

"TIMEPIECE GEAR MEMBER"

The present invention relates to a timepiece gear member and to a method of making the same.

5 A timepiece gear member or timepiece wheel is disclosed in Japanese Laid-open Patent Publication No. 62-161076 and is constituted by a wheel and pinion which are formed separately, after which the two components are connected together with interference between them. Japanese Laid-Open Patent Publication No. 61-48869 discloses that a pinion portion, gear portion and shaft portion of a timepiece gear member may be formed integrally of resin. Further, 10 Japanese Laid-open Patent Publication No. 61-55472 discloses that a central hole, a base portion and a toothed portion of a timepiece gear member may be integrally formed by effecting swelling of the said base portion.

15 In the construction disclosed in Japanese Laid-open Patent Publication No. 62-161076, the gear portin or wheel of the timepiece gear member is formed by effecting gear milling of an annular plate obtained by press working. The pinion member, which is separate from the gear member, is formed by gear milling a shaft member produced 20 on a lathe. The pinion portion is then made an interference fit in the gear portion. Accordingly, the process time required to produce the gear portion and pinion portion is of the order of 20 to 30 seconds, while the

assembly time involves a further 1 to 2 seconds.

5 In the construction of Japanese Laid-open Patent
Publication No. 61-48869, it is necessary that it should have
the strength to bear the slip force of the centre wheel
and pinion, the strength to bear the force exerted at the
time of assembling or detaching the hands, and the strength
to bear the pressure exerted by a regular lever. Therefore,
this wheel and pinion requires the use of a high strength
member, makes it necessary to enlarge the module of the
10 gear and pinion, and to increase the thickness of the gear.
Further, the process time takes well over ten seconds.
Accordingly, it involves high cost due to the use of expensive
material, and due to the relatively considerable processing
time, and the timepiece has to be made thick and large in
15 order to improve its strength.

In the timepiece wheel of Japanese Laid-open Patent
Publication No. 61-55472, although this construction has the
advantage of involving less process time, the construction
involves making a hole in the central portion and forming
20 ten independent teeth in the circumference thereof by
compressing the plate base. Thus, each tooth has to be large
in order to improve the strength of die. Further, since the
diameter of the hole has to be larger than the thickness of
the base portion when the central hole is made, the resultant
25 gear in which teeth have to be formed around the hole is

necessarily very large. Therefore, this construction is not suitable for the acceleration or deceleration gear train in a timepiece. Above all, if the timepiece wheel is used in a front gear train, or in an acceleration or deceleration gear train, then due to the fact that the central hole is very large, and due to the fact that the front gear train always has a broken portion formed by shearing the torque loss at the bearings is very large. Furthermore, since each tooth is formed independently the height of each tooth is liable to vary.

The variation of tooth height makes the positioning of the gear difficult at the top surface of the teeth.

According, therefore, to the present invention, there is provided a timepiece gear member comprising at least one bearing portion, which is adapted to be supported by a frame, a pinion portion and a gear wheel portion, the bearing, pinion and gear wheel portions being made from a common metal plate member by plastic working so as to be integral with each other.

Preferably, the bearing, pinion and gear wheel portions are formed by forging, compressing, shearing or bending, the teeth of the gear wheel portion being formed by forging, compressing or shearing.

There are preferably two bearing portions on opposite sides respectively of the pinion portion.

The gear wheel portion preferably has a substantially larger diameter but a smaller axial thickness than the pinion portion.

5 The said at least one bearing portion may be constituted by a recess or a projection.

The invention also comprises a timepiece provided with at least one timepiece gear member as set forth above.

10 Additionally, the invention comprises a method of making a timepiece gear member comprising employing plastic working to form the timepiece gear member with a pinion portion, at least one bearing portion, and a gear wheel portion from a common metal plate member so as to be integral with each other.

15 The plastic working may be effected by a die, the finished timepiece gear member being ejected from the die by means of an ejector disposed radially inwardly of the teeth of the pinion portion.

The invention is illustrated, merely by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a plan view of the assembled frame of a timepiece employing timepiece gear members according to the present invention;

Figures 2 to 5 are sectional views of the frame of Figure 1;

Figure 6 is a sectional view of part of another embodiment of a timepiece similar to that of Figure 1;

Figures 7(a) and (b) are perspective views of the teeth of the wheel and pinion respectively of part of the gear train of Figure 1,

Figure 8 is a sectional view of another embodiment of a timepiece similar to that of Figure 1;

Figure 9 shows the tooth profile of a pinion of one embodiment of a timepiece gear member of the present invention,

Figures 10 to 12 are sectional views showing timepiece gear members of other embodiments;

Figures 13(a) and (b) are respectively plan and sectional views illustrating the manufacture of a timepiece gear member of the present invention;

Figure 14 is a sectional view showing another embodiment of the present invention;

Figure 15 is a sectional view of a fifth wheel and pinion in accordance with an embodiment of the present invention;

Figures 16(a) and (b) are respectively plan and sectional views illustrating forging or compressing and shearing of the fifth wheel and pinion of Figure 15 and a major portion of a die for this purpose.

5 Figures 17(a) and (b) are sectional views showing yet a further embodiment of a timepiece incorporating timepiece gear members according to the present invention and

Figure 18 is a sectional view of a timepiece gear member according to the present invention and a die therefor.

10 In a preferred embodiment of the present invention (Figures 1 to 5 and 7), a timepiece includes a main plate 1 between which and a gear train bridge or frame 2 on the back side of the main plate 1 there is a gear train. The gear train includes a centre wheel and pinion 3, a third wheel and pinion 5, a fourth wheel and pinion 4, and a fifth wheel and pinion 6. The centre wheel and pinion 3 is rotatably supported by a hollow axle or bearing portion 3e projecting through the main plate 1 and enclosed in an annular thin flange 1a (Figure 2) formed from the material of the main plate 1. The flange 1a is formed by
15 burring to form an annular projection of substantially half the thickness of the main plate 1 itself.

20 "Burring" is a flanging process in which a small hole is drilled in a flat plate, and the portion of the plate around the hole is thereafter bent up by a punch having a diameter larger than that of the hole.

25 The freedom of rotation of the fourth wheel and pinion 4 and of the centre wheel and pinion 3 is determined by the upper surface of the main plate 1 and the lower surface of the frame

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The centre wheel and pinion 3 has a pinion portion 3b on part of the axle portion thereof and a gear wheel or base portion 3c slidably mounted on an axle portion. The gear wheel portion 3c has teeth 3a which engage a pinion portion 5b of the third wheel and pinion 5. The wheel and pinion 5 may be formed by forging or compressing. Thus the material of the wheel and pinion 5 may be compressed by the use of a die so as to reduce the thickness of the said material in order to obtain a desirable shape, e.g. by upsetting the pinion portion 5b and a pivot portion 5d thereof. The wheel and pinion 5 also includes a gear wheel 5c with teeth 5a (which are formed by blanking) at one end of an axle portion, whose other end is formed with the pivot or bearing portion 5d to engage in a hole in the main plate 1. At the one end of the axle portion, there is a concave recess or bearing portion 5e engaged by a boss 2b carried by a small bridgelike member struck out from the bridge 2 between two short openings (Figure 1). Thus the boss 2b may be formed by drawing and compressing and/or half-blanking.

One example of a half-blanking process is a process in which a plate is provided with a projection by mounting one surface of the plate across a die, forcing a punch into the opposite surface of the plate, and stopping the travel of the punch when the leading end of the latter is within the thickness of the plate, so that the said portion is forced into the die without being removed from the base material of the plate.

The teeth 5a engage a pinion portion 4b on part of an axle portion 4d of the fourth wheel and pinion 4. The latter

has a gear wheel or base portion 4c secured on another part of the axle portion thereof. At the gear wheel end of the axle portion 4d, there is a concave recess 4e which constitutes a bearing portion and which is united integrally with the pinion portion 4b and the gear wheel 4c. The bearing portion 4e is supported by being engaged by a central boss or dowel 2a on the inner side of the bridge 2. Thus the fourth wheel and pinion 4 is supported by the central boss 2a and by the flange 1a by way of the centre wheel and pinion 3. At the other end of the axle 4d, a spindle 4f is an interference fit with the axle portion 4d and is rotatably supported in the hollow axle portion of the second wheel and pinion 3. The fourth wheel and pinion 4, except for the axle 4f may be formed by hot or cold forging or by compression, and the teeth 4a may be formed by shearing or blanking. Thus the bearing portion 4e, the pinion portion 4b and the gear wheel 4c are formed integrally by plastic working such as forging or compressing.

The teeth 4a on the gear wheel 4c, which are formed by forging, compressing or shearing, engage a pinion portion 6b of the fifth wheel and pinion 6. The latter has a gear wheel portion 6e having teeth 6a, an upper pivot boss or bearing portion 6d rotatably mounted in a hole in the bridge 2, and a lower concave recess or bearing portion 6c which is engaged by a boss on a stator 7 secured to the main plate 1.

The pinion portion of the centre wheel and pinion 3 (Figure 4) is engaged by the teeth 16a of a first wheel

and pinion or minute wheel 16 which is rotatably supported in a hole in the main plate 1 and has a pinion portion 16b, projecting therethrough with end facing teeth in engagement with an hour wheel 17 rotatably mounted on the flange 1a (Figure 2). The first wheel and pinion 16 also has upstanding teeth 16c (Figure 4). The first wheel and pinion 16 is formed by press working and by shearing from a thin plate member. The teeth 16c and the pinion portion 16b (Figure 7) are made by firstly making a shaped hole and thereafter bending. The gear wheel with teeth 16a is made by shearing to form the teeth profile. Therefore, the present invention is suitable for mass production and the manufacturing cost can be reduced.

Movement of the first wheel and pinion 16 from the hole in the main plate 1 is limited by a half-blanked portion 9a (Figure 4) of a magnetic core 9. The hour wheel 17 is between the main plate 1 and a dial face plate. The space between the main plate 1 and the face plate, and thus the limit of movement of the hour wheel 17 is set by three projections 1i which are made by drawing or half blanking the main plate 1.

The main plate 1 has bent up portions 1c for limiting the inclination of the third wheel and pinion during assembly. The portions 1c are bent up from the tongue formed by a U-shaped opening in the plate 1. The fifth wheel and pinion 6 is made in a similar manner to the third wheel and pinion

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Because there is a relation ($D1/D2 \leq 3$) between the external diameter $D1$ of the gear wheel 6a and the external diameter $D2$ of the pinion portion 6b, all the teeth of the wheel 6a can be obtained by forging. The hole in which the upper pivot boss 6d is mounted in the gear train bridge 2 is formed by half blanking. The pinion height L of each of the above forged pinions should not be less than 0.4mm. The number of pinion teeth should be not more than eight. The material for the components is desirably copper alloy, or brass, or aluminium. In order to make a timepiece thinner, the ratio of gear wheel thickness T with respect to pinion thickness L , i.e. T/L , is desirably not more than one half. The gear wheel thickness T is preferably not more than 0.25mm in order to be able to effect press blanking of teeth profiles having a relatively small module.

The purpose of half-blanking the gear train bridge 2 to support the fourth wheel 4 and the fifth wheel 6 is to reduce the contact resistance of the portions for determining the looseness of the wheels and pinions. The purpose is also to control the looseness of the wheels and pinions without the use of a jewel or the like.

The purpose of the recess formed by half-blanking around the hole which supports the upper pivot 6d of the fifth wheel and pinion 6 is to provide an oil reservoir.

5 The stator 7 has a rotor 8. The latter is made of plastics and magnetic material and has a lower pivot supported in a hole in the main plate 1 formed by half-blanking. The rotor 8 has an upper pivot supported in a hole formed in a sloping portion provided in a half-blanked portion of the bridge 2. The stator 7 is positioned in the horizontal direction by two burred portions 1b provided in the main plate 1. On the stator 7 (Figure 3) is a coil block comprising 10 the magnetic core 9, a coil frame, a coil lead, an insulating plate 11, and a coil lead substrate 10 with connecting portions to the ends of the coil. The coil lead substrate 10 also has a pattern on the side of the magnetic 15 core 9, and a hole to receive an IC chip 12. The coil lead substrate 10 has a pattern opposite to a projection, or gold "bump", of the IC chip 12. With the IC chip 12 in the hole in the coil lead substrate 10, it is pressed by IC chip pressing springs 2p (Figure 1) on the gear train bridge 20 2. The spring force makes a conductive contact between the IC chip 12 and the pattern. The magnetic core 9 is pressed against the stator 7 by spring force from core pressing springs 2q (Figure 1).

A crystal unit 13 (Figure 3) is positioned in a longitudinal seating hole provided in the main plate 1 (Figure 5). The crystal unit 13 has two terminals 13b. A bent-up portion 1c of the main plate 1 supports the crystal terminals 13b, being
5 insulated therefrom by part of the insulating plate 11. On the other side of the terminals 13b, a pattern on the coil lead substrate 10 is pressed into conductive contact with the terminals 13b by springs 2c pressed out of the bridge 2. The body of the crystal unit 13 is pressed by a crystal pressing
10 spring 2d (Figure 3). A copper portion 10a (Figure 5) protrudes from the edge of coil lead substrate 10 and is disposed in conductive contact with the cathode of a battery 14 by the spring force of a negative terminal spring 1e in the main plate 1. A two-pronged positive terminal 2d is integrally
15 formed from the gear train bridge and resiliently contacts the positive electrode casing of the battery 14 (Figure 5).

A stem 15 (Figure 4) is guided for reciprocation in one direction in holes in an end flange 1f and a bracket 1g bent up from the main plate 1. The main plate 1 is upset
20 by drawing or half-blanking to form two upwardly projecting guide portions for the stem 15. The reason for this structure is to overcome any defects caused by misalignment of the guide holes. Because the guide holes for the stem 15 are near the

bent portions of the flange 1f and bracket 1g, the guide holes punched before bending may be deformed when bending takes place. As a result, the accuracy of the hole diameters is not always obtained.

5 The stem 15 has two grooves 15a separated by a sloping sided annular land, and a toothed portion 15b. A tongue-like detent or "click" spring 1h is pressed out of the main plate 1 to engage resiliently in one of the grooves 15a, its end being bent. In order to remove the stem 15, the end of the
10 detent spring 1h can be pressed down by an instrument to disengage the detent spring 1h from the groove 15a and to remove it from the path of the stem 15 which can thus be removed. Normally, however, when the stem 15 is pulled out, the detent
15 spring 1h rides over the sloping sided annular land into the other of the grooves 15a. When the detent spring 1h is engaged in the other groove 15a, the position of the stem 15 is such that the toothed portion 15b is engaged with the teeth 16c of the first wheel and pinion 16 and the hands
20 can be rotated to adjust the time displayed. During manual rotation of the hands by the stem 15, the electrical operation of the timepiece is interrupted, part of the stem 15 bearing on the coil lead substrate 10 pressed against it by tongue springs 2r (Figure 4). In order to correctly pull out the stem 15, one part of the detent 1h is cut so that there is

almost no gap between the spring portion and the main plate rigid portion after cutting (such a cut is called a zero cut). The thrust force of the stem 15 being moved is received by the zero-cut portion of the spring in order to prevent the distortion of the end portion of the detent spring 1h in the thrust direction.

The main plate 1 is manufactured from a long strip of ribbon-shaped material which passes through metal working tools. First, the outline shape of a main plate is cut together with holes therein. This outline shape is joined to the body of the strip by tie bars 1j (Figure 1) provided on the main plate 1. The main plate 1 is then sequentially or simultaneously treated to form perforations, upset portions, bent portions and cutaway portions to receive the components of the timepiece which are to be disposed between the main plate 1 and the gear train bridge 2. The other components are made separately and placed in position on the main plate 1, for example, the stator 7, the rotor 8, the first, centre, third, fourth and fifth wheel and pinions 16, 3, 5, 4 and 6, the IC chip 12, the crystal unit 13 and the electrical and electronic connections. Then the gear train bridge 2 is placed in position upon the components, and the tie bars 1j, having been cut to release the main plate 1, are bent up and over the edge of the gear train bridge 2 to hold the latter in place on the main plate 1 with the components properly positioned and held therebetween.

The movement is attached, by way of a dial, to a back cover of the timepiece by a plurality of springs 2f provided on the gear train bridge 2. Therefore, an intermediate frame is not necessary.

5 To determine the space between the main plate 1 and the gear train bridge 2, several double bent portions 1k (Figure 2) are formed from the main plate 1, and their end portions are drawn or half-blanked to form projections 1l to engage the bridge 2. Generally, there is much variation or tolerance in bending and, therefore, the bending process is not suitable for determining the looseness of the wheels. However, this variation can be absorbed if the height of the projections 1l is controlled by the height of the double bent portions 1k. To locate the bridge 2 on the main plate 1, the latter has a concave portion 1s cut out of the flange 1f (Figure 2) to form a pair of fingers to engage a portion 2k of the gear train bridge 2.

15 Except for the tie bars 1j, the circumferential portions of the main plate 1, when formed as a thin plate, are formed by bending or drawing in order to strengthen the edges to prevent distortion and to improve the rigidity of the main plate. Additionally, thickened ridges 1m are formed by drawing or half blanking, particularly near circumferential portions which have no bent or drawn portions.

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25 On the gear train bridge 2, ridges 2j are formed near the

pivot holes, thereby improving the rigidity and preventing distortion of the main plate.

As explained above, the fourth wheel and pinion 4 has bearing portions 4d, 4e, a pinion portion 4b and a base or gear wheel portion 4c whose circumference is provided with teeth 4a, the bearing portion 4d, 4e, pinion portion 4b, and gear wheel portion 4c being formed integrally by plastic working such as forging or compressing, and the profiles of the teeth 4a being formed by forging, compressing or shearing. The wheels and pinions 5, 6 are similarly formed. Thus the bearing portions 5d, 5e, pinion portion 5b and gear wheel portion 5c of the third wheel and pinion 5 may be formed integrally by such plastic working, the profiles of the teeth 5a being formed by forging, compressing or shearing. Furthermore, the bearing portions 6d, 6c, pinion portion 6b and gear wheel portion 6e of the fifth wheel and pinion 6 may be formed integrally by such plastic working, the profiles of the teeth 6a being formed by forging, compressing or shearing.

In a modification of the foregoing example, shown in Figure 6, more use is made of blanking and bending in the manufacture of wheels and pinions. Thus, a rotor 107 has a central portion from which teeth 107a are cut and struck upwardly to form a pinion portion, whilst portions

107b are bent downwardly to grip and hold a magnet 107c.
A main plate 101 has a boss 101b formed thereon to engage
in a hole in the magnet 107c to provide a lower pivot for
the rotor 107. The teeth 107a of the pinion portion engage
5 a boss 102b on a downwardly projecting portion of a gear
train bridge 102, which boss forms an upper pivot for the
rotor 107. Teeth are cut out of the periphery of a fifth
wheel and pinion 106 to engage with the teeth 107a of
the rotor 107. Teeth are also cut and struck upwardly
10 to form the pinion portion 106a of the fifth wheel and
pinion 106. The fifth wheel and pinion 106 has a gear
wheel portion 106b having teeth 106c. A hole 106d in the
gear wheel portion 106b acts as a bearing portion. A fourth
wheel and pinion 104 has peripheral teeth 104b cut out and
15 engaged with the teeth of the pinion portion of the fifth
wheel and pinion 106. The central portion of the fourth
wheel and pinion 104 is cut and struck downwardly to form
teeth 104a of a pinion portion thereof. The fourth wheel and
pinion 104 is mounted with interference on a shaft 104c
20 which carries the seconds hand of the watch. The shaft
104c acts as a bearing portion which is rotatably mounted
in a hole formed in the bridge 102 and in the hollow
spindle of a centre wheel and pinion 103, which

itself is rotatably mounted in a flanged hole in the main plate 101. A third wheel and pinion 105, which is formed by press blanking, has peripheral teeth 105b in engagement with the teeth 104a of the pinion portion of the fourth wheel and pinion 104. The central portion of the third wheel and pinion 105 is cut and bent, after a zero cut, to form teeth 105a of a pinion portion of the third wheel and pinion 105. Any burring of the pinion 104a is arranged to be located internally of the latter so that it does not affect the engagement between the pinion 104a and the teeth 105b. Moreover, any burring of the teeth 105a is in the circumferential direction. There is a central pivot hole or bearing portion 105e in the third wheel and pinion 105 and in this hole 105a there is mounted an upper pivot boss 102a formed on a downwardly projecting portion of the bridge 102 which is cut and drawn to produce the said portion. A similar lower pivot boss 101a is formed by half-blanking or plastic working from the main plate 101 and is engaged by the teeth 105a. The latter are engaged by the peripheral teeth on the wheel of the centre wheel and pinion 103. The remainder of the watch is similar to that described above.

The number of teeth on each pinion in the Figure 6 construction is desirably not more than eight, in view of the size of the pinions and the manufacturing requirements.

The desirable thickness of the material is not more than 0.2mm to enable manufacture by pressing.

5 The third wheel and pinion 105 may have its bearing portion 105e, pinion portion 105a and a gear wheel portion 105c thereof formed integrally by plastic working, such as forging or compressing, the profiles of the teeth 105b of the gear wheel portion 105c being formed by forging, compressing or shearing. Furthermore, the fourth wheel and pinion 104 may have its bearing portion 104c, pinion 10 portion 104a and a gear wheel portion 104d thereof formed integrally by such plastic working, the profiles of the teeth 104b of the gear wheel portion 104d being formed by forging, compressing or shearing. Additionally, the fifth wheel and pinion 106 may have its pinion portion 15 106a, gear wheel portion 106b and bearing portion 106d formed integrally by such plastic working, the profiles of the teeth 106c being formed by forging, compressing or shearing.

20 In Figure 8 there is shown a timepiece having a main plate 301 and a gear train bridge 302. A centre wheel and pinion 303 comprises a centre gear 303a and a centre pinion 303b such that there may be a predetermined sliding torque between the centre gear 303a and the centre pinion 303b.

A fourth wheel and pinion 304 comprises a fourth gear 304a, a fourth pinion 304b, and a recess portion 304c which is formed integrally with the portions 304a, 304b by forging or compressing. The fourth wheel and pinion 304 also has a centre hole 304e formed by shearing as described below, and a fourth shaft 304d which is fixed in the centre hole 304e. The centre wheel and pinion 303 is rotatably supported by an annular flange portion 301a of the main plate 301 and by two projections or bearing portions 303b on the shaft of the fourth wheel and pinion 304. The fourth wheel and pinion 304 is supported by the annular flange portion 301a by way of the centre wheel and pinion 303, and by a pivot hole 302a of the gear train bridge 302. The degree of looseness of the centre wheel and pinion 303 and of the fourth wheel and pinion 304 are determined by the main plate 301 and the gear train bridge 302.

A third wheel and pinion is constituted by one integral member comprising a third pinion 305b for engaging with the centre gear 303a, a third gear 305a for engaging with the fourth pinion 304b, a lower pivot or bearing portion 305c, and an upper pivot or bearing portion 305d. In the third wheel and pinion 305, the lower pivot 305c is rotatably supported by a hole in the

main plate 301 and the upper pivot 305d is rotatably supported by a hole in the gear train bridge 302.

5 A fifth wheel and pinion 306 is constituted by one integral member comprising a fifth gear 306a for engaging with the pinion of a rotor 308, a fifth pinion 306b for engaging with the fourth gear 304a, a lower pivot or bearing portion 306c and an upper pivot or bearing portion 306d. The third wheel and pinion 305, and fourth wheel and pinion 304, and the fifth wheel and pinion 306 are formed by the
10 forging and compressing techniques referred to above except for the tooth profiles of the gears which are formed by press blanking. However, the centre hole 304e of the fourth wheel and pinion 304 is formed by press blanking, so that the diameter of the centre hole 304e is less than that of the
15 recess portion 304c which is formed by forging. Since the finished surface of the pivot portions are not adversely affected by press blanking and are constituted by the smooth surfaces, a timepiece wheel can be manufactured having less torque loss.

20 Thus each of the gears and pinions 304, 305, 306 has a plurality of portions which are integral with each other and which are formed by plastic working, namely a pinion portion, bearing portions on opposite sides of the latter, and a gear wheel portion, the teeth of the gear wheel

portion being formed by forging, compressing or shearing.

Figure 9 is an illustration showing the tooth profile of the pinion of each wheel shown in Figures 2 and 8. It is desirable that none of the teeth (which may be six in number) should be independent of the others in order to make it easy to perform the forging or compressing. It is also desirable that the tooth thickness at the root of each tooth is either equal to that at the edge of the tooth or that the tooth thickness at the root of the tooth should be larger than that at the edge portion of the tooth in order to make the material of the pinion flow easily. It is further desirable that an appropriate curve 305h is provided at the connecting portion between the upper surface of the base or bearing portion 305a of the gear and the pinion portion 305b; that an appropriate curve 305h is provided at the connecting portion between the upper pivot 305d and the base of the portion 305a; that an appropriate curve 305e is provided at the connecting portion between the lower pivot 305f and the pinion 305b; and that an appropriate curve 305g is provided at the gear portion of the pinion, as shown in Figure 10, in order to make the material flow easily. This is the same in the other embodiments.

Figure 11 is a sectional view showing another construction of a timepiece wheel as used in Figures 2 and 8. In Figure 11, the third wheel and pinion 305 is shown

merely as one example. Since the manufacturing method is the same as that mentioned above, it is not described further.

The third wheel and pinion 305 comprises the third gear 305a, third pinion 305b, lower pivot 305c and upper pivot 305d. The third pinion 305b includes a taper θ . This taper is provided so that the pieces may be taken off from the pattern easily after the forging or compressing, and the angle θ is preferably between 0.1° and 3° . In particular, if the third pinion 305b has a pinion height n equal to or more than 0.4mm, by providing the taper θ , it is possible to stabilise the quality.

A shoulder portion 305j reduces the contact resistance of the bearing and so on. Such a shoulder portion can also be provided on the side of the lower pivot 305c.

The recessed portions 5e and 6c shown in Figure 2 make it easy to achieve the projection of the pivots 5d and 6d at the time of forging or compressing. It is desirable that the depth of these recessed portions should be greater than the thickness T of the gear portions.

The provision of the upper pivot 306d of the fifth wheel and pinion 306 shown in Figure 8 makes it easy for the lower pivot 306c to project at the time of forging or compressing and makes it easy to push the

material to the edge of the pinion teeth. Further, it is desirable that the depth s of upper pivot 306d should be less than the height of the fifth pinion 306b, thereby preventing damage to the die at the time of forging or
5 compressing and making mass production easier. Furthermore, it is desirable that the volume of the upper pivot 306d should be less than that of the lower pivot 306c, thereby rendering it easy to secure the required quality.

The Figure 8 construction comprises a minute wheel
10 and pinion 316. The latter comprises a minute gear 316a, a minute pinion 316b, a lower pivot 316c between the gear 316a and the pinion 316b, and an upper pivot 316d formed integrally of metal material. Although not shown in Figure 8, the minute pinion 316b engages with an
15 hour wheel, and the minute gear 316a engages a centre pinion at all times. The height of the minute pinion 316b is less than the length h from the top surface of the minute gear 316a to the top of the pinion 316b. As a result, the lower pivot 316c can be given a cylindrical shape,
20 and in particular, it is possible to achieve forging or compressing easily when the length of pinion portion is very long.

In Figure 12, an end face of the pinion portion of the fifth wheel and pinion 306 has a flat portion 306h, one portion of which is a shoulder surface, the other portion thereof being formed by a circular arc 306i or by a sloping surface, thereby reducing the contact resistance when the pinion turns between the main plate and the gear train bridge. It is possible to combine the above-mentioned embodiments, thereby improving the quality of manufacturing.

Figures 13(a) and (b) are respectively plan and sectional views illustrating the manufacture of a timepiece wheel and pinion by plastic working. As one example of such a timepiece wheel and pinion, the third wheel and pinion 5 of Figure 2 is used for explanation. The die to form the wheel and pinion is referred to later in connection with Figure 16.

Step 1: a strip member 30 is inserted into a die, and pilot holes 31 and 32, which act as guide holes for effecting positioning in the following process, are formed in the strip member 30.

Step 2: a compressive load is applied to one portion of the strip member 30 (over an area larger than that of the gear 5a) from both the front and back surfaces, thereby reducing the thickness of the strip member 30 in this area so as to form a flange. Further, the greater

part of the material of the portion which is made thin projects downwardly to form the pinion 5b and the lower pivot 5d, thereby obtaining a desirable gear tooth profile and lower pivot (this is referred to as forging or compressing). Furthermore, the provision of the recess portion 5e, which becomes the upper pivot, makes it easier to form the downwardly projecting lower pivot 5d. Since the surface of the recess portion 5e, the lower pivot 5d, and the pinion 5b can be formed very smoothly by making the finishing surface of the die smooth, it is possible to form a timepiece wheel having a very small torque loss at the pivot portion and at the gear portion.

Step 3: The gear 5a is removed from the strip member 30 by shearing, thereby completing the third wheel and pinion. The above processing is the same as that in the other embodiments (except for the fourth wheel and pinion).

Figure 14 is a sectional view showing another embodiment of a gear train bridge. A stator 407 has a shaft portion 407c. A fifth wheel and pinion 406 is manufactured by the processing method as explained with reference to Figure 13, wherein the fifth wheel and pinion 406 does not include the upper pivot and the recess portion 406c which acts as the lower pivot which is supported by the shaft portion 407c. The degree of looseness of the fifth wheel and pinion 406 is determined by the gear train bridge 402 and

the stator 407. As the stator 407 is one of the members supporting the shaft portion 407c, the stator 407 is referred to here for the purposes of explanation. However, other members, for example the main plate, can be used for such supporting. Further, the recess portion 406c can be replaced by a through hole, and the length of the shaft portion 407c is arranged to be that of the gear thickness of the fourth wheel 404 engaging with fifth wheel and pinion 406 or more than that.

Figure 15 is a sectional view of a fifth wheel and pinion according to a further embodiment of the present invention. Figure 16(a) is a plan view illustrating a process for forming the bearing portion and pinion of the said fifth wheel and pinion by forging or compressing and the process for forming the teeth profiles of the gear by shearing. Figure 16(b) is a sectional view of the structure shown in Figure 16(a) and a simplified sectional view showing the greater part of a die used in the forging or compressing and shearing. Figure 17 is a sectional view illustrating one way of supporting a timepiece wheel according to the present invention. Figure 18 is a simplified sectional view of another die which may be used in the forging or compressing.

In Figure 15 there is shown a fifth wheel and pinion 206 which is formed by the following process. The fifth wheel and pinion 206 comprises a gear or flange portion 306e having gear teeth 206a for engaging a rotor; a fifth pinion 206b; a shaft portion 206f; and bearings 206d and 206c which are adapted to be supported by a gear train bridge and by a dowel of a main plate respectively. A burr 206g may be formed on the upper surface of the pinion 206b and on the lower surface of the shaft portion 206f. The burr 206g is not always formed, but sometimes occurs as a result of the processing conditions or the die manufacturing.

As shown in Figure 16, the fifth wheel and pinion 206 may be formed as follows:-

Step 1: a strip member 230 is inserted into a die, and pilot holes 231 and 232 are formed in the strip member 230 which become reference holes for positioning the strip member 230 in the following process.

Step 2: a compressive load is applied to one portion of the strip member 230 (over an area larger than that of the gear portion 206e and its teeth 206a) from both the front and back surfaces, thereby reducing the thickness of the strip member 230 in this area, as a result of which the gear portion 206e can be formed. The greater part of the material

of the portion of the strip member which has been so thinned is forced downwardly, thereby forming the fifth pinion 206b, shaft portion 206f, and bearings 206c and 206d.

The fifth wheel and pinion 206 is thereby given its desired shape except for the profiles of the teeth 206a. This processing is referred to as forging or compressing.

Further, the provision of the bearing portion 206d ensures that there is sufficient material to form the upper surface of the pinion 206b and that this upper surface, which would otherwise be difficult to make, can be easily formed.

Furthermore, since the fifth pinion 206b, bearing portions 206c and 206d and so on can be given very smooth surfaces by making the finished surface of the die smooth, it is possible to produce a timepiece wheel and pinion having a very small torque loss at its bearing portion and at the portion where it engages another part.

Step 3: the gear portion 206e with its teeth 206a is removed from the strip member 230 by shearing to form the fifth wheel and pinion 206.

In addition thereto, the fifth gear portion 206e can be given a circular shape by rolling. The fifth wheel and pinion 206 may be formed from iron, copper alloy, aluminium, super plastic material such as super plastic aluminium (for example, Cu-77.5%, Al-10%, Fe-4.5%, Ni-6%, Mn-2%), super plastic titanium alloy, super plastic stainless

steel alloy and so on. If the fifth wheel and pinion 206 is processed by upsetting, a copper alloy, aluminium, and a super plastic alloy can be used, super plastic material being the most desirable.

5 In the forging or compressing illustrated in Figure 16(b), an ejector 221, which forms the blind hole 206c, is inserted into a lower die 220. The fifth pinion teeth profiles of an upper die 223 are formed by an electric discharge machine, cutting and so on.

10 An ejector 224, having mostly the same configuration, is inserted into the portion of the upper die 223 which forms the pinion. A pin 225 for forming the blind hole 206d is inserted into the ejector 224. The pin 225 is fixed to the ejector 224. The ejectors 221 and 224 have

15 the purpose of ejecting articles which remain in the upper or lower dies 223 and 220 after the forging or compressing. Since the gear portion 206e will be destroyed or damaged if the gear portion 206e is pushed by a large ejecting force, it is arranged that the ejection

20 is achieved within the outer diameter of the pinion where the gear portion 206e is strongest. Further, a slight gap is provided between the ejector 221 and the lower die 220, and between the ejector 224 and the upper die 223, respectively. These gaps make the filling

of material into the die easier in the course of the forging or compressing, when the sum of the pinion height l_1 and the height of the shaft portion 206f is at least two and a half times the thickness t of the gear portion 206e. In particular

5 at the time of forging or compressing, these gaps act as openings for permitting the escape of air or oil and so on which exist in the space for forming the fifth pinion 206b and the shaft portion 206f. Since a very large force is applied to effect such forging or compressing, the use of

10 cemented carbide is desirable as the material for the dies. Next, in the shearing, a punch or drift 228, which forms the tooth profiles of the fifth gear teeth 206a, moves downwardly to effect the shearing of the tooth profiles of the fifth gear teeth 206a, thereby completing the fifth wheel

15 and pinion 206.

In Figures 17(a) and (b), there is shown a timepiece movement comprising a main plate 201 and a gear train bridge 202. A centre wheel and pinion 203 comprises a centre gear 203a and a centre pinion 203b. Slipping can occur at a

20 predetermined slide torque between the centre gear 203a and the centre pinion 203b. A fourth wheel and pinion 204 comprises a fourth gear having teeth 204a, a fourth pinion 204b, and a recess portion 204c which are integrally formed of metal. The centre hole and the teeth

profiles 204a of the fourth wheel and pinion 204 are cut by press shearing in the following process, a fourth shaft 204d being fixed in the said centre hole. The centre wheel and pinion 203 is rotatably supported by an annular flange portion 201a of the main plate 201 and by two
5 projections or bearing portions on the shaft of the fourth wheel and pinion 204 which is mounted on the centre wheel and pinion 203. The fourth wheel and pinion 204 is supported by the annular flange portion 201a by way of the centre wheel and pinion 203 and by a pivot hole 202a in the gear train bridge
10 202. The degree of looseness of the centre wheel and pinion 203 and of the fourth wheel and pinion 204 is determined by the main plate 201 and gear train bridge 202.

A third wheel and pinion 205 comprises a third pinion 205b for engaging the centre gear 203a; a third gear
15 portion 205a for engaging the fourth pinion 204b; a shaft portion 205e; a bearing portion 205c; and an upper pivot 205d, all these portions being formed integrally of metal. In the third wheel and pinion 205, the bearing portion 205c
20 is rotatably supported by a dowel or boss 201s of the main plate 201. The upper pivot 205d is rotatably supported in a hole in the gear train bridge 202. The degree of looseness thereof is determined by the bottom

surface of the bearing portion 205c, the upper surface of the dowel 201s, the surface of a shoulder portion 205g, and the gear train bridge 202. Although the lower surface of the third pinion 205b may have a burr, an appropriate gap is provided so that the burr does not contact the upper surface of the main plate 201.

A fifth wheel and pinion 206 comprises a fifth gear portion having teeth 206a for engaging the pinion of a rotor 208; a fifth pinion 206b for engaging the fourth gear 204a; bearing portions 206c and 206d; and a shaft portion 206f, all these portions being formed integrally. The bearing portion 206c is rotatably supported by a dowel 201t of the main plate 201, and the bearing portion 206d is rotatably supported by a dowel 202s of the gear train bridge 202. The degree of looseness of the fifth wheel and pinion 206 is determined by the bottom surface of the bearing portion 206c, the upper surface of the dowel 201t, the bottom surface of the bearing portion 206d, and the lower surface of the dowel 202s. Further, although a burr may occur on the upper surface of the fifth pinion 206b and on the lower surface of the shaft portion 206f, a predetermined gap is provided so that the burrs do not contact the gear train bridge 202 and the main plate 201. The

distance L between the bearings of the fifth wheel and pinion 206 is at least twice as large as the axial length ℓ_1 of the pinion 206b so that any tilting of the fifth wheel and pinion 206 will be small.

5 A minute wheel 216 comprises a minute gear 216a for engaging the centre pinion 203b, a minute pinion 216b for engaging an hour wheel 217, a lower pivot 216c, an upper pivot 216d and a shaft portion 216e, the method of making the minute wheel 216 being the same as that of the fifth
10 wheel and pinion 206. However, the body of the timepiece will be thick if the minute portion 216b has a burr portion, the nature of the process being such that it is difficult to form a burr of predetermined dimensions. Consequently, it is arranged that the burr is destroyed during the forging or compressing and
15 shearing. The portion where the burr 216f is destroyed may make the outside diameter of the gear larger than the teeth profiles throughout the circumference or at one portion of the pinion teeth profiles. Therefore, the backlash and clearance and so on are set to appropriate values such that
20 the destroyed burr portion 216f engages the hour wheel 217. The burr of the fourth pinion 204b can be treated by the same method as that of the minute pinion 216b. The burr portion 204f is prevented from engaging the third gear 205a so as to control drifting of the seconds hand. Further,
25 the pinion shape of the fourth wheel and pinion 204 is such that the latter can be easily assembled.

Figure 18 is an illustration of another embodiment showing a lower die 240 which may be used in the forging or compressing. As the upper die is the same as that shown in Figure 16, reference to it is omitted. The lower die 240 is provided with a through hole having a cylindrical portion, the through hole being formed by electrical discharge processing. An ejector 241 is inserted into the said through hole. The cylindrical portion forms the shaft portion 206f and the ejector 241 forms a lower pivot 206h at the bottom of the shaft portion 206f. The occurrence of a burr between the ejector 241 and the through hole in the forging or compressing is prevented by controlling the space (pivot height) for forming the pivot 206h.

The ejector shown in Figures 16 and 17 can be provided on one of both of the upper and lower dies. Further, the pin 225 can be moved upwardly when the upper pivot is formed in a manner corresponding to the formation of the lower pivot of Figure 18. In the forging or compressing described above, a strip member is used merely for purposes of explanation. However, a blank which is a bar member cut to a predetermined length can be processed by upsetting. Thus, by employing such as a process right up to the teeth profiles of the gear, low material costs can be achieved.

Although the specific description of the present invention has referred to a timepiece wheel having both a pinion and a gear wheel portion, the present invention is also applicable to a timepiece wheel having a pinion without a gear wheel .
5 portion. For example, the pinion may be formed by shearing at a diameter having slightly larger than the pinion outer diameter or by processing by upsetting.

Furthermore, although the fifth wheel and pinion has been used for purposes of explanation in the various embodiments,
10 the invention can also be applied to other timepiece wheels.

As mentioned above, the bearing portion and the pinion portion of the timepiece wheel are formed by forging or compressing, thereby achieving a very smooth surface of the bearing portion and pinion portion, and reducing the torque
15 loss at the bearing portion and so on. It is therefore possible to connect such a timepiece wheel and pinion having a small torque to the front gear train. In view of the die structure, the length of supporting portions of the timepiece wheel and pinion is sufficient to permit gear overlap so as to achieve
20 a thin timepiece.

A timepiece having such wheels and pinions formed integrally by metal material in their deceleration or acceleration gear trains has timepiece members of adequate strength, and the processing time can be substantially reduced,

the processing time being, for example, 0.5 second, because
all the processes are achieved by plastic working. Further,
the tooth profiles of the pinion may have a taper configuration,
and a curvature may be employed at the connecting portion
5 of the pinion and wheel and at connecting portion of the pivot
and gear, thereby improving the flow of material in the
forging or compressing, and further thereby increasing the
height of pinion sufficiently. A taper or draft may be formed
on the pinion portion, thereby improving detachability and
10 quality.

C L A I M S

1. A timepiece gear member comprising at least one bearing portion, which is adapted to be supported by a frame, a pinion portion, and a gear wheel portion, the bearing, pinion and gear wheel portions being made from a common metal plate member
5 by plastic working so as to be integral with each other.
2. A timepiece gear member as claimed in claim 1 in which the bearing, pinion and gear wheel portions are formed by forging, compressing, shearing or bending, the teeth of the gear wheel portion being formed by forging, compressing or shearing.
- 10 3. A timepiece gear member as claimed in any preceding claim in which there are two bearing portions on opposite sides respectively of the pinion portion.
4. A timepiece gear member as claimed in any preceding claim in which the gear wheel portion has a substantially
15 larger diameter but a smaller axial thickness than the pinion portion.
5. A timepiece gear member as claimed in any preceding claim in which the said at least one bearing portion is
20 constituted by a recess or a projection.
6. A timepiece gear member substantially as hereinbefore described with reference to and as shown in the accompanying drawings.
7. A timepiece provided with at least one timepiece
25 gear member as claimed in any preceding claim.



8. A method of making a timepiece gear member comprising employing plastic working to form the timepiece gear member with a pinion portion, at least one bearing portion, and a gear wheel portion from a common metal plate member so as to be integral with each other.

9. A method as claimed in claim 8 in which the bearing, pinion and gear wheel portions are formed by forging, compressing, or shearing, the teeth of the gear wheel portion being formed by forging, compressing or shearing.

10. A method as claimed in claim 8 or 9 in which the plastic working is effected by a die, the finished timepiece gear member being ejected from the die by means of an ejector disposed radially inwardly of the teeth of the pinion portion.

11. A method of making a timepiece gear member substantially as described with reference to the accompanying drawings.

