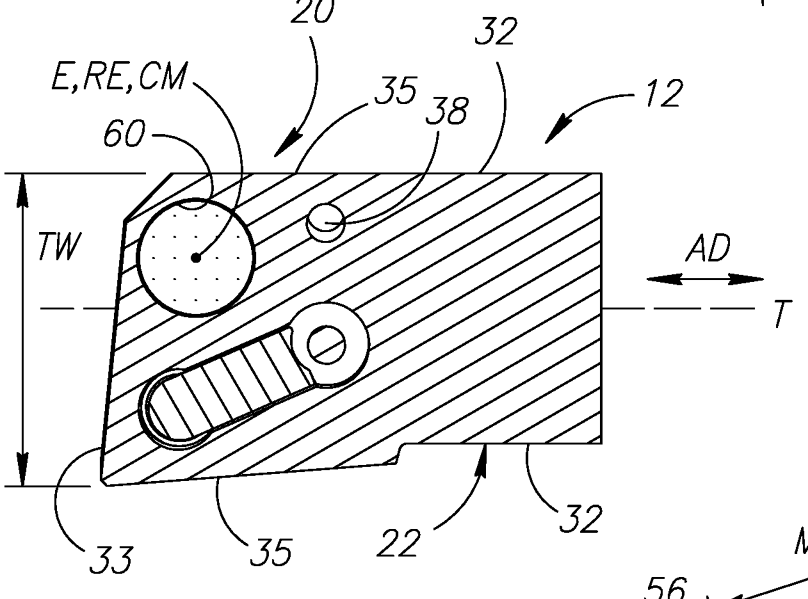

FIG.6

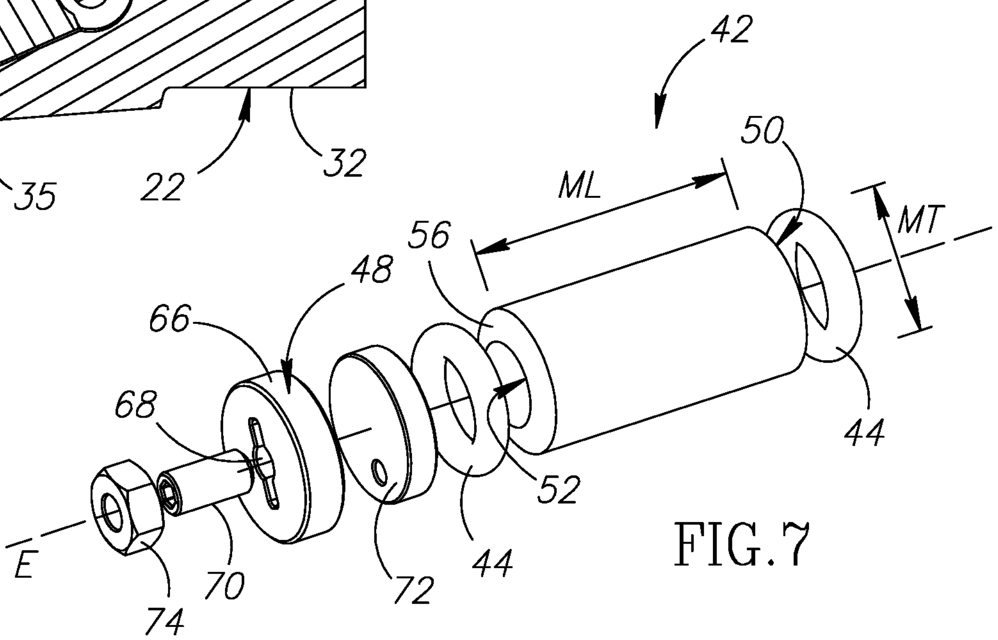

FIG.7

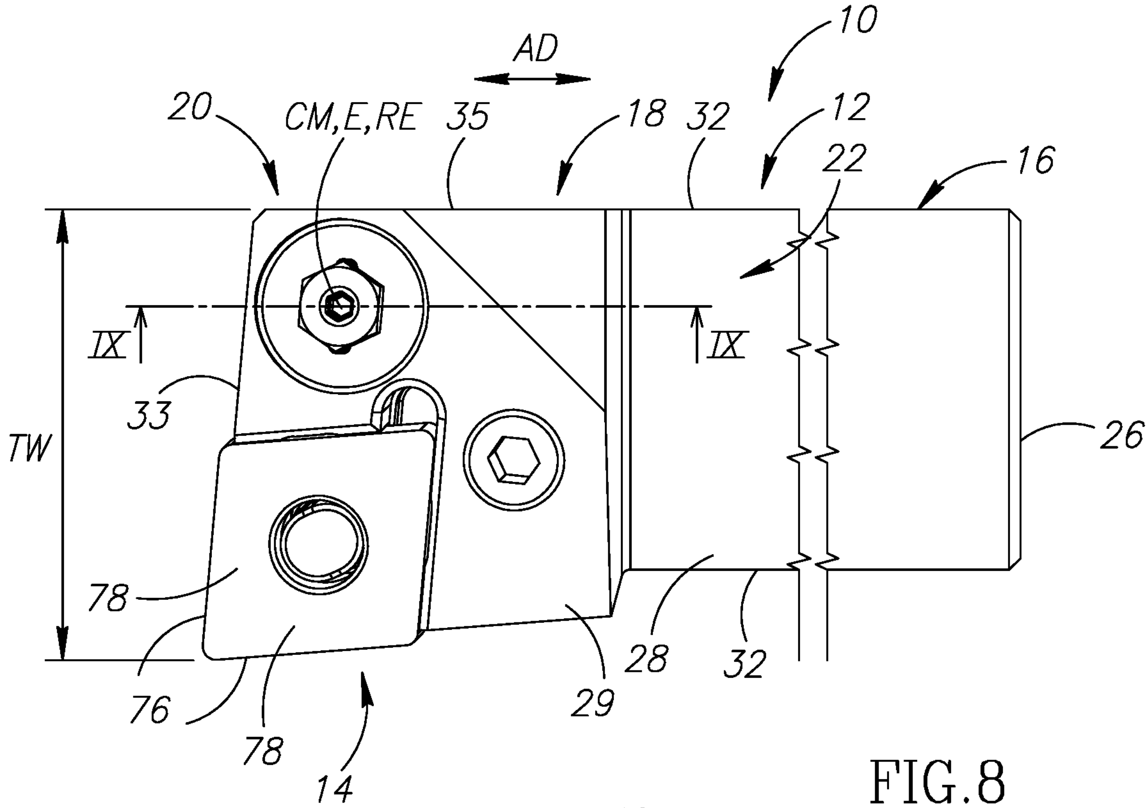
10
AD
20
CM,E,RE
35
18
32
12
22
16
IX
IX
33
TW
26
78
28
32
76
29
78
14

FIG.8

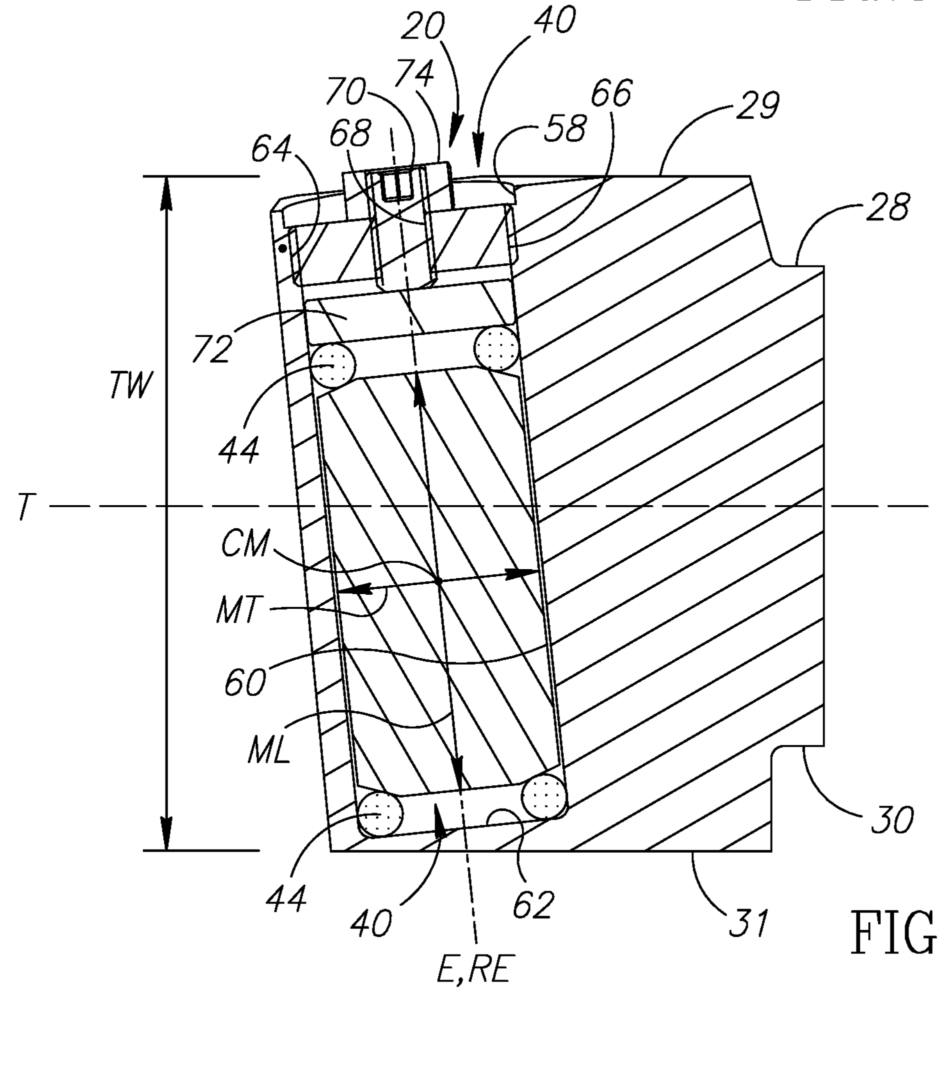
20
40
74
70
66
68
58
29
64
28
72
TW
44
T
CM
MT
60
ML
30
44
40
62
31
E,RE

FIG.9

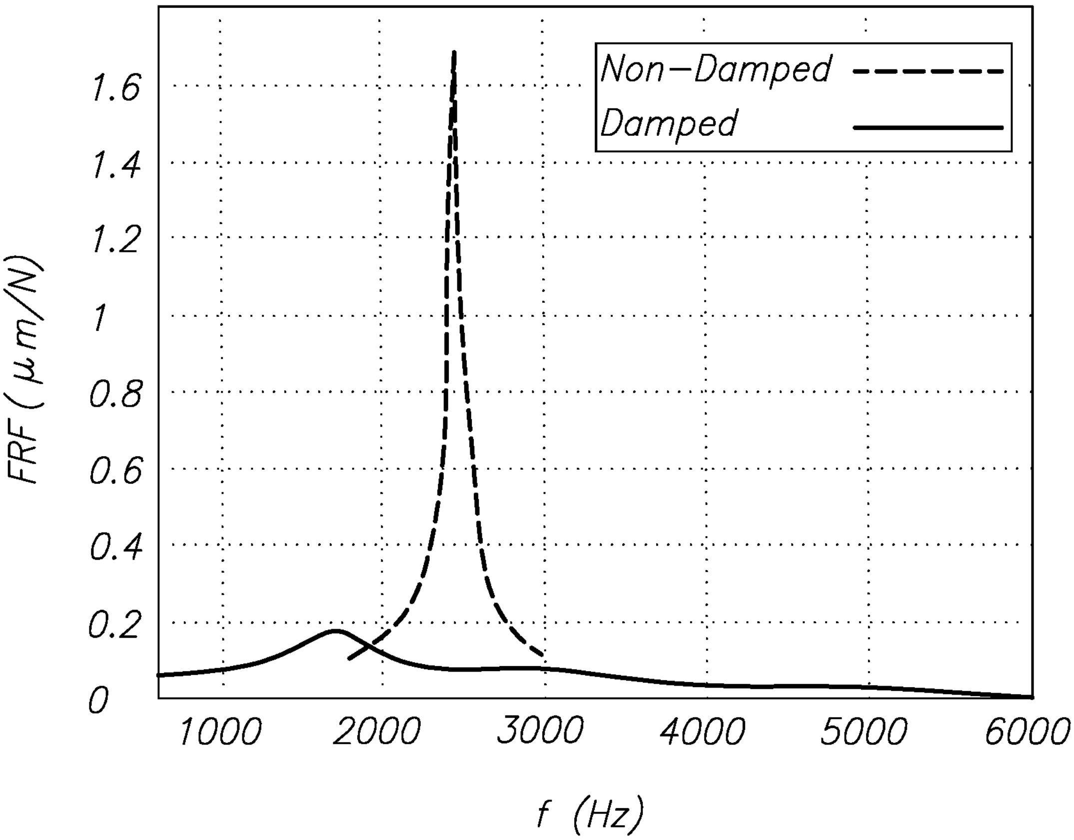
Non−Damped
Damped
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
FRF (μm/N)
1000
2000
3000
4000
5000
6000
f (Hz)

FIG.10

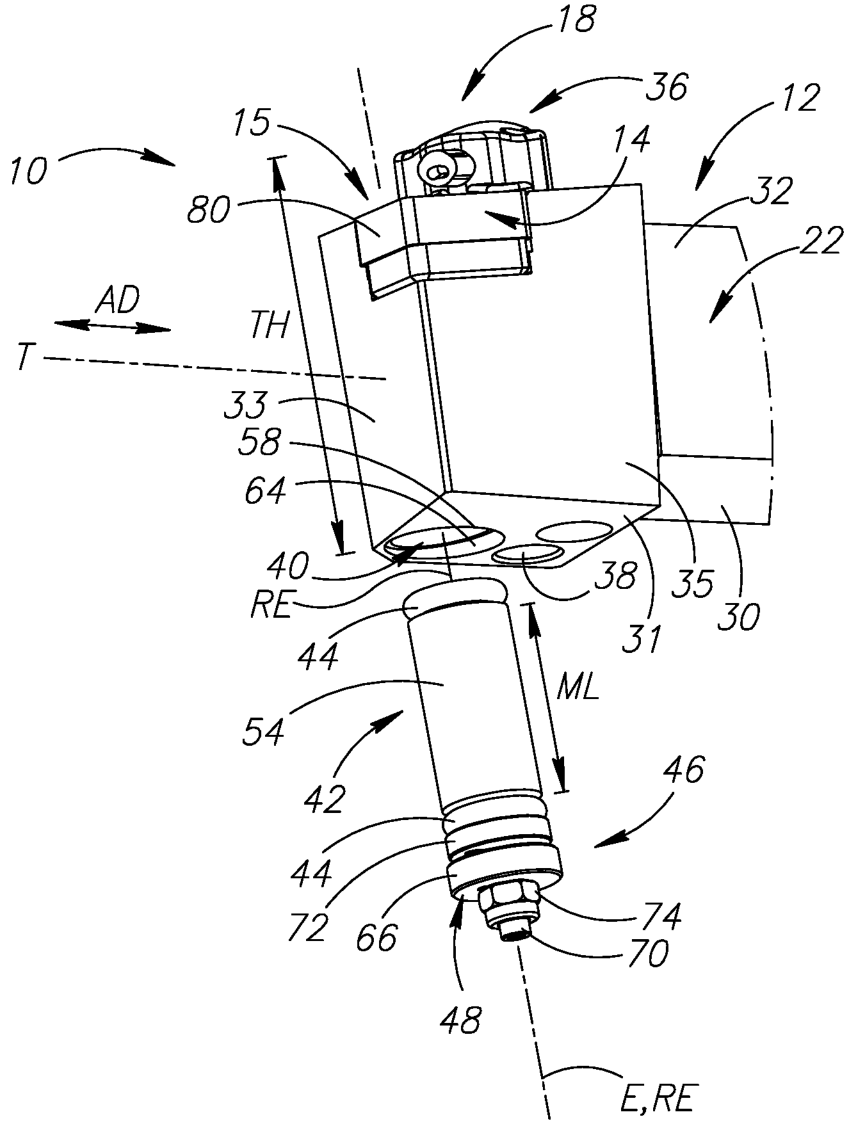
18
36
12
15
14
10
32
80
22
AD
TH
T
33
58
64
40
RE
38
35
30
31
44
ML
54
42
46
44
44
72
66
74
70
48
E,RE

FIG.1