US 20140245645A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2014/0245645 A1

(43) Pub. Date: Sep. 4, 2014

Marchand

(54) **MECHANICAL SYSTEM COMPRISING A DEVICE FOR CONNECTION BETWEEN A WEARING PART AND THE SUPPORT THEREOF, HEAVY-CONSTRUCTION MACHINE BUCKET, AND METHOD FOR IMPLEMENTING SAID SYSTEM**

(76) Inventor: **Fabrice Marchand**, Saint Galmier (FR)

(21) Appl. No.: **14/342,099**

(22) PCT Filed: **Aug. 31, 2012**

(86) PCT No.: **PCT/EP2012/066959**

§ 371 (c)(1),
(2), (4) Date: **Apr. 29, 2014**

(30) **Foreign Application Priority Data**

Sep. 1, 2011 (FR) 1157731

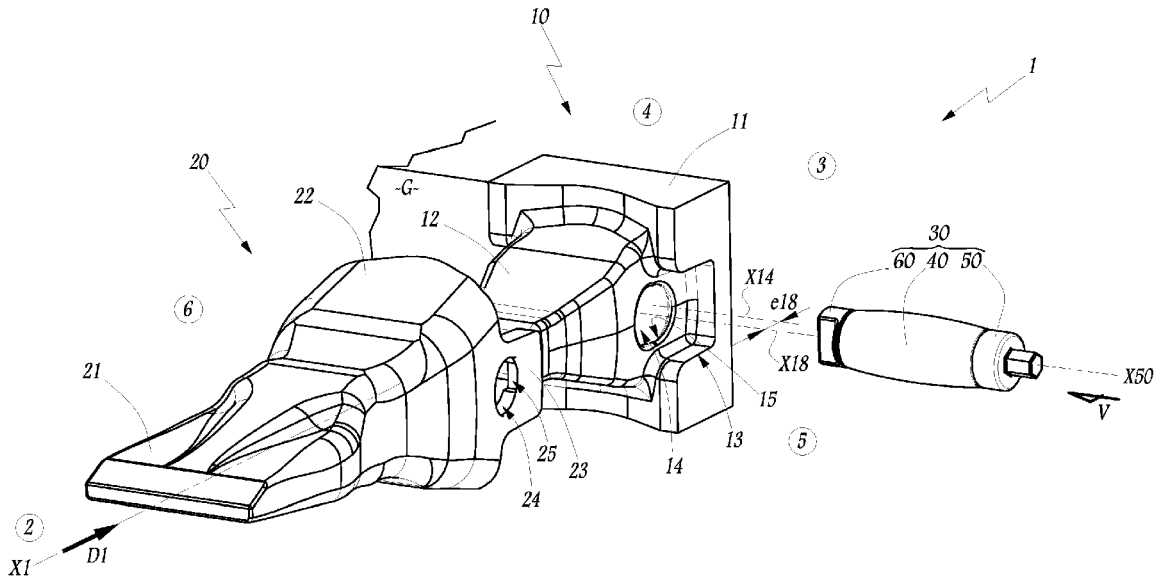
Publication Classification

(51) **Int. Cl.**
E02F 9/28 (2006.01)

(52) **U.S. Cl.**
CPC ***E02F 9/2833*** (2013.01)
USPC **37/444**; 37/457; 29/525.02

(57) **ABSTRACT**

A mechanical system includes a support, a wearing part and a device for interconnecting them. The support includes two openings on either side of a housing for receiving the device. The device includes a threaded key, a nut, and an elastic sheath having a wall adjustable by deformation. Each opening includes a first part centered on a central axis of the housing and radially extending by a maximum of 180° around the central axis, and a second part connected to the first part and radially staggered in relation to the central axis. In the insertion configuration, the device passes through the second part and does not exert any locking force on the wearing part. In the locking configuration, the axis of the key is essentially aligned with the central axis, the sheath wall is adjusted in the housing and the device exerts locking forces on the wearing part.



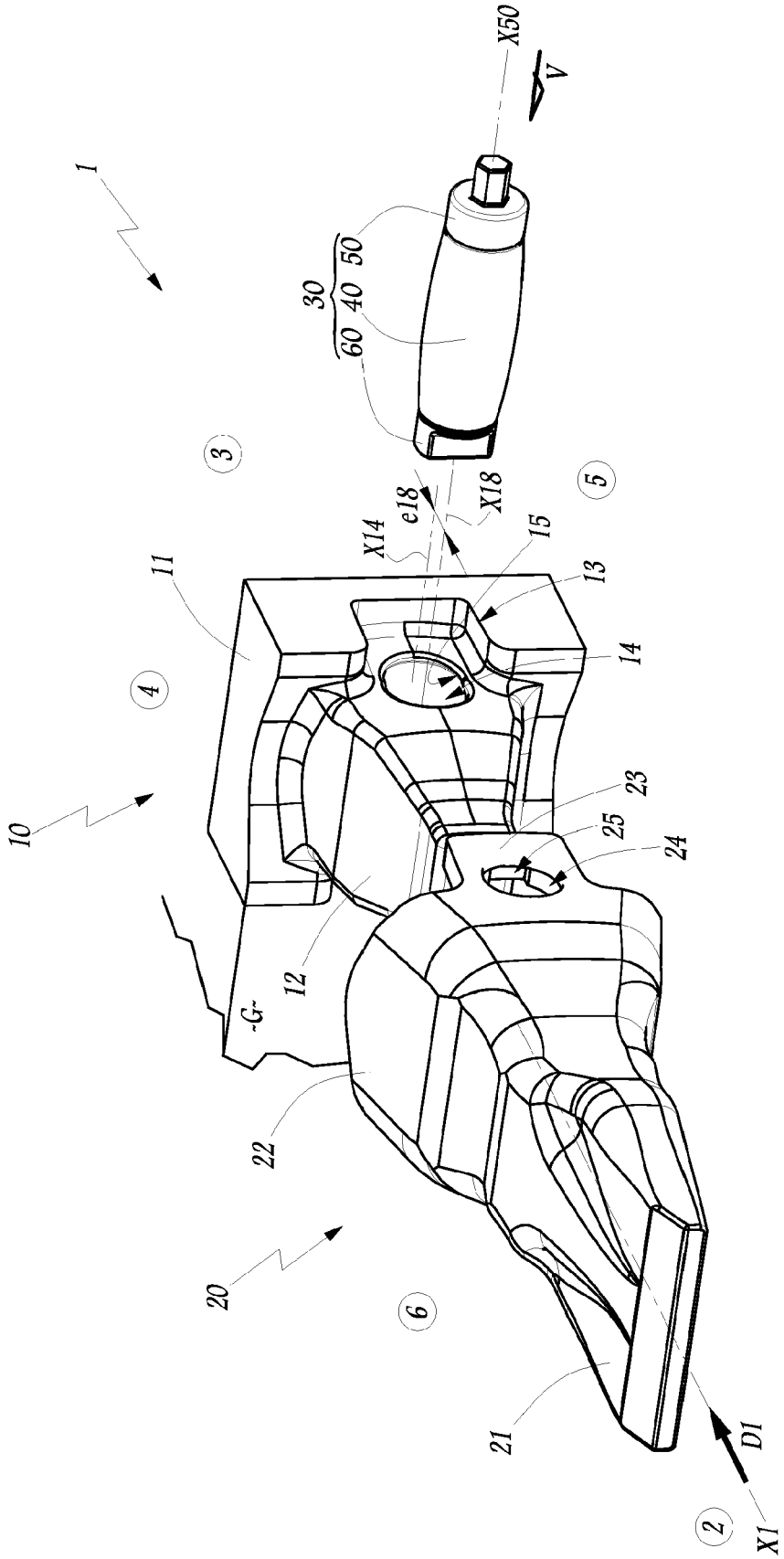

X50
V
1
30
40
50
60
3
5
X14
e18
X18
15
13
11
14
4
10
23
25
24
12
-G-
22
20
6
21
D1
2
X1

Fig. 1

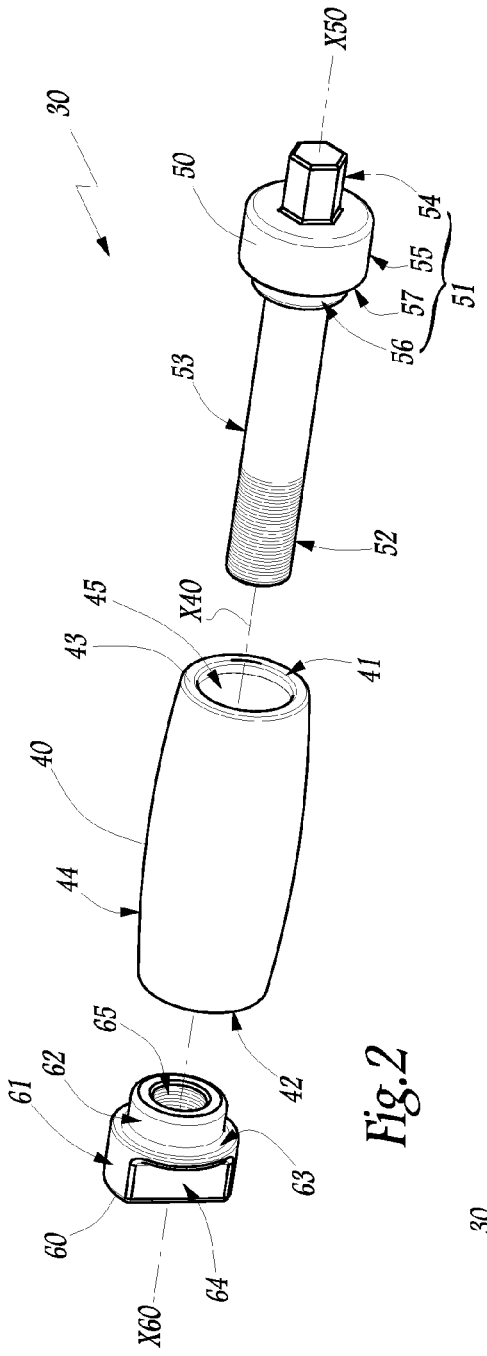


Fig.2

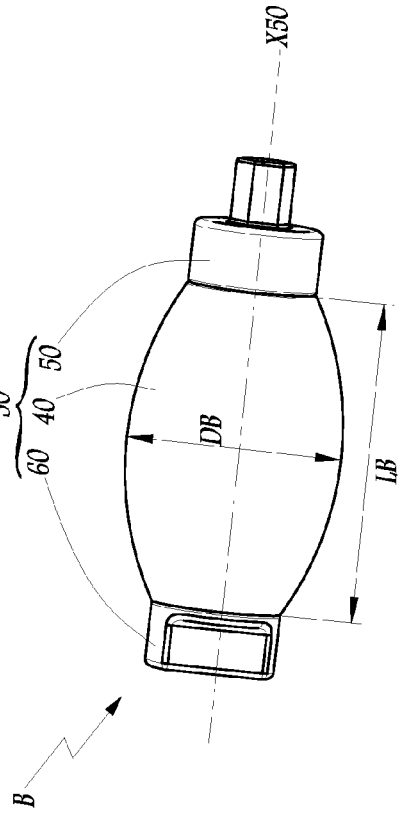


Fig.4

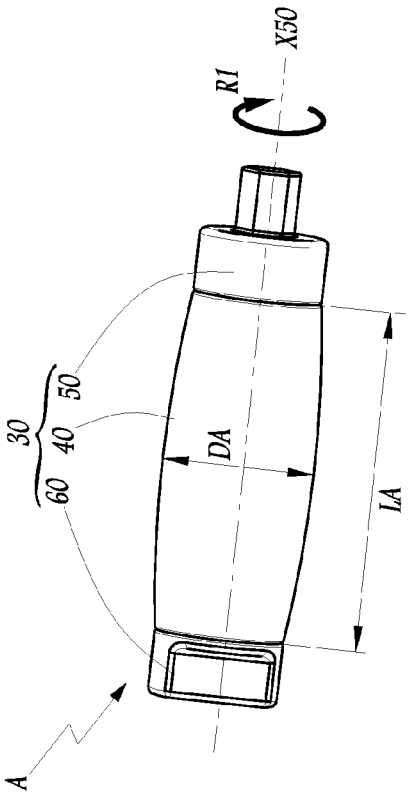


Fig.3

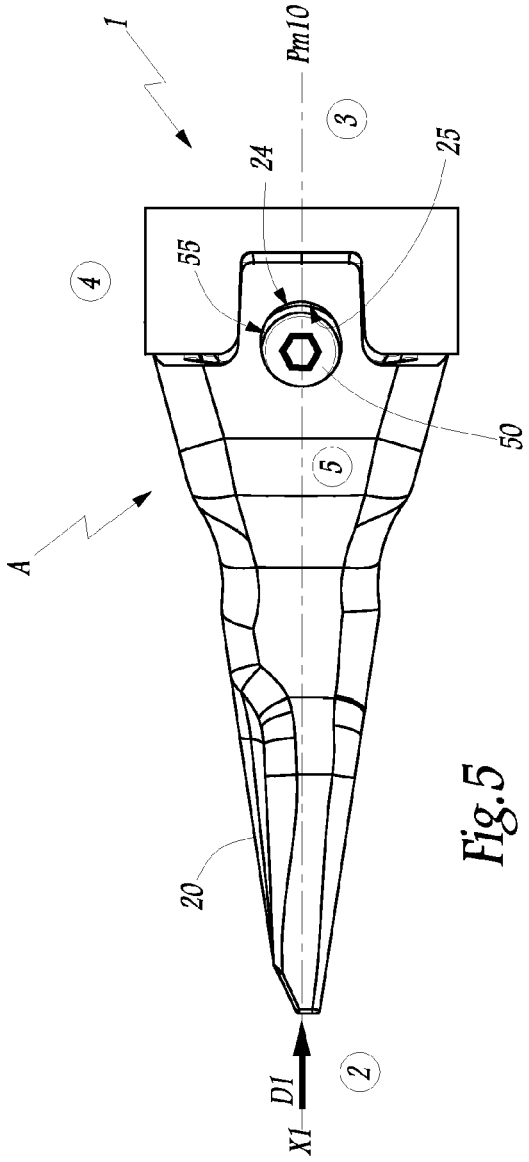


Fig.5

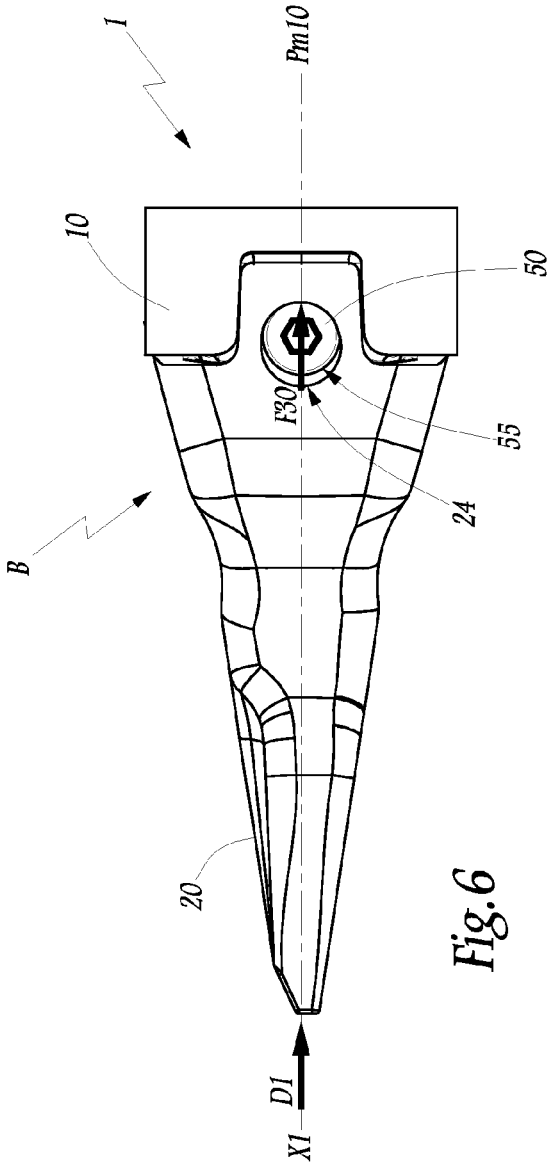


Fig.6

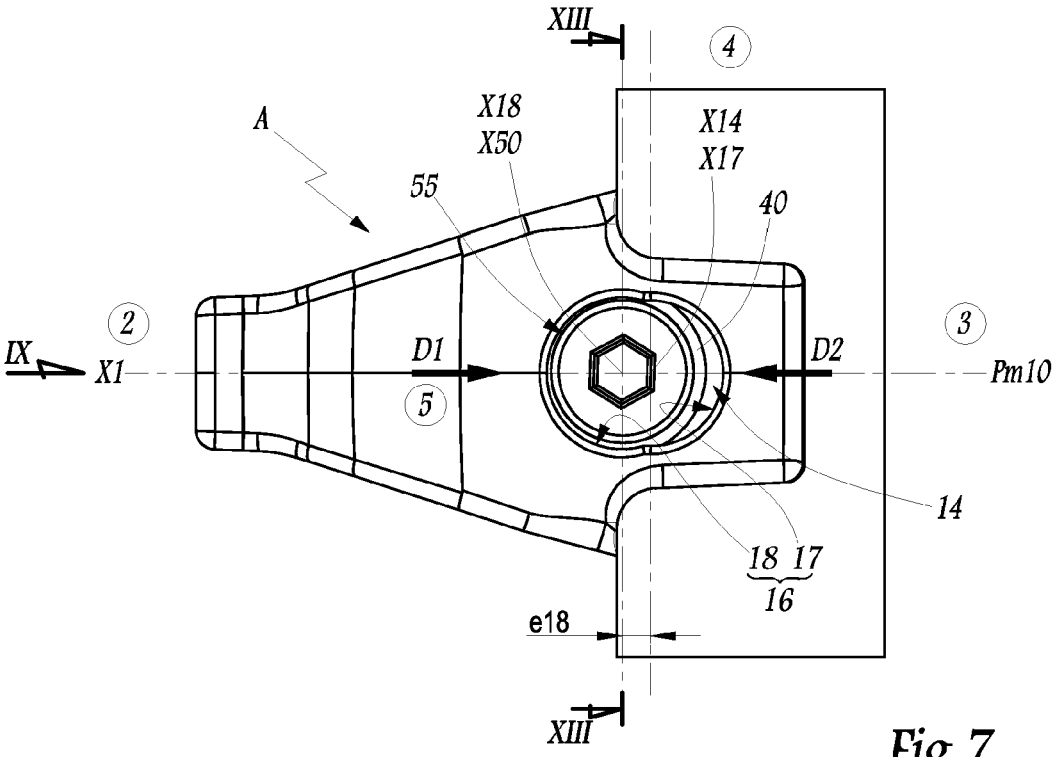

XIII
4
A
X18
X50
X14
X17
55
40
2
3
IX
X1
D1
D2
Pm10
5
14
18 17
16
e18
XIII

Fig.7

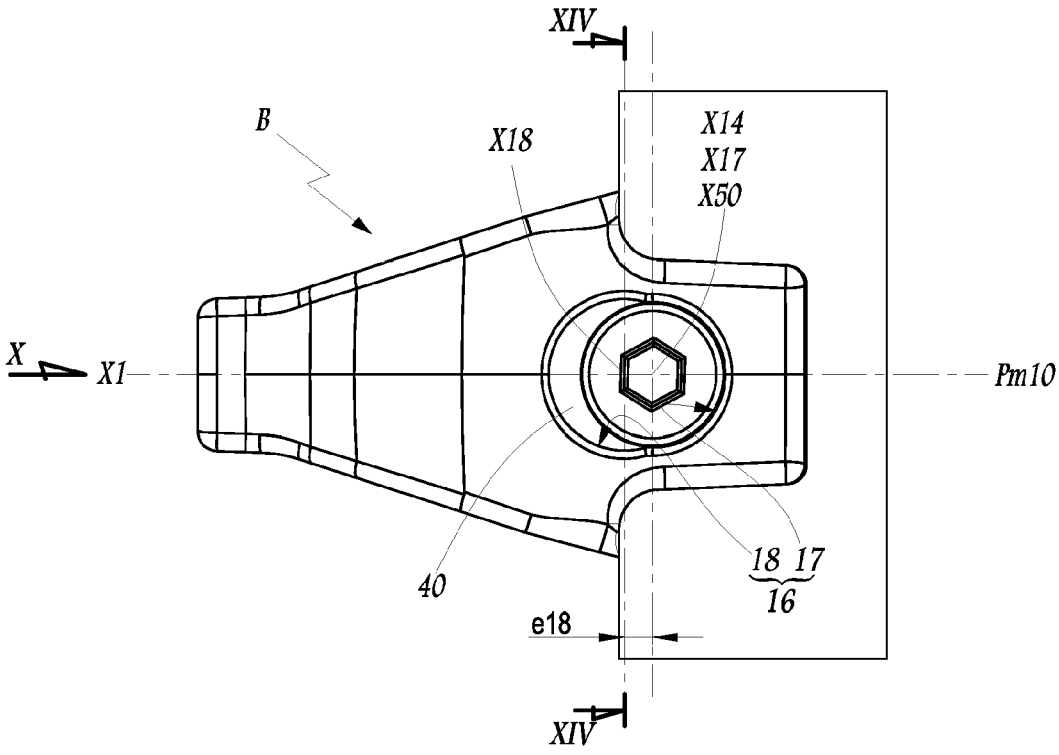

XIV
B
X18
X14
X17
X50
X
X1
Pm10
40
18 17
16
e18
XIV

Fig.8

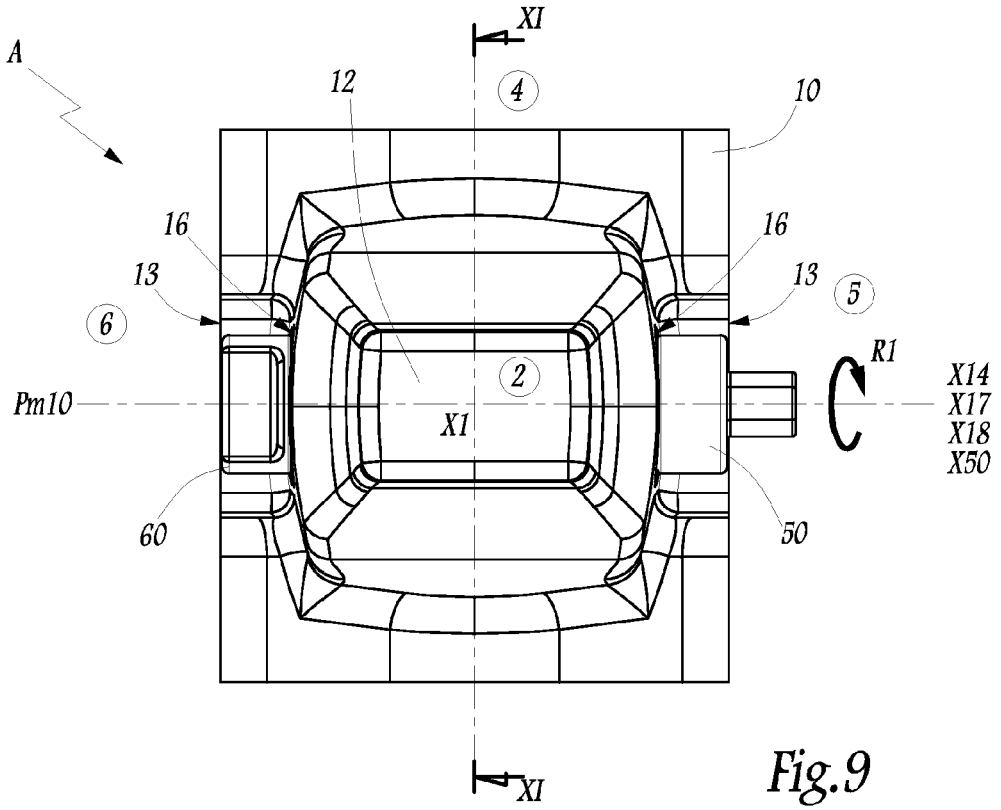

A
XI
12
4
10
16
16
13
13
6
5
R1
2
Pm10
X1
X14
X17
X18
X50
60
50
XI

Fig.9

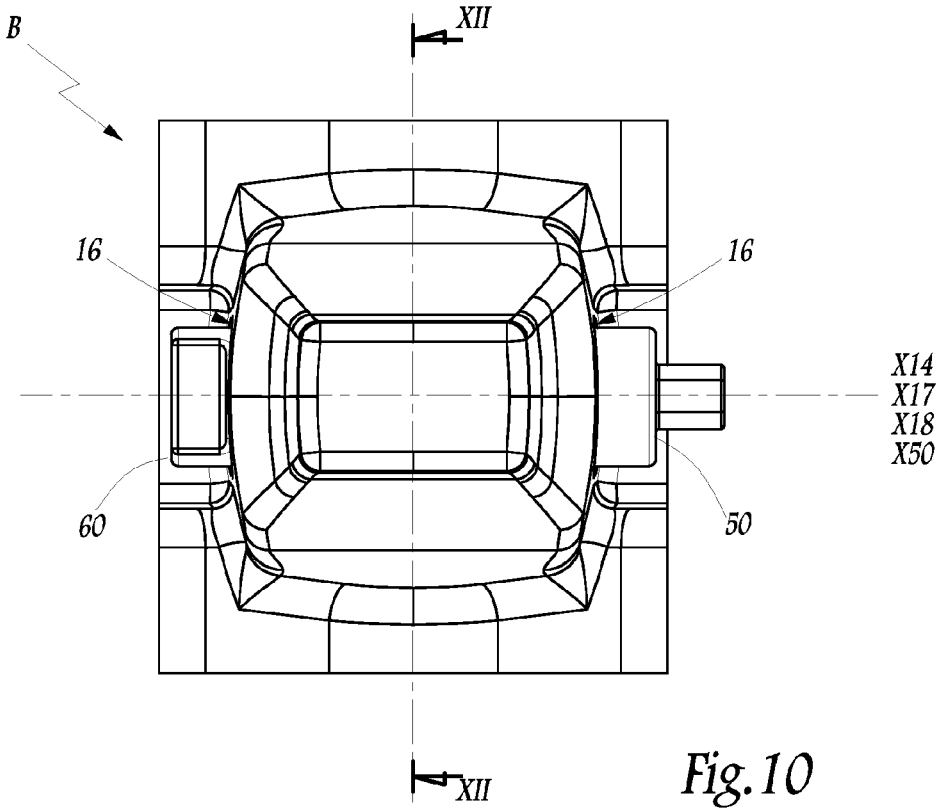

B
XII
16
16
X14
X17
X18
X50
60
50
XII

Fig.10

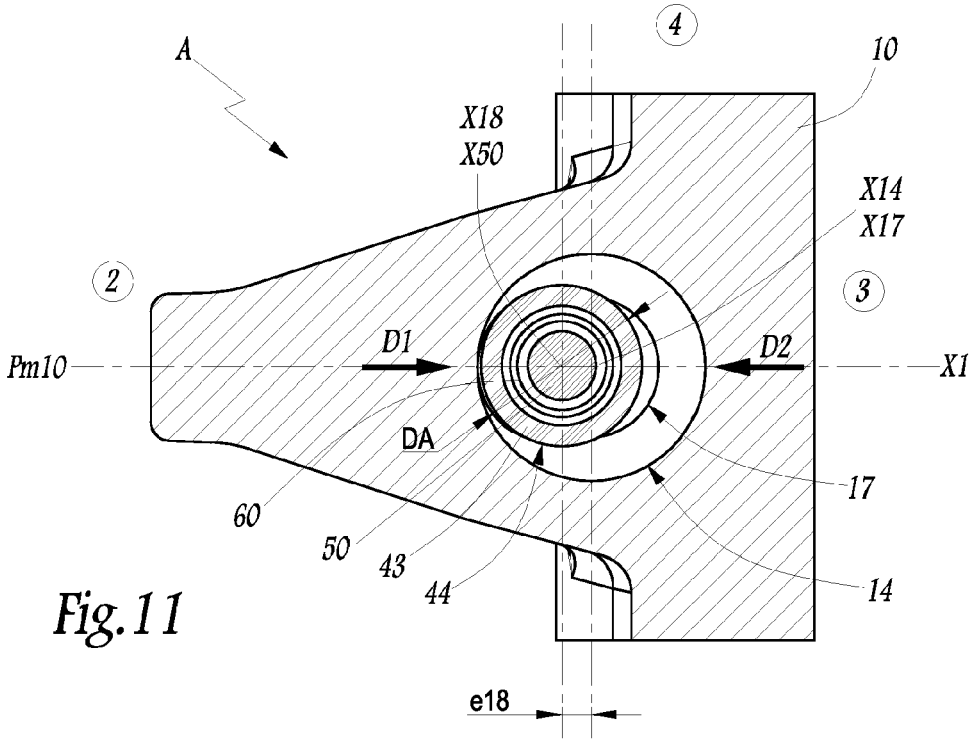

A
4
10
X18
X50
X14
X17
2
3
Pm10
D1
D2
X1
DA
17
60
50
43
44
14
e18

Fig.11

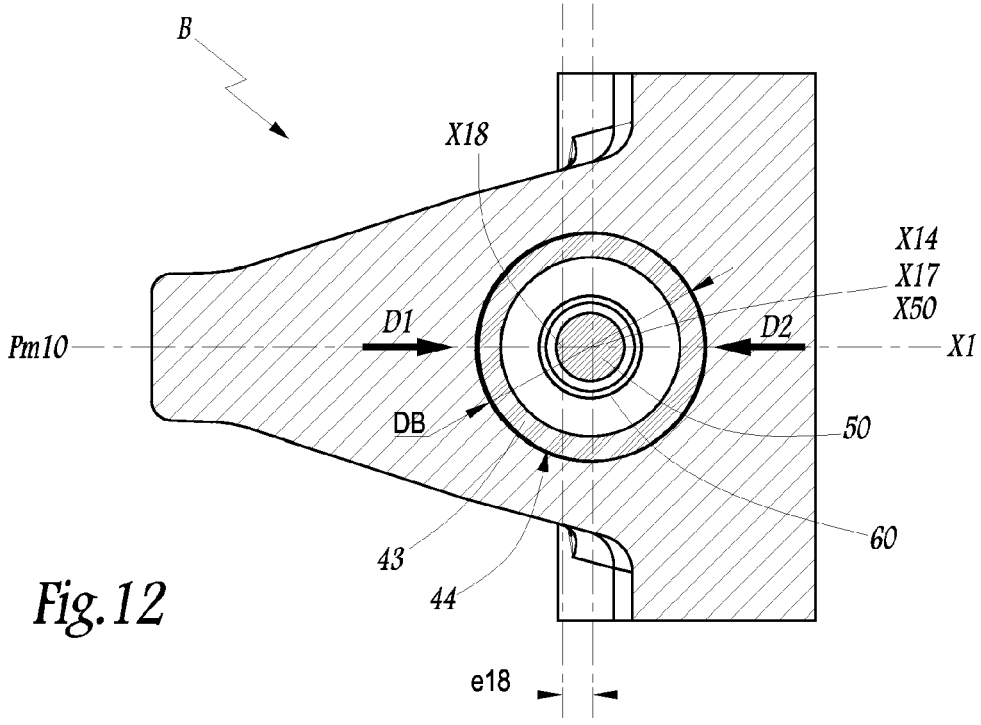

B
X18
X14
X17
X50
Pm10
D1
D2
X1
DB
50
60
43
44
e18

Fig.12

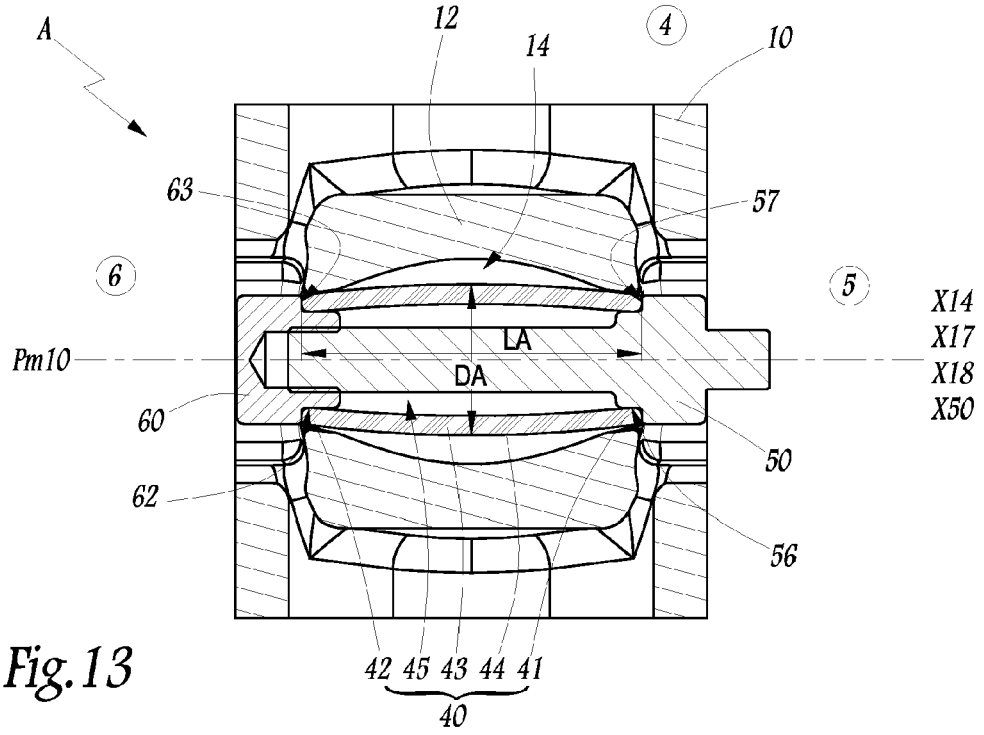

A
12
14
4
10
63
57
6
5
X14
X17
X18
X50
Pm10
LA
DA
60
50
62
56
42 45 43 44 41
40

Fig.13

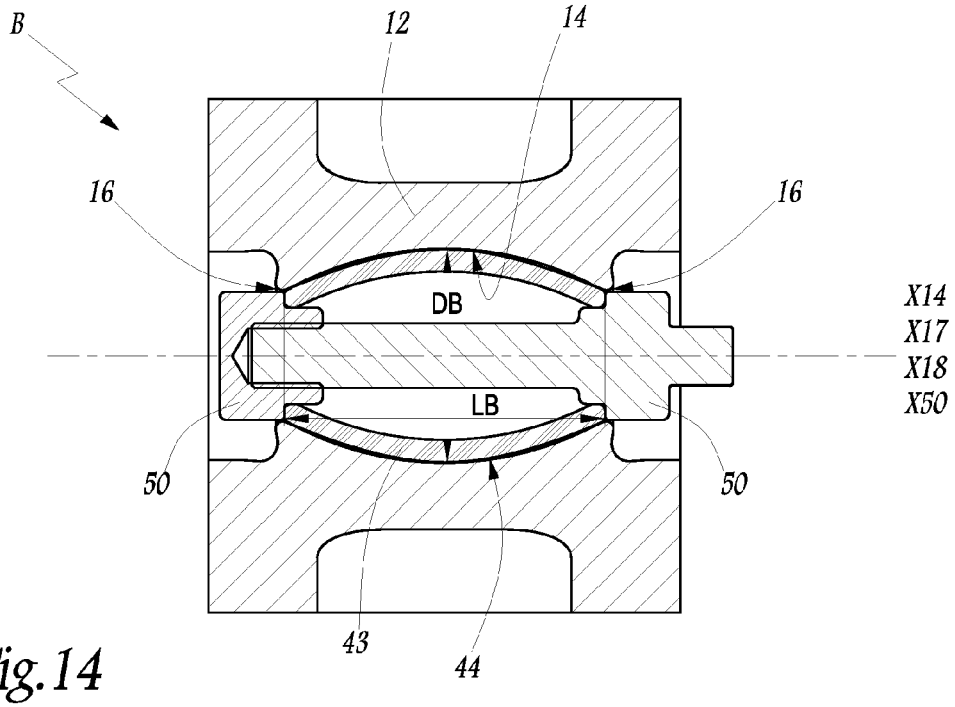

B
12
14
16
16
DB
X14
X17
X18
X50
LB
50
50
43
44

Fig.14

MECHANICAL SYSTEM COMPRISING A DEVICE FOR CONNECTION BETWEEN A WEARING PART AND THE SUPPORT THEREOF, HEAVY-CONSTRUCTION MACHINE BUCKET, AND METHOD FOR IMPLEMENTING SAID SYSTEM

[0001] The present invention relates to a mechanical system comprising a support, a wearing part and a connection device between the wearing part and its support, in particular a tooth and its support belonging to a piece of heavy-construction machine equipment. The invention also relates to a heavy-construction machine bucket comprising at least one such system. Lastly, the invention relates to a method for implementing such a system.

[0002] The invention relates to the field of heavy-construction machine equipment, in particular the buckets, hoppers or other receptacles that may scrape, remove and transport materials so that they may be evacuated from a given location to other workstations using heavy-construction machines.

[0003] In a known manner, a bucket includes a leading blade equipped with wearing parts provided for their ability to penetrate the material and protect the other elements making up the bucket. Fastened on the leading blades are support-adapters having a profile nose, while the wearing parts are teeth or shields that are positioned on the support-adapter using a precise connection. This connection is temporary so that the wearing parts can be replaced after wear.

[0004] The connection between the wearing part and its support may be done by keying. To be high-performing, the keying devices must provide a rigid connection of the elements that they join. Traditionally, the assembly and disassembly of the keyings is done by using striking tools, which create a risk of injury for operators.

[0005] Also known are keying devices that do not require the use of striking tools. In that case, special restrictive equipment is necessary, in particular to disassemble the wearing part. Furthermore, the known devices are complex to manufacture and use.

[0006] FR-A-2 878 871 describes a keying connection device between a wearing part and its support. In the example of FIGS. **5** to **7**, the device comprises two cylinders that screw onto one another and a rubber sheath placed between them. The screwing of the two cylinders deforms the sheath in a housing of the support, while the cylinders are housed in orifices of the wearing part. The connection provided by such a device lacks rigidity, efficiency and reliability. In particular, the cylinders are not systematically in a rear contact position to ensure retention of the tooth.

[0007] US-A-2007 261 278 describes another connection device between a wearing part and its support. The device comprises a deformable sheath between two washers, which in turn are positioned between two cylindrical members. Screwing the two members deforms the sheath in a housing of the support. This connection device has a similar operation, but a more complex construction compared to the earlier one.

[0008] The aim of the present invention is to propose an improved connection device, making it possible to eliminate striking operations for the assembly and disassembly of the wearing parts. In particular, the invention relates to a connection device by keying that is high-performing, reliable, strong, simple and practical.

[0009] To that end, the invention relates to a mechanical system comprising a support, a wearing part and a connection device between the wearing part and its support, in particular between a bucket tooth and its support that belong to a heavy-construction machine, the support comprising two orifices emerging on either side of a housing for receiving the connection device, the connection device comprising:

[0010] a key including a body that is elongated along the key axis between a threaded foot and a head,

[0011] a nut capable of being screwed on the threaded foot of the key, and

[0012] a sheath made from an elastically deformable material, arranged around the body, provided with a first end pressed against the head, a second end pressed against the nut, and a wall adjustable by deformation in a housing of the support, by screwing between the threaded foot of the key and the nut, between an insertion configuration and a locked configuration of the connection device.

The system is characterized in that:

[0013] each through orifice of the housing includes a first part centered on a central axis of the housing and extending radially over more than 180° around that central axis, and a second part connected to the first part and radially offset relative to the central axis,

[0014] in the insertion configuration, the connection device passes through the second part of the orifices and does not exert a locking force on the wearing part, and

[0015] in the locked configuration, the key axis is substantially aligned with the central axis of the housing, the wall of the sheath is adjusted in the housing, and the connection device exerts locking forces on the wearing part.

[0016] The invention thus makes it possible to produce a rigid connection between the wearing part, in particular a bucket tooth, and its support, with considerable simplicity and high performance levels. Owing to the shape of the orifices emerging on either side of the housing formed in the support, the device can press the tooth against the support in the locked configuration. The key, the nut and the sheath are removable from each other in the insertion configuration and secured in the locked configuration. As a result, the connection device according to the invention is easy to manufacture and use. The mechanical system can be assembled and disassembled much more quickly and with a reduced risk of injury.

[0017] According to other advantageous features of the invention, considered alone or in combination:

[0018] The central axis is transverse to a fitting direction of the wearing part on the support, preferably perpendicular to the fitting direction.

[0019] The second part is centered on a secondary axis offset parallel and radially relative to the central axis, the secondary axis preferably being offset relative to the central axis in a direction parallel to and opposite a fitting direction of the wearing part on the support.

[0020] The wearing part comprises two bearing orifices that, when the wearing part is fitted on the support, are each positioned across from the second part of one of the through orifices of the housing of the support, and in that in the locked configuration, the connection device exerts locking forces in the bearing orifices.

[0021] Each bearing orifice includes a recess in which either the head or the nut is partially housed in the locked configuration.

[0022] In the locked configuration, the head and the nut are partially framed, radially to the central axis of the housing, by the first parts of the orifices.

[0023] A flat is formed on the nut, said flat being suitable for being housed, at least in the insertion configuration, in the wearing part.

[0024] The key has a center of gravity situated on the key axis.

[0025] The invention also relates to a heavy-construction machine bucket, comprising at least one mechanical system as described above. In practice, the bucket generally comprises a series of supports each receiving a tooth, which behaves like a wearing part and is secured to its support by a connection device.

[0026] Alternatively, other heavy-construction machine equipment may also be equipped with the mechanical system according to the invention.

[0027] Lastly, the invention relates to a method for implementing a mechanical system as described above. The method is characterized in that it comprises the following steps:

[0028] a) positioning the sheath around the body of the key;

[0029] b) positioning the nut on the threaded foot of the key;

[0030] c) positioning the wearing part on the support;

[0031] d) positioning the connection device in the housing of the support, in the insertion configuration where the connection device passes through the second part of the orifices and does not exert any locking force on the wearing part;

[0032] e) deforming the sheath in the housing by screwing the threaded foot of the key into the nut;

[0033] f) stopping the screwing in the locked configuration where the axis of the key is substantially aligned with the central axis of the housing, the wall of the sheath is adjusted in the housing and the connection device exerts locking forces on the wearing part.

[0034] The invention will be better understood upon reading the following description, provided solely as an non-limiting example and done in reference to the appended drawings, in which:

[0035] FIG. **1** is an exploded perspective view of a mechanical system according to the invention, comprising a support secured to a bucket that is partially shown, a wearing part, and a connection device for connecting the wearing part and the support, said connection device being shown in the locked configuration and comprising a sheath, a threaded key and a nut;

[0036] FIG. **2** is an exploded perspective view of the connection device;

[0037] FIG. **3** is an assembled perspective view of the connection device in an insertion configuration;

[0038] FIG. **4** is an assembled perspective view of the connection device in a locked configuration;

[0039] FIG. **5** is a side view along arrow V of FIG. **1**, showing the mechanical system and the connection device in an insertion configuration;

[0040] FIG. **6** is a view similar to FIG. **5**, showing the mechanical system and the connection device in a locked configuration;

[0041] FIGS. **7** and **8** are views similar to FIGS. **5** and **6**, respectively, the wearing part not being shown;

[0042] FIGS. **9** and **10** are elevation views along arrow IX in FIG. **7** and arrow X in FIG. **8**, respectively;

[0043] FIGS. **11** and **12** are cross-sections along line XI-XI in FIG. **9** and along line XII-XII in FIG. **10**; and

[0044] FIGS. **13** and **14** are cross-sections along line XIII-XIII in FIG. **7** and along line XIV-XIV in FIG. **8**, respectively.

[0045] FIGS. **1** to **14** show a mechanical system **1** according to the invention, equipping a heavy-construction machine bucket G.

[0046] The mechanical system **1** comprises an adapter-support **10**, a wearing part **20** of the tooth type, as well as a connection device **30** between the support **10** and the tooth **20**. The system **1** extends substantially along an axis X1, along which a first direction D1 for fitting of the tooth **20** on the support **10** is defined as well as a second direction D2, parallel to and opposite the first direction D1, for disassembling the tooth **20**.

[0047] The bucket G is partially shown in FIG. **1**, for simplification purposes. The support **10** is secured to the bucket G, while the tooth **20** is a wearing part designed to be disassembled when it is too worn by the operation of the bucket G.

[0048] The connection device **30** comprises a sheath **40**, as well as a threaded key or screw **50** and a nut **60** positioned on either side of the sheath **40**. The device **30** may be inserted into a housing **14** of the support **10**, in an insertion configuration A shown in FIGS. **3**, **5**, **7**, **9**, **11** and **13**. The relative screwing of the nut **60** and the key **50**, in a direction of rotation R1, deforms the sheath **40** inserted between them, from the insertion configuration A to a locked configuration B shown in FIGS. **4**, **6**, **8**, **10**, **12** and **14**.

[0049] Thus, the device **30** is adjustable between the insertion configuration A, where the sheath **40** is not in contact or is only partially in contact with the housing **14** while the device **30** does not exert any retaining force on the tooth **20**, on the one hand, and the locked configuration B, where the sheath **40** is adjusted in the housing **14** of the support **10**, while the device **30**, more specifically the key **50** and the nut **60**, bear against the tooth **20**, thereby forming a coupling connection between the tooth **20** and its support **10**.

[0050] To facilitate the identification of the different parts of the mechanical system **1** spatially, defined are: a front side **2** at which the tooth **20** is situated, a rear side **3** at which the support **10** is situated, an upper side **4** that is oriented opposite the ground when the system **1**, a first side **5** for insertion of the device **30** into the support **10**, and a second side **6** opposite the insertion side **5**.

[0051] The support **10** comprises a base **11**, partially shown in FIGS. **1** and **5** to **14**, as well as a fitting nose **12** provided to be engaged in a cavity of the tooth **20** configured to that end. Furthermore, a housing **13** for receiving lugs **23** of the tooth **20** is formed on each side **5** and **6** of the base **11**. Each housing **13** includes walls situated toward the rear **3**, the top **4** and the bottom, and is open toward the front **2** so as to receive the lugs **23**. The housing **14** extends through the nose **12**, along an axis X14 perpendicular to the axis X1, between the sides **5** and **6**. This housing is framed by the housings **13** on the sides **5** and **6**.

[0052] Two orifices **16** are formed on the sides **5** and **6** in the nose **12**, emerging on either side of the housing **14** along the axis X14. Each orifice **16** comprises a first part **17** and a second part **18** that are connected to each other. The part **17** is a half-cylinder that is centered on an axis X17 combined with the axis X14, closed over 180° toward the rear **3** and open at 180° toward the front **2**. The part **18** is a cylinder portion that is centered on a secondary axis X18 that is off-centered relative to the axes X14 and X17, closed over more than 180°

toward the front **2** and connected to the part **17** toward the rear **3**. As shown in FIG. **7**, the secondary axis X18 is offset radially and parallel to the axis X14, in the direction D2 opposite the fitting direction D1, according to a radial gap e18. The axes X14, X17 and X18 are situated in a same median plane Pm10 of the support **10**. The orifices **16** globally have an oblong shape elongated along the axis X1. The part **18** delimits an opening with transverse dimensions larger than the opening delimited by the part **17**, so as to facilitate the insertion of the device **30** in the housing **14** through the part **18** in the insertion configuration A, while the device **30** becomes housed in the part **17** in the locked configuration B.

[0053] In an alternative that is not shown, the orifices **16** may have a different shape suitable for the present application. For example, the part **17** may be a cylinder portion closed over less than 180° in the direction D1, in other words extending radially over more than 180° around the axis X14. According to another example, the part **17** may be a cylinder portion closed in a direction that is slightly inclined relative to the axis X1.

[0054] The tooth **20** comprises an active part **21** situated toward the front **2** and a hollow part **22** oriented toward the rear. In a known manner, the part **21** is provided to scrape and remove materials, for example dirt or gravel, while the part **22** is provided for fitting of the tooth **20** on the support **10**. More specifically, the part **22** comprises the inner cavity, shown in FIGS. **1**, **5** and **6**, configured for fitting on the nose **12** of the support **10**, as well as the lugs **23** that are oriented toward the rear and provided to be received in the housings **13**, in contact with the top **4** and the bottom, as shown in FIGS. **5** and **6**.

[0055] Orifices **24**, each having a substantially cylindrical shape, are formed in each lug **23**, on either side of the tooth **20** on the sides **5** and **6**. These orifices **24** are positioned across from the part **18** of the orifices **16** when the tooth **20** is fitted on the support **10**, thereby allowing the device **30** to be inserted in the housing **14**, then allowing the device **30** to be used. Only the lug **23** and the orifice **24** situated on the side **5** are shown in FIGS. **1**, **5** and **6**. The lug situated on the side **6** is similar to the lug **23** situated on the side **5**, while the orifice **24** situated on the side **6** is configured to receive the nut **60** provided with a flat **64**, for example against a shoulder perpendicular to the axis X1. As shown in FIG. **1**, the orifice **24** situated on the side **5** preferably comprises a recess **25**, forming a possible favored bearing for the key **50**. Alternatively, this orifice **24** and/or the recess **25** may have different shapes suitable for the present application. For example, the orifices **24** may have more or less elongated oblong shapes. Furthermore, the orifice **24** situated on the side **6** is preferably provided with a recess **25**. The orifices **24** are provided to receive the device **30**, more specifically the key **50** and the nut **60**, bearing on the tooth **20** in the direction D1, in the locked configuration B described below.

[0056] The sheath **40** is made from an elastically deformable material, for example an elastomer. The sheath **40** is elongated between longitudinal ends **41** and **42** along a central axis X40. In the insertion configuration A, the end **41** is situated on the side **5**, whereas the end **42** is situated on the side **6**. This distinction is made for spatial identification purposes only, given that the ends **41** and **42** are reversible. The sheath **40** comprises a wall **43** that is centered on the axis X40 and curved radially opposite the axis X40. The wall **43** delimits an outer surface **44** forming an ellipsoid of revolution around the axis X40, truncated at the ends **41** and **42**. The wall **43** also delimits an inner cavity **45**, which is centered on the axis X40, emerging at the ends **41** and **42** and provided to receive the key **50**, with a radial gap formed between the sheath **40** and the key **50**. In practice, the housing **14** and the outer surface **44** have substantially complementary shapes in the locked configuration B, such that the wall **43** of the sheath **40** can be adjusted in the housing **14** of the support **10** by hugging its inner contours.

[0057] The key **50** is made from metal, for example steel. The key **50** comprises a body **53** elongated along an axis X50 between a head **51** and a threaded foot **52**. More specifically, the head **51** comprises a hexagonal part **54** for being actuated by a tool, not shown for simplification purposes, a first cylindrical part **55** bearing in the orifice **24** of the tooth **20**, a second cylindrical part **56** having a diameter smaller than the diameter of the part **55**, and an annular shoulder **57** that is formed radially to the axis X50 between the parts **55** and **56** and faces the foot **52**. The center of gravity of the key **50** is situated on the axis X50. With the exception of the threading of the foot **52** and the part **54**, the key **50** is a piece of revolution around the axis X50, with no off-centered part.

[0058] The nut **60** is made from metal, for example steel similar to that of the key **50**. The nut **60** comprises a first cylindrical part **61** bearing in the orifice **24** of the tooth **20**, as well as a second cylindrical part **62** having a diameter smaller than the diameter of the part **61**. The parts **61** and **62** are coaxial and centered on axis X60. The nut **60** also comprises an annular shoulder **63** that is formed radially to the axis X60 between the parts **61** and **62**. The flat **64** is formed in the part **61**, with a first planar face parallel and radially offset relative to the axis X60, as well as a second planar face perpendicular to the axis X60 and turned on the opposite side from the part **62**. In other words, the flat **64** is open at the part **61**, but not at the part **62**, forming a stop for the nut **60** positioned in the lug **23** and the orifice **24** situated on the side **6** of the tooth **20**. A tapping **65** is formed in the nut **60** along the axis X60, emerging at the part **62**, but preferably not emerging at the part **61**. The tapping **65** is complementary to the threading of the foot **52** of the key **50**.

[0059] The operation of the connection device **30** equipping the mechanical system **1** is described below.

[0060] In a first step a), an operator positions the sheath **40** on the key **50**. The body **53** is positioned in the cavity **45** and is surrounded by the wall **43**, while the end **41** bears against the head **51**.

[0061] In a second step b), the operator positions the nut **60** at the end of the key **50**, with the shoulder **63** and the shoulder **57** facing each other. The tapping **65** is screwed on the threaded foot **52**, with the sheath **40** inserted between the head **50** and the nut **60**. The end **41** bears against the shoulder **57**, while the end **42** bears against the shoulder **63**. Furthermore, the wall **43** is adjusted radially to the axis X40, on the one hand on the cylindrical part **56** at the end **41**, and on the other hand on the cylindrical part **62** at the end **42**. The connection device **30** is then assembled, as shown in FIG. **3**, with the axes X40, X50 and X60 combined. These axes are subsequently together designated using reference X50.

[0062] In a third step c), the operator positions the tooth **20** on the support **10**, with the active part **21** oriented so as to be able to scrape and remove materials during operation of the system **1**. The hollow part **22** is fitted on the nose **12**, with complementary planes bearing against each other. The lugs **23** are received in the housings **13** of the base **11**. The orifices

24 are placed across from the orifices **16** on the sides **5** and **6**, such that the housing **14** is accessible to insert the device **30** in the insertion configuration A.

[0063] In a fourth step d), the operator positions the preassembled connection device **30** in the housing **14** of the support **10**. The device **30** passes through the orifice **24**, then the orifice **16** situated on the side **5**, starting with the nut **60** and ending with the head **51**, with the wall **43** of the sheath **40** slightly centripetally deforming as it passes through. The flat **64** of the nut **60** becomes housed in the orifice **24** situated on the side **6**, while the head **51** is positioned in the orifice **24** situated on the side **5**.

[0064] The device **30** is then in the insertion configuration A. The device **30**, more specifically the key **50** and the nut **60**, do not exert any retaining force on the tooth **20** in the direction D1, such that the relative positions of the support **10** and the tooth **20** are not locked. The device **30** passes through the part **18** of the orifices **16** and the key axis X50 is substantially aligned with the secondary axis X18. In other words, the axis X50 is offset radially and parallel to the central axis X14 of the housing **14**, in the direction D2. Play is globally formed between the cylindrical part **55** and the part **18** of the orifice **16** situated on the side **5**. That same part **55** is not in contact, or is only partially in contact, with the inner bore of the orifice **24** situated on the side **5**. The outer surface **44** of the sheath **40** is not in contact, or is only partially in contact, with the surface of the housing **14**. A length LA of the sheath **40** is delimited by the axial separation between the ends **41** and **42** of the sheath **40**, in other words, between the shoulders **57** and **63** along the axis X50. Furthermore, a maximum diameter DA of the sheath **40** is delimited around the key axis X50 by the surface **44**.

[0065] At this stage, the axes X14, X17, X18 and X50 are situated substantially in the median plane Pm10 of the support **10** containing the axis X1, as shown in FIGS. **5**, **7**, **9**, **11** and **13**. Nevertheless, except at the flat **64**, the connection device **30** is released in the system **1**. In other words, the axis X50 is mobile in and outside the plane Pm10.

[0066] In a fifth step e), the operator deforms the sheath **40** in the housing **14** by screwing the key **50** in the nut **60**. More specifically, the operator uses a tool to exert a screwing torque, around the axis X50 in the direction of rotation R1, on the part **54** of the head **51**, such that the threaded foot **52** penetrates the tapping **65**. The nut **60** is kept abutting at the flat **64** in the orifice **24** situated on the side **6**. The direction of rotation R1 may be identified by a marking, not shown for simplification purposes, on the head **51** of the key **50**, so as to facilitate the operator's task.

[0067] Thus, the device **30** goes from the insertion configuration A to the locked configuration B. The rotation R1 of the key **50** gradually brings the head **51** closer to the nut **60**, such that the sheath is compressed along the axis X50 between the shoulder **57** and the shoulder **63**. The wall **43** deforms with an accentuation of its curvature in the middle part, i.e., an intermediate part between the shoulders **57** and **63**. The outer surface **44** of the sheath **40** gradually bears against the inner wall of the housing **14**, first on the front side **2**, then on the sides **5** and **6** and on the rear side **3**, as can be seen by comparing FIGS. **11** and **12**. At the same time, the head **51** and the nut **60** translate in the direction D1, in the orifices 16 and 24 situated on the side 5 and the side 6, respectively. Thus, the axis X50 is offset in the direction D1, until it is substantially aligned with the central orifice X14 of the housing **14**. The cylindrical parts **55** and **61** become housed in the corresponding part **17** of the orifices **16**, until they bear against the orifices **24** and the recesses **25** in the direction D1.

[0068] Lastly, in a sixth step f), the operator stops the screwing of the device **30** in the locked configuration B. The key axis X50 is then substantially aligned with the central axis X14 of the housing **14**. The device **30** passes through the part **17** of the orifices **16**. The wall **43** of the sheath **40** is adjusted in the housing **14** of the support **10**, with the surface **44** hugging the contours of the housing **14**. A length LB of the sheath **40**, which is smaller than the length LA, is delimited by the axial separation between the ends **41** and **42** of the sheath **40** along the axis X50. Furthermore, a maximum diameter DB of the sheath **40**, which is larger than the diameter DA, is delimited around the key axis X50 by the surface **44**. The deformation of the wall **43** is no longer possible, such that the sheath **40** has a compression strength, and therefore screwing strength, that is perceptible by the operator.

[0069] In the locked configuration B, the head **51** and the nut **60** exert locking forces on the tooth **20** in the direction D1, while the sheath **40** bears in reaction in the housing **14**, forming a coupling link between the tooth **20** and the support **10**. In particular, the locking forces exerted by the device **30** on the tooth **20** in the direction D1 are shown by an arrow F30 in FIG. **6**. Advantageously, these forces F30 are distributed symmetrically relative to the plane Pm10. The head **51** and the nut **60** are framed on top **4** and bottom by the parts **17** of the orifices **16**, so as to limit untimely movements transverse to the plane Pm10 during operation of the system **1**. Furthermore, the sheath **40** is made from a deformable material rigid enough to prevent or reduce movements of the device **30** in the direction D2. Additionally, a metal insert can be molded in the wall **43** of the sheath **40**. Under these conditions, tilting of the device **30** in the housing **14** is prevented in the locked configuration B.

[0070] Thus, when mechanical forces are exerted on the active part **21**, the part **22** of the tooth **20** is firmly retained in the usage position simultaneously by the connection device **30** in the locked configuration B, by the nose **12**, and by the walls of the housings **13** receiving the lugs **23**.

[0071] Subsequently, in a disassembly step g), the operator can use the tool to unscrew the device **30** in a direction opposite the direction of rotation R1. The forces exerted by the device **30** on the tooth **20** and in the support **10** are released, from the locked configuration B toward the insertion configuration A. Next, the device **30** may be removed from the system **1**, eliminating the coupling connection between the tooth **20** and the support **10**. Thus, the device **30** allows the tooth **20** to be disassembled without a hammer, after wearing of said tooth, through operations opposite the mounting operations.

[0072] The component elements of the connection device **30** may be configured differently without going beyond the scope of the invention. In practice, the component elements of the device **30** are specifically designed to withstand the wear of the system **1** during operation, as well as to withstand several assembly and disassembly operations using the tool.

[0073] In an alternative that is not shown, the length of the key **50** along the axis X50 is such that neither the actuating part **54** nor the nut **60** protrude outside the orifices **24** of the lugs **23**, when the system **1** is assembled. As shown in FIG. **10**, the head **51** of the key **50** is then protected in the lug **23** of the tooth **20**.

[0074] According to another alternative that is not shown, the part(s) for actuating the device **30** using one or more tools

are configured differently. For example, the part **55** may include a circular or polygonal recess, open toward the outside on the side **5**, facilitating the penetration of the tool. According to another example, the nut **60** may also be configured to be actuated by a tool on the side **6**. In that case, for example, a cavity or a hexagonal rod may be formed on the part **61** instead of the flat **64**.

[0075] According to other alternatives that are not shown, the housing **14**, the orifices **16** and **24** and the axes X14 and X18 may be configured or arranged differently with respect to one another, as long as the device **30** exerts a sufficient locking force F30 on the tooth **20** in the locked configuration B. For example, the housing **14** may not be cylindrical, but may include planar bearing faces for the sheath **40**. According to another example, the parts **17** and **18** of the orifices **16** may have shapes different from those of FIGS. **7** and **8**, while being connected to each other. According to another example, the axis X14 of the housing **14** may not be perpendicular to the axis X1, but inclined in a transverse direction relative to the axis X1. According to one particular example, the axes X14 and X18 may be inclined by 10° or 20° relative to the axis X1. According to another example, the axes X14 and X18 may be perpendicular to the axis X1, both respectively situated on either side of the plane Pm10. In that case, preferably, the part **17** of the orifice is situated toward the bottom of the nose **12**, while the part **18** is situated toward the top **4** of the nose **12**.

[0076] According to another alternative that is not shown, the orifices **24** formed in the lugs **23** may include reinforced shoulders and/or thermal treatments of the contact areas with the key **50** and the nut **60**, so as to have an increased surface hardness and facilitate locking of the device **30** in the locked configuration B. Furthermore, the nut **60** and the orifice **20** for receiving that nut **60** on the side **6** may be configured in any manner suitable for the present application, by allowing the screw **50** to be screwed in the tapping **65** to go from the insertion configuration A to the locked configuration B.

[0077] According to another alternative that is not shown, a metal insert may be arranged between the sheath **40** and the key **50**, or may be molded directly in the wall **43**.

[0078] Furthermore, the technical characteristics of the different embodiments may be combined with each other in whole or in part. Thus, the connection device may be adapted in terms of cost and performance.

1-10. (canceled)

11. A mechanical system (**1**) comprising a support (**10**), a wearing part (**20**) and a connection device (**30**) between the wearing part (**20**) and its support (**10**), in particular between a bucket tooth (**20**) and its support (**10**) that belong to a heavy-construction machine (G), the support (**10**) comprising two orifices (**16**) emerging on either side of a housing (**14**) for receiving the connection device (**30**), the connection device (**30**) comprising:

a key (**50**) including a body (**53**) that is elongated along the key axis (X50) between a threaded foot (**52**) and a head (**51**),

a nut (**60**) capable of being screwed on the threaded foot (**52**) of the key (**50**), and

a sheath (**40**) made from an elastically deformable material, arranged around the body (**53**), provided with a first end (**41**) pressed against the head (**51**), a second end (**42**) pressed against the nut (**60**), and a wall (**43**) adjustable by deformation in a housing (**14**) of the support (**10**), by screwing (R1) between the threaded foot (**52**) of the key (**50**) and the nut (**60**), between an insertion configuration (A) and a locked configuration (B) of the connection device (**30**),

wherein each through orifice (**16**) of the housing (**14**) includes:

a first part (**17**) centered on a central axis (X14) of the housing (**14**) and extending radially over more than 180° around that central axis (X14), and

a second part (**18**) connected to the first part (**17**) and radially offset relative to the central axis (X14),

wherein in the insertion configuration (A), the connection device (**30**) passes through the second part (**18**) of the orifices (**16**) and does not exert a locking force on the wearing part (**20**), and

wherein in the locked configuration (B), the key axis (X50) is substantially aligned with the central axis (X14) of the housing (**14**), the wall (**43**) of the sheath (**40**) is adjusted in the housing (**14**), and the connection device (**30**) exerts locking forces (F30) on the wearing part (**20**).

12. The mechanical system (**1**) according to claim **11**, wherein the central axis (X14) is transverse to a fitting direction (D1) of the wearing part (**20**) on the support (**10**).

13. The mechanical system (**1**) according to claim **11**, wherein the second part (**18**) is centered on a secondary axis (X18) offset parallel and radially relative to the central axis (X14), the secondary axis (X18) preferably being offset relative to the central axis (X14) in a direction (D2) parallel to and opposite a fitting direction (D1) of the wearing part (**20**) on the support (**10**).

14. The mechanical system (**1**) according to claim **11**, wherein the wearing part (**20**) comprises two bearing orifices (**24**) that, when the wearing part (**20**) is fitted on the support (**10**), are each positioned across from the second part (**18**) of one of the through orifices (**16**) of the housing (**14**) of the support (**10**), and in the locked configuration (B), the connection device (**30**) exerts locking forces (F30) in the bearing orifices (**24**).

15. The mechanical system (**1**) according to claim **14**, wherein each bearing orifice (**24**) includes a recess (**25**) in which either the head (**51**) or the nut (**60**) is partially housed in the locked configuration (B).

16. The mechanical system (**1**) according to claim **11**, wherein in the locked configuration (B), the head (**51**) and the nut (**60**) are partially framed, radially to the central axis (X14) of the housing (**14**), by the first parts (**17**) of the orifices (**16**).

17. The mechanical system (**1**) according to claim **11**, wherein a flat (**64**) is formed on the nut (**60**), said flat (**64**) being suitable for being housed, at least in the insertion configuration (A), in the wearing part (**20**).

18. The mechanical system (**1**) according to claim **11**, wherein the key (**50**) has a center of gravity situated on the key axis (X50).

19. A heavy-construction machine bucket (G), comprising at least one mechanical system (**1**) according to claim **11**.

20. A method for implementing a mechanical system (**1**) according to claim **11**, comprising the following steps:

positioning the sheath (**40**) around the body (**53**) of the key (**50**);

positioning the nut (**60**) on the threaded foot (**52**) of the key (**50**);

positioning the wearing part (**20**) on the support (**10**);

positioning the connection device (**30**) in the housing (**14**) of the support (**10**), in the insertion configuration (A) where the connection device (**30**) passes through the

second part (**18**) of the orifices (**16**) and does not exert any locking force on the wearing part (**20**);

deforming the sheath (**40**) in the housing (**14**) by screwing (R1) the threaded foot (**52**) of the key (**50**) into the nut (**60**); and

stopping the screwing (R1) in the locked configuration (B) where the axis of the key (X50) is substantially aligned with the central axis (X14) of the housing (**14**), the wall (**43**) of the sheath (**40**) is adjusted in the housing (**14**) and the connection device (**30**) exerts locking forces (F30) on the wearing part (**20**).

* * * * *