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(54) Title: LEDGER MECHANISM FOR ROD MAKING MACHINES

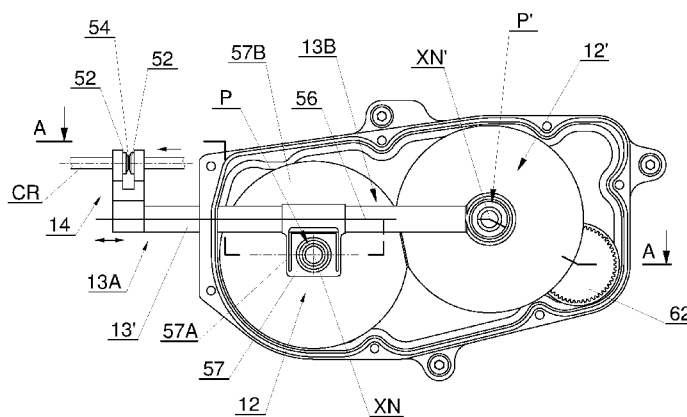


Fig. 6

(57) Abstract: The object of the invention is a ledger mechanism for rod making machines of tobacco industry comprising a first gear arrangement (12') having a first pivot (P') for performing reciprocating movement and a second gear arrangement (12) having a second pivot (P) for performing reciprocating movement, and a connecting member (13') mounted to the pivots of the first and second gear arrangement, and a ledger (14) with cutting tubes (52) mounted to a connecting member (13'), the first pivot (P') and the second pivot (P) are mechanically coupled with each other. The ledger mechanism is characterized in that a connecting member (13') is longer than a distance between the axes of the first and second pivot (P, P'), and a ledger (14) with cutting tubes (52) is located at the connecting member (13') outside the inner part (13B) of connecting member (13') delimited by axes of the first and second pivot (P, P') of the first and second gear arrangement (12, 12').

## LEDGER MECHANISM FOR ROD MAKING MACHINES

The object of the invention is a ledger mechanism for rod making machines in tobacco industry.

In the tobacco industry are used rod making machines i.e. cigarette making machines and filter making machines (also combined filter making machines). Continuous tobacco or filter rods are cut into discrete lengths (rods) by a cut-off device. Cutting off is realized by means of a rotary cutting head with knives positioned on its periphery, whereas the axis of rotation of the cutting head is arranged at an angle with relation to a horizontal plane. Inclining the cutting head provides a horizontal speed component of the knife parallel to the rod movement, the horizontal speed component of the knife should be equal to the speed of the rod being cut while cutting in order to enable proper cutting a continuous moving rod. Cutting a continuous rod requires that such a rod is supported whilst cutting which is usually realized by means of a ledger which has a round hole or holes to guide the rod and a slot through which knives of a cutting head move repeatedly. Typically it is designed as a set of cutting tubes with a certain distance between them. In the art there are several mechanisms involving rotary motion for driving a ledger whereas the ledger itself makes linear reciprocating movement. British patent GB2108820 presents a ledger driven by a ledger mechanism comprising two gear arrangements consisting of an internal gear within which orbits an external gear which is half the diameter of the internal gear. The ledger is positioned on a connecting member the ends of which are pivotally joined with the external gears at points on the pitch diameter of the gears, due to which the ledger makes linear horizontal reciprocating movement. The disadvantage of the solution is that the ledger is situated between the gear arrangements or its pivotal joints and it is difficult to arrange a cutting head as far as the space factor is concerned.

American patent US6,478,031 presents a similar mechanism where a connecting member being a rod-supporting part between drive gears is made of two members connected to one another with a pivot pin. The two members are connected by an anti-backlash spring. Another American patent US4,444,210 presents a ledger mechanism in which there is used an elastic cushioning insert to manage with tensions in the connecting member.

All the above mentioned documents disclose mechanisms with a ledger situated between gear arrangements of a ledger mechanism. Very important issue of the above mentioned inventions is the distance between the centre of the mass of the ledger and the line of movement of the pivotal joints of the gear arrangements. Due to this distance inertia forces are produced

which cannot be balanced easily, the bigger the distance is the bigger inertia forces are produced. The result is very noisy operation of the mechanisms.

The purpose of the present invention is developing a ledger mechanism which can be used at very high speed of a continuous rod of about 600m/min. The invention concerns improvements in such a mechanism.

The object of the invention is a ledger mechanism for rod making machines of tobacco industry comprising a first gear arrangement having a first pivot for performing reciprocating movement and a second gear arrangement having a second pivot for performing reciprocating movement, and a connecting member mounted to the pivots of the first and second gear arrangement, and a ledger with cutting tubes mounted to a connecting member, first pivot gear and second pivot gear are mechanically coupled with each other.

A ledger mechanism is characterized in that a connecting member is longer than a distance between the axes of the first and second pivot, and a ledger with cutting tubes is located at the connecting member outside the inner part of connecting member delimited by axes of the first and second pivot of the first and second gear arrangement.

A ledger mechanism is characterized in that the distance between the axis of the connecting member and the axis of the second pivot is bigger than the distance between axis of the connecting member and the first pivot.

A ledger mechanism is characterized in that the axis of the connecting member crosses the axis of the first pivot of the first gear arrangement.

A ledger mechanism is characterized in that the connecting member and the second gear arrangement are connected resiliently.

A ledger mechanism is characterized in that the resilient joint is a flat spring.

A ledger mechanism is characterized in that the connecting member and the second gear arrangement are connected with a slide bearing.

A ledger mechanism is characterized in that the first gear arrangement is the drive gear.

A ledger mechanism is characterized in that the second gear arrangement is the drive gear.

A ledger mechanism is characterized in that a ledger with cutting tubes is located on the end part of the connecting member.

A ledger mechanism is characterized in that the first and second gear arrangements are hypocycloidal gears of  $k=2$ .

The advantage of applying the ledger mechanism according to the invention is very low level of noise. Moreover the whole unit can be easily exchanged in case a new length of rods is needed.

The object of the invention will be described with reference to the drawing. In the drawing: Fig. 1 shows schematically a kinematics diagram of a hypocycloid gear arrangement; Fig. 2 shows a kinematics diagram of two gear arrangements shown in Fig. 1 in one position; Fig. 3 shows a kinematics diagram of two gear arrangements shown in Fig. 1 in a second position; Fig. 4a shows a kinematics diagram of two gear arrangements in another embodiment; Fig. 4b shows a kinematics diagram of two gear arrangements in another embodiment; Fig. 5 shows a kinematics diagram of two gear arrangements in another embodiment; Fig. 6 shows an embodiment of a ledger mechanism according to the invention; Fig. 7 shows a cross-section of a ledger mechanism of fig. 6; Fig. 8 shows a supporting member of for a connecting member; Fig. 9 shows another supporting member for a connecting member.

Typically a gear arrangement 12 being a hypocycloid gear arrangement applied in the invention comprises a fixed ring gear 10 and an orbiting gear 11 which are presented schematically in fig. 1. The fixed ring gear 10 has internal teeth, the teeth of the orbiting gear 11 are in mesh at point R with the teeth of the fixed ring gear 10, whereas the ratio  $k$  of the pitch diameter of the fixed gear to the diameter of the orbiting gear is 2:1 i.e.  $k=2$ . The orbiting gear 11 orbits around the centre C of the fixed ring gear 10 and while orbiting rotates around its centre M. Due to the diameter ratio, as the orbiting gear 11 orbits and rotates, a point N on the pitch diameter of the gear 11 reciprocates horizontally along a straight line segment L marked with dashed line. Thus rotary movement of the orbiting gear 11 can be transformed into reciprocating linear movement of the point N. A pivot can be arranged at the point N for connecting to other mechanisms. It can be noted that the condition of proper operating of the mechanism is that the distance NM which is the pitch radius of the movable gear 11 is equal to the distance MC being a distance between the centre M of the orbiting gear 11 and the centre C of the fixed ring gear 10. Fig. 2 presents schematically two gear arrangements, the first gear arrangement 12' and the second gear arrangement 12 comprising fixed and orbiting gears respectively 10, 11 and 10', 11' staying in mesh at points R, R'. There are two pivots arranged at points N and N' on the pitch diameters of the orbiting gears 11, 11' in order to connect the orbiting gears 11, 11' with a connecting member 13. The first pivot is arranged at point N' of the first gear arrangement 12' and the second pivot is arranged at point N of the second gear arrangement 12. Due to such an arrangement the connecting member follows the movements of the points N, N' and makes horizontal linear movement and can be used for supporting a ledger 14 with cutting tubes for

cutting a continuous rod of tobacco industry i.e. tobacco or filter rod. The linear movement of the connecting member may be realized by turning the orbiting gears 11, 11' in one direction i.e. both clockwise or anticlockwise in the plane of the drawing or in opposite directions. The movements of the gears 11, 11' may be synchronized by means of e.g. a pair of gears not shown in this diagram, it may also be realized by means of a gear train. In fig. 2 and 3 the gear 11 orbits anticlockwise and the gear 11' orbits clockwise. In fig. 2 the gears 11, 11' and both the points N, N' and the points R, R' all take up rightmost position, the points N and R overlap and the points N' and R' overlap as well. In fig. 3 the mechanism is shown after the gears 11, 11' have made orbiting movement and their centers have made certain angular movement with reference to the points C, C', the connecting member 13 has started its movement to the left side in the drawing.

It is commonly known that in the connecting member 13 there will appear tensile and/or compressive tensions which often constitute excessive loads both to the connecting member and the pivots at the points N, N'. Moreover if the ledger is situated at a certain distance above the gear arrangements, the connecting member and the pivots at the points N, N' are loaded with moment of inertia caused by the weight of the ledger and a supporting part of the ledger. Fig. 4 shows a schematic illustration of an embodiment of a mechanism according to the invention. It comprises two gear arrangements 12, 12' comprising respectively both fixed and orbiting gears 10, 11 and 10', 11' and a connecting member 13'. The point N' of the movable gear 11' lies on the axis of the connecting member 13'. The center C' of the gear 10' also lies on the axis of the connecting member 13'. The center C of the ring gear 10 lies below the axis of the connecting member 13'. The point N lies below the axis of the connecting member 13' and there is applied a supporting member 15 for supporting the connecting member 13' at point T resiliently, flexibly or in general not rigidly. As shown schematically in fig. 4a at the point T there may be a slidable joint whereas the supporting member 15 may be a rigid support. This is due to the fact that the connecting member is not intended to be driven by the second gear, the function of the second gear arrangement is to support the connecting member rather than to provide a driving force. The supporting member may also be designed as a flexible member like a flat spring. The connecting member is longer than the distance between the pivots at the points N, N' of the both gear arrangements. At the end 13A of the connecting member 13' i.e. outside an inner part 13B there may be positioned a ledger 14. The inner part 13B of the connecting member 13' is the part located between the pivots at the points N and N'. Both the point N and the point N' reciprocate horizontally the same way but the pivot arranged at the point N' is the driving element for the connecting member 13' and the ledger 14. The pivot at the point N is used to support the connecting member 13', it is synchronized with and follows the horizontal reciprocating movement

of the pivot at the point  $N'$ , the synchronization may be realized by e.g. a pair of gears (not shown). In fig. 4b a similar embodiment is presented. In this embodiment the connecting member 13' is situated slightly higher with reference to centers  $C$  and  $C'$ , the distance between the center  $C$  and the axis of the connecting member 13' which is equal to the distance between a pivot at point  $N$  and the axis of the connecting member 13' equals to  $d_1$ . The distance between the center  $C'$  and the axis of the connecting member 13' which is equal to the distance between a pivot at point  $N'$  and the axis of the connecting member 13' equals to  $d_2$ , whereas  $d_1$  is bigger than  $d_2$ . In fig. 5 there is another embodiment of the mechanism shown schematically. There is a pivot at the point  $N$  of the second gear arrangement 12 which lies on the axis of a connecting member 13". This pivot is the drive pivot for the connecting member 13". At the end part 13C of the connecting member 13" there is a point  $T'$  for supporting the connecting member 13" and there is a supporting member 15' connected to the pivot at the point  $N'$  which constitutes a support for the connecting member 13" and does not drive the connecting member 13". The presented schemes can be mirrored with reference to a horizontal plane, in other words they can be placed upside down maintaining their kinematics operation.

In fig. 6 there is shown a front view (without a cover and with partial cross section) of the embodiment of a ledger mechanism according to the present invention comprising two gear arrangements 12, 12' and in fig. 7 there is shown a cross-section A-A of the gear arrangements 12, 12' of fig. 6. In the gear arrangement 12 there is a main shaft 30 rotary mounted in a housing 34 by means of two bearings 32 and 33, the main shaft 30 having its rotation axis  $XC$ . The rotation axis  $XC$  is also the axis of a fixed ring gear 10. The rotation axis  $XC$  corresponds to the center  $C$  of the fixed ring gear 10 in fig. 4. In the main shaft 30 there is a crank shaft 36 rotary mounted in the main shaft 30 by means of two bearings 37 and 38, the crank shaft 36 having its rotation axis  $XM$ . The rotation axis  $XM$  corresponds to the center  $M$  of the orbiting gear in fig. 4. On the crank shaft 36 there is fixed an orbiting gear 11, whereas the axis of the orbiting gear 11 overlaps the crank shaft rotation axis  $XM$ . The orbiting gear 11 meshes with the fixed ring gear 10 mounted in the housing 34, the point of meshing is marked with the annotation  $R$ . The crank shaft 36 is provided with a crank pin 44 having an axis  $XN$  which corresponds to the point  $N$  in fig. 4, at which there is a pivot  $P$ . There are two bearings 45 and 46 mounted on the crank pin 44 and in a supporting member 57. The crank pin 44, the bearings 45 and 46 and the supporting member 57 constitute the pivot  $P$ .

The gear arrangement 12' is designed similarly. In the gear arrangement 12' there is a main shaft 30' rotary mounted in the housing 34 by means of two bearings 32' and 33', the main shaft 30' having its rotation axis  $XC'$ . The rotation axis  $XC'$  corresponds to the center  $C'$  of the fixed ring

gear 10' in fig. 4. In the main shaft 30' there is a crank shaft 36' rotary mounted in the main shaft 30' by means of two bearings 37' and 38', the crank shaft 36' having its rotation axis XM'. The rotation axis XM' corresponds to the center M' of the movable gear in fig. 4. On the crank shaft there is fixed an orbiting gear 11', whereas the axis of the orbiting gear 11' overlaps the crank shaft rotation axis XM'. The orbiting gear 11' meshes with the fixed ring gear 10' mounted in the housing 34, the point of meshing is marked with the annotation R'. The crank shaft 36' is provided with a crank pin 44' having an axis XN' which corresponds to the point N' in fig. 4, at which there is a pivot P'. In a bearing housing 47 fixed to a connecting member 13' there are mounted two bearings 48 and 49 fixed on the crank pin 44'. The bearing housing 47, the bearings 48 and 49 and the pin 44' constitute the pivot P'. The crank pin 44' rotates while the gear arrangement 12' operates and the bearing housing 47 fixed to the connecting member 13' makes linear reciprocating movement parallel to the direction of movement of the continuous rod CR and drives this way the connecting member 13'. The connecting member also realizes the function of supporting a ledger 14.

The connecting member 13 is longer than the distance between the pivots P and P'. The ledger 14 having cutting tubes 52 is mounted at the end of a connecting member 13' (fig. 6). The inner part 13B of the connecting member 13' is located between the pivots P and P'. Between the cutting tubes 52 there is a slot 54 through which a cutting blade (not shown) of a typical cutting head moves in order to cut a continuous rod CR which moves along a tube channel 55. As it can be seen in fig. 6 the continuous rod CR is situated close above the connecting member 13' which is possible due to the arrangement of the gear arrangements 12 and 12' and the connecting member 13'. The axis 56 of the connecting member 13' lies horizontally and crosses the axis XN' in the gear arrangement 12'. The axis XN of the gear arrangement 12 lies below the connecting member 13.

The supporting member 57 is designed to join the connecting member 13' with the pivot P. The crank pin 44 rotates while the gear arrangement 12 operates and the supporting member 57 makes linear reciprocating movement parallel to the direction of movement of the continuous rod CR. In the presented embodiment the supporting member 57 comprises two flat springs 57A and a mount 57B which is fixed to the connecting member 13' (fig. 8), it may be glued or screwed to the connecting member 13'. In case compressive or tensile tensions appear in the connecting member 13' the flat springs 57A will bent slightly. According to the arrangement, the ledger 14 is not situated between the pivots P, P' of the gear arrangements 12, 12' but outside of the pivots P, P'. This enables constructing a compact mechanism, which can be applied in a machine with limited space for cutting the rod. It is easy to adapt it to any cutting head.

The supporting member 57 comprising the flat springs 57A and the mount 57B may be replaced with a housing 58 (fig. 9) which is rigid and in which there is placed a slide linear bearing 59 for the connecting member 13'.

The ledger mechanism is driven by a motor which is not shown in the drawing, the motor drives a pinion 61 which stays in mesh with a gear 62 mounted fixedly on the shaft 30'. The pinion 61 is designed to be easily detachable from the motor. On the shaft 30' there is also fixedly mounted a gear 63 which stays in mesh with a gear 64 of the same pitch diameter fixedly mounted on the shaft 30. Due to the drive train both the gear arrangements 12 and 12' rotate in opposite directions at the same rotational speed. Both the pivots P and P' make the same reciprocating movements thanks to which the connecting member 13' together with the ledger 14 and the cutting tubes 52 also make the reciprocating movement needed for proper cutting a continuous rod on a rod making machine of tobacco industry.

Typical aspects of balancing the mechanism commonly known to specialists in mechanics are omitted in the description.

The advantage of the ledger mechanism according to the invention is a combination of small dimensions of the mechanism and low level of noise. Furthermore the ledger with the cutting tubes lies outside the gear arrangements. In practice the ledger mechanism is easily exchangeable so the time needed for setting a new length of cutting is very short. It can be realized by unscrewing the housing with a mechanism and replacing it with a housing comprising a mechanism for a new length of cutting.

### Claims

1. Ledger mechanism for rod making machines of tobacco industry comprising
  - a first gear arrangement (12') having a first pivot (P')
  - for performing reciprocating movement and
  - a second gear arrangement (12) having a second pivot (P) for performing reciprocating movement, and
  - a connecting member (13') mounted to the pivots of the first and second gear arrangement, and
  - a ledger (14) with cutting tubes (52) mounted to a connecting member (13'),
  - first pivot (P') and second pivot (P) are mechanically coupled with each other

**characterized in that**

  - a connecting member (13') is longer than a distance between the axes of the first and second pivot (P, P'), and
  - a ledger (14) with cutting tubes (52) is located at the connecting member (13') outside the inner part (13B) of the connecting member (13') delimited by axes of the first and second pivot (P, P') of the first and second gear arrangement (12, 12').
2. Ledger mechanism according to claim 1, wherein the distance between the axis (56) of the connecting member (13') and the axis of the second pivot (P) is bigger than the distance between the axis (56) of the connecting member (13') and the first pivot (P').
3. Ledger mechanism according to claim 1 or 2, wherein the axis (56) of the connecting member (13') crosses the axis (XN') of the first pivot of the first gear arrangement (12').
4. Ledger mechanism according to any of claims 1 to 3, wherein the connecting member (13') and the second gear arrangement (12) are connected resiliently.
5. Ledger mechanism according to any of claims 4, wherein the resilient joint is a flat spring (57A).
6. Ledger mechanism according to any of claims 1 to 5, wherein the connecting member (13') and the second gear arrangement (12) are connected with a slide bearing (59).
7. Ledger mechanism according to any of claims 1 to 6, wherein the first gear arrangement (12') is the drive gear.

8. Ledger mechanism according to any of claims 1 to 7, wherein the second gear arrangement (12) is the drive gear.
9. Ledger mechanism according to any of the above claims wherein a ledger (14) with cutting tubes (52) is located on the end part (13A) of the connecting member (13').
10. Ledger mechanism according to any of the above claims wherein first and second gear arrangements (12, 12') are hypocycloidal gears of ratio  $k=2$ .

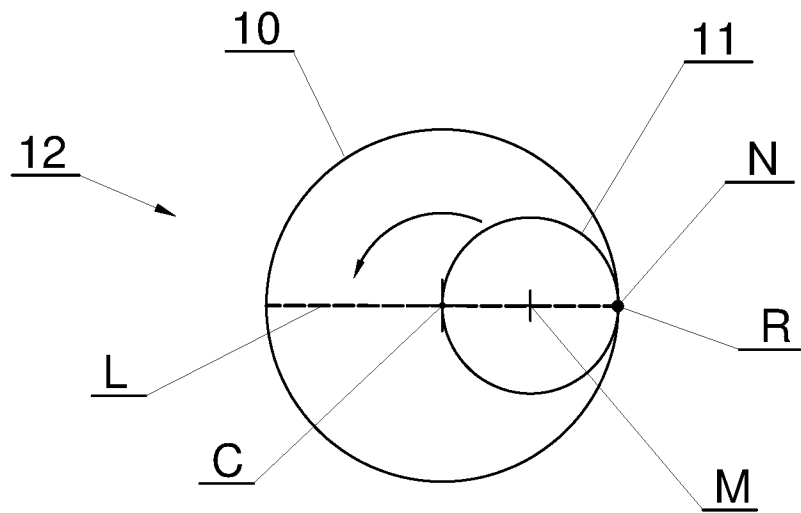


Fig. 1

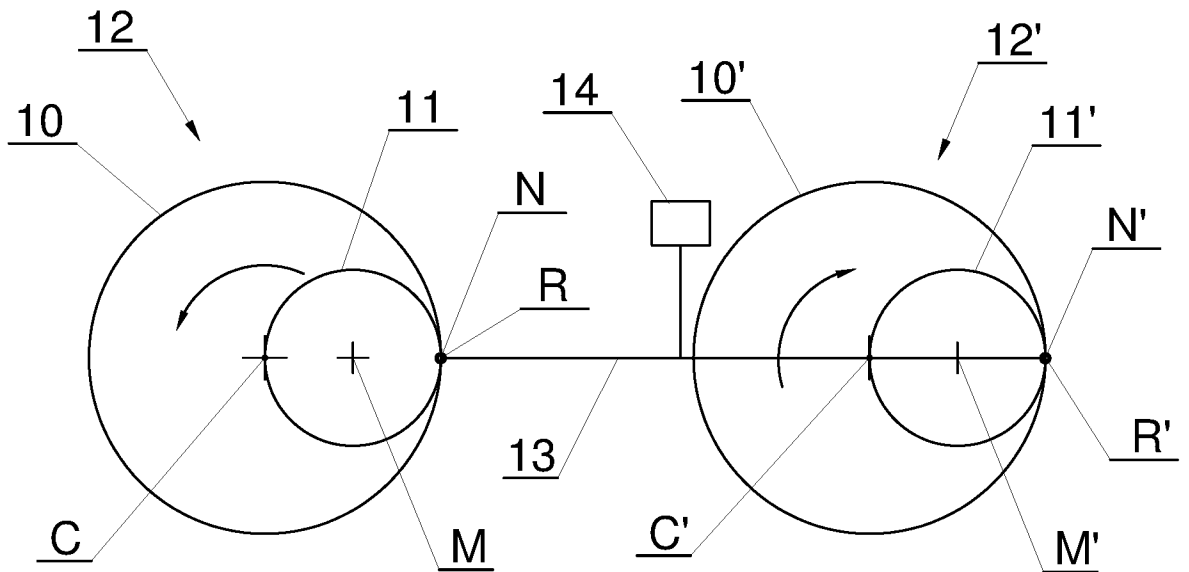


Fig. 2

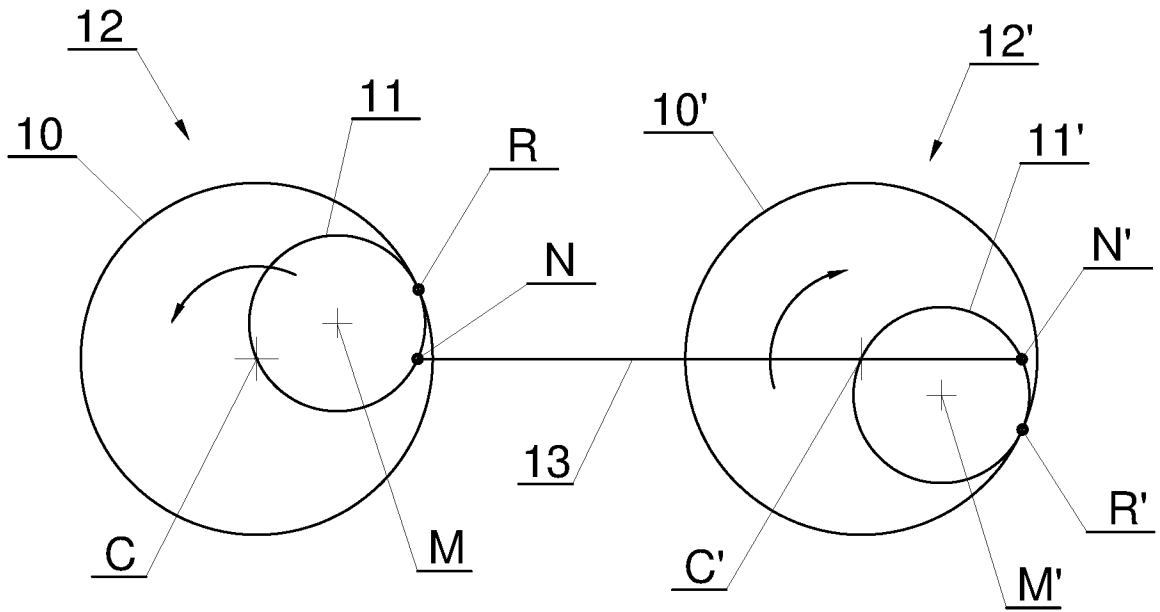


Fig. 3

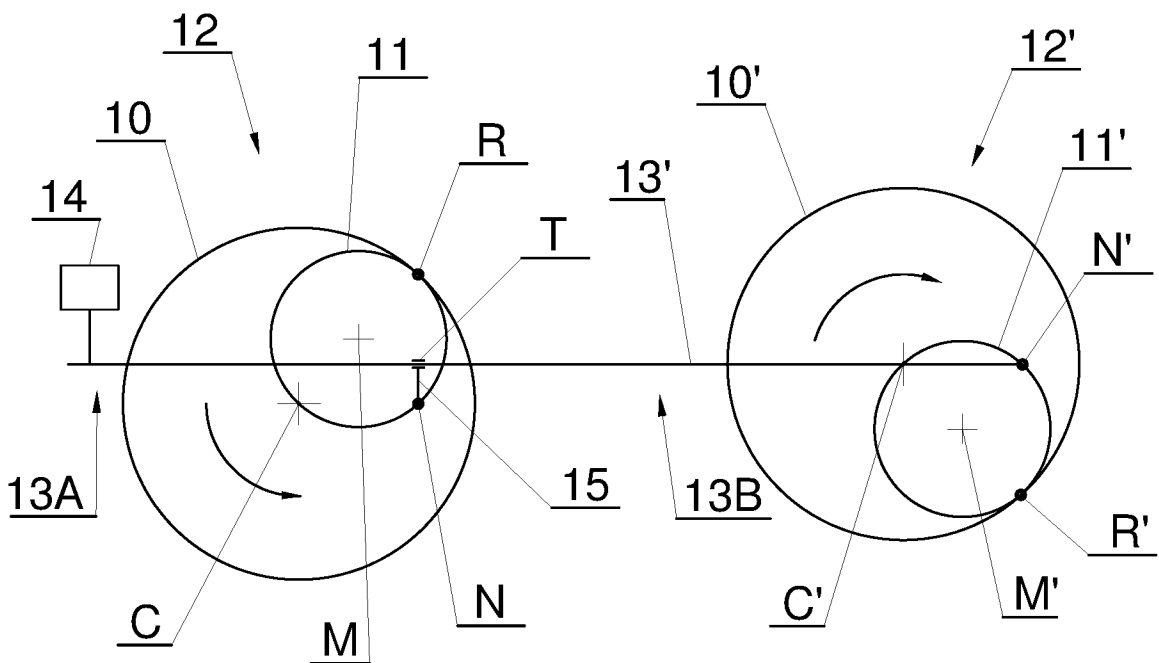


Fig. 4a

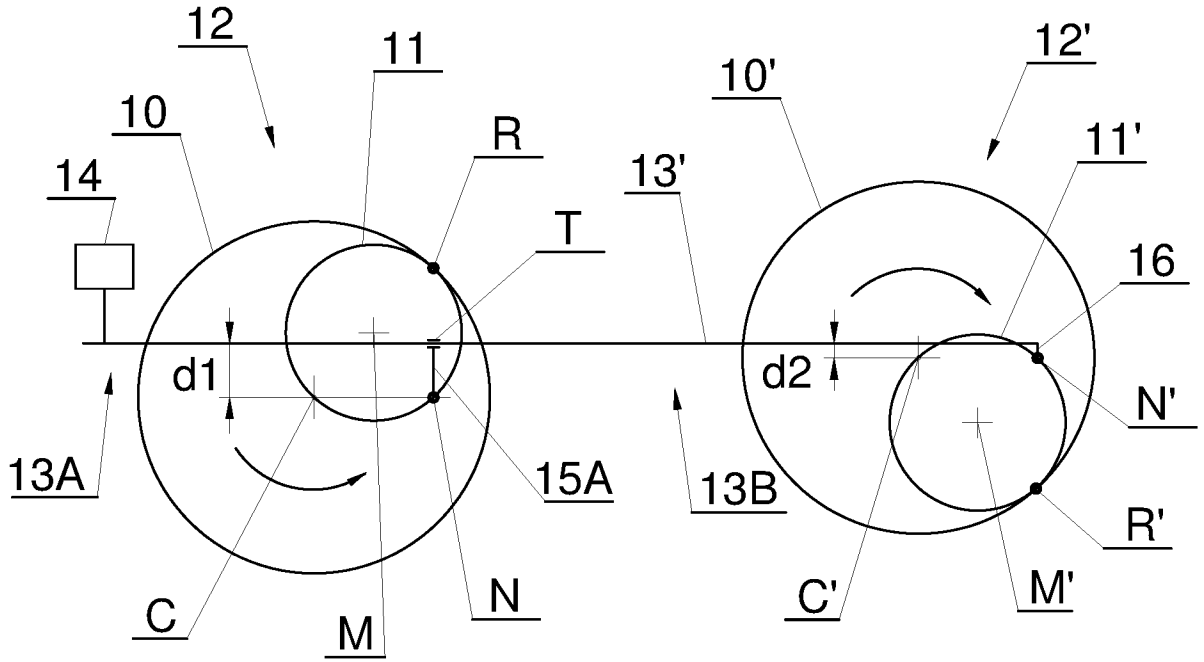


Fig. 4b

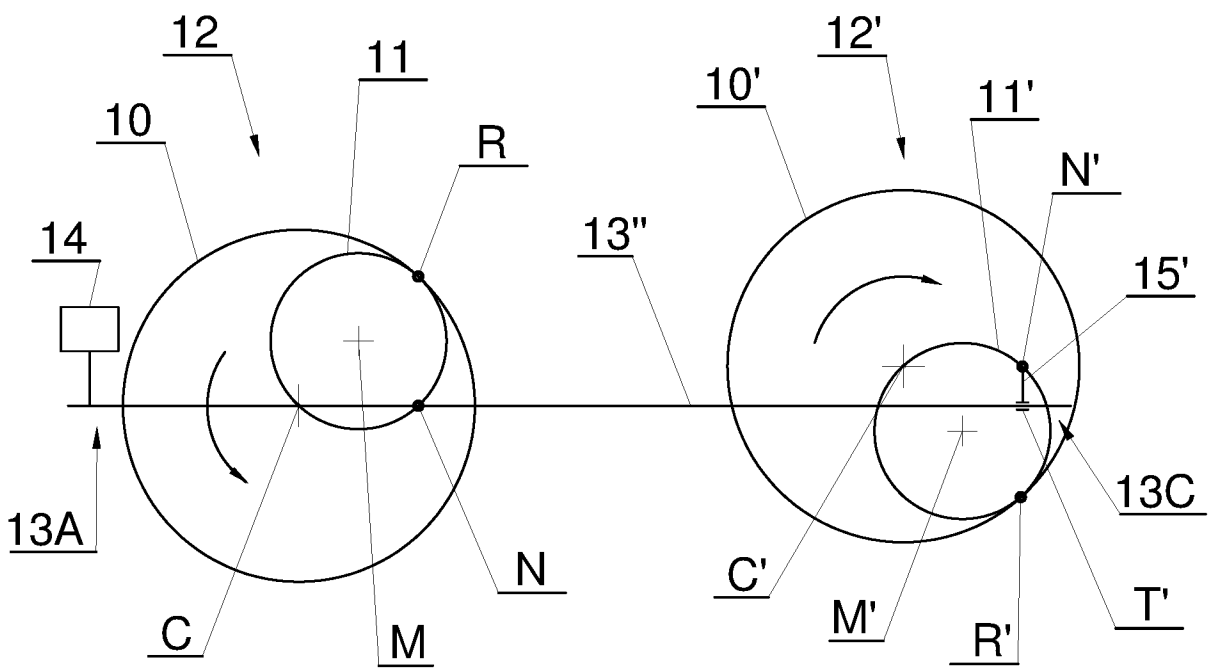


Fig. 5





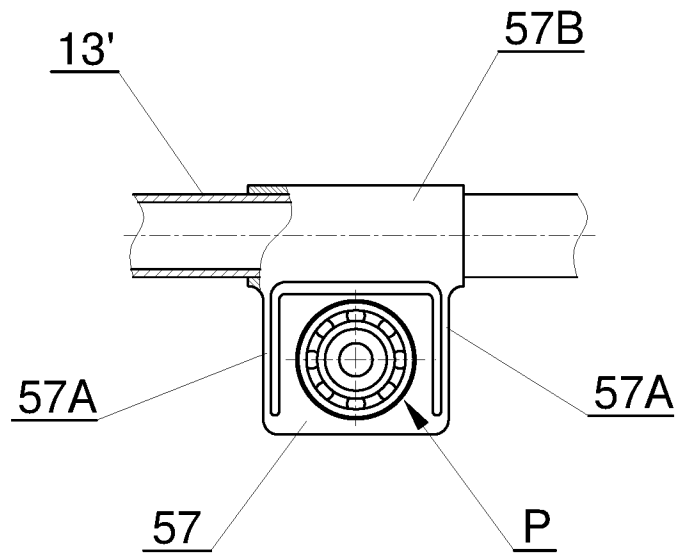


Fig. 8

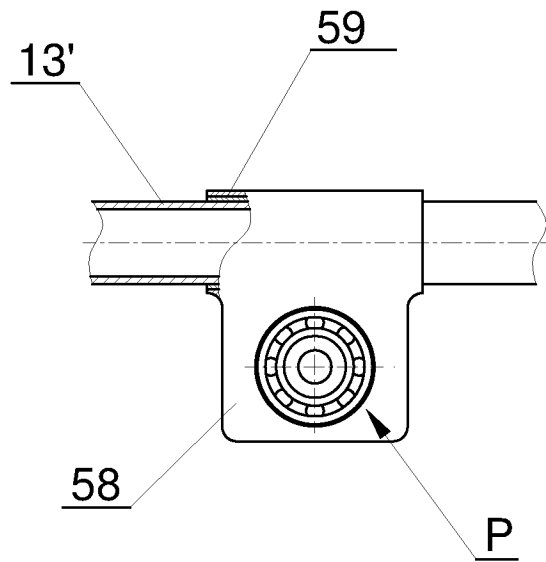


Fig. 9

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/IB2014/059149

A. CLASSIFICATION OF SUBJECT MATTER INV. A24C5/28 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) A24C		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 3 995 519 A (LABBE FRANCIS A M ET AL) 7 December 1976 (1976-12-07) abstract; figures -----	1-10
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A	EP 1 108 367 A2 (HAUNI MASCHINENBAU AG [DE]) 20 June 2001 (2001-06-20) abstract; figures ----- -/--	1-10
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
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Date of the actual completion of the international search  5 June 2014	Date of mailing of the international search report  24/06/2014	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Marzano Monterosso	

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International application No  
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International application No

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