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(54) **MANUFACTURING METHOD OF GEARS FOR A SPEED CHANGE DEVICE AND ITS APPARATUS**

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(57) **ABSTRACT**

[Problems] To present a manufacturing method of gears for a speed change device, capable of manufacturing gears for a speed change device by using a manufacturing apparatus, small in the load when forming, and small and simple in structure, and capable of obtaining gears for a speed change device not limited in gear deforming positions, small in generation of strain, and large in strength.

[Solving Means] Having a large end and a small end forming a revere-tapered tooth part S on an outer circumference thereof, to spline teeth S of an intermediate material W having the small end provided in a rim of the large end thereof, a plurality of dies **21** having a radial shape and an inclination angle θ to a gear axial line L**1** and slidably holding to an inclined axial line L**2** on a holding member **22** are slid from outside of the radiation direction toward the center by a pushing cam mechanism **23**, and thereby pushing the reverse-tapered blade part **21***a* formed at the leading end of the die **21**, and the spline teeth S are formed in the reverse-tapered tooth part **12***a*, and the die **21** is slid by an extracting mechanism **24** from the center of the radiation direction toward the outside along the inclined axial line L**2**.

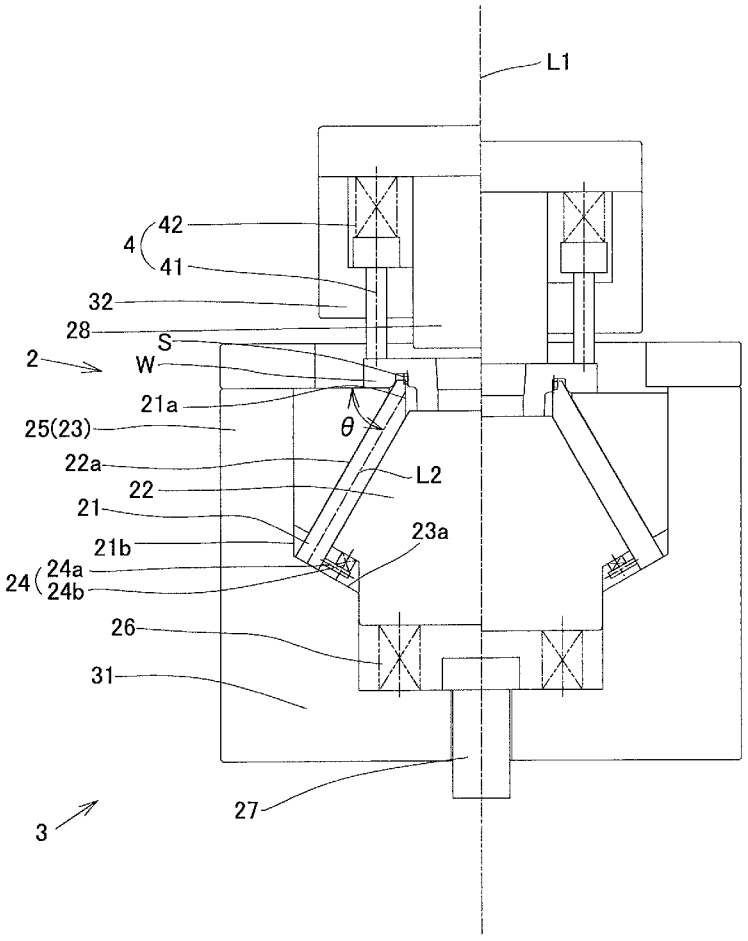


FIG. 1

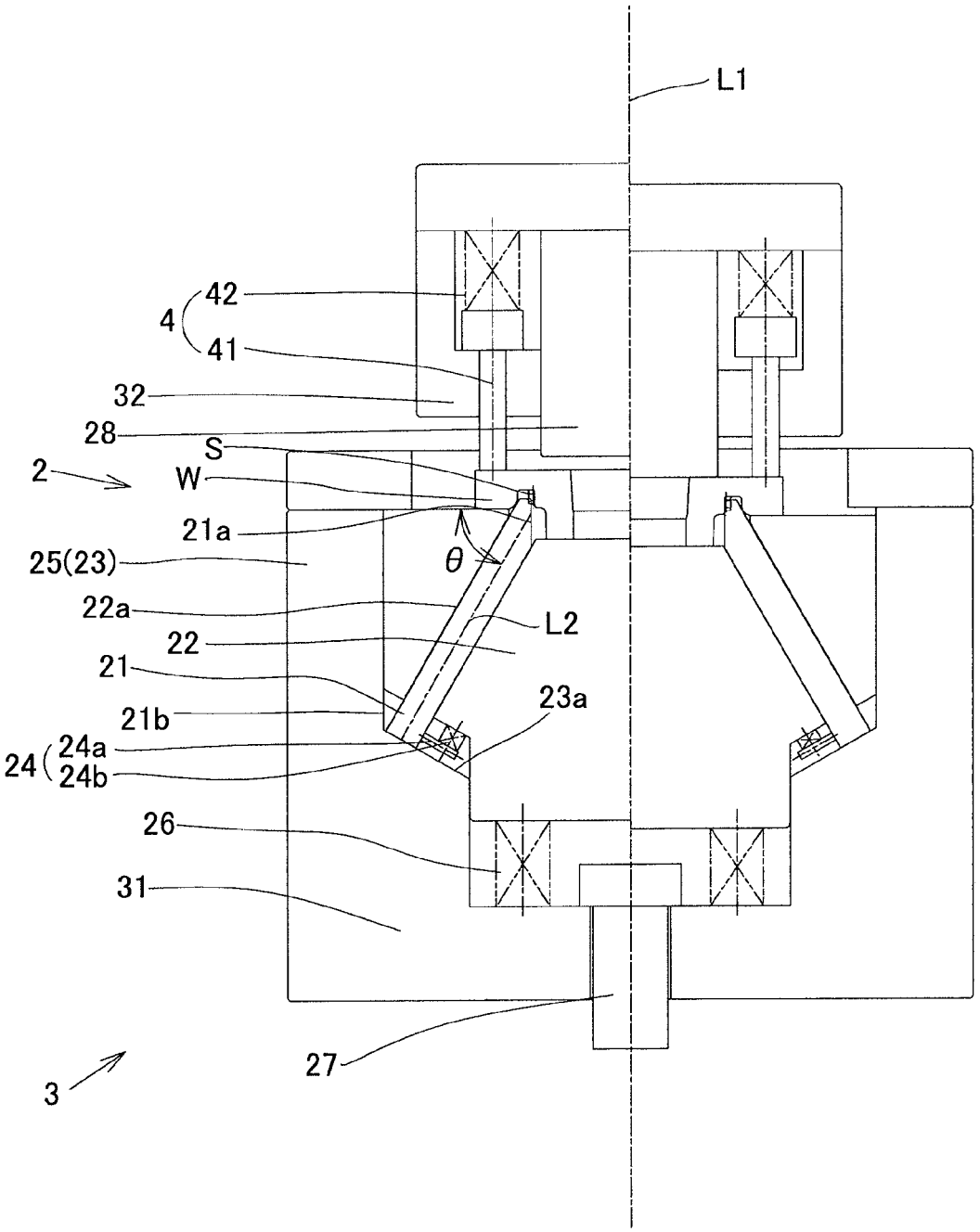

L1
42
4
41
32
28
S
2
W
21a
θ
25(23)
22a
L2
22
21
23a
21b
24a
24
24b
26
31
27
3

FIG. 2(C)

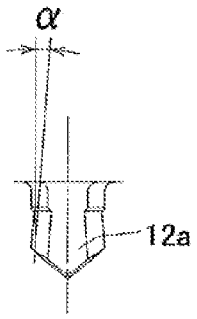


FIG. 2(A)

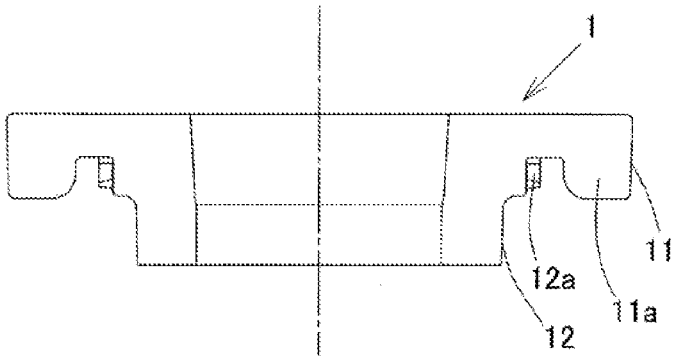


FIG. 2(D)

FIG. 2(B)

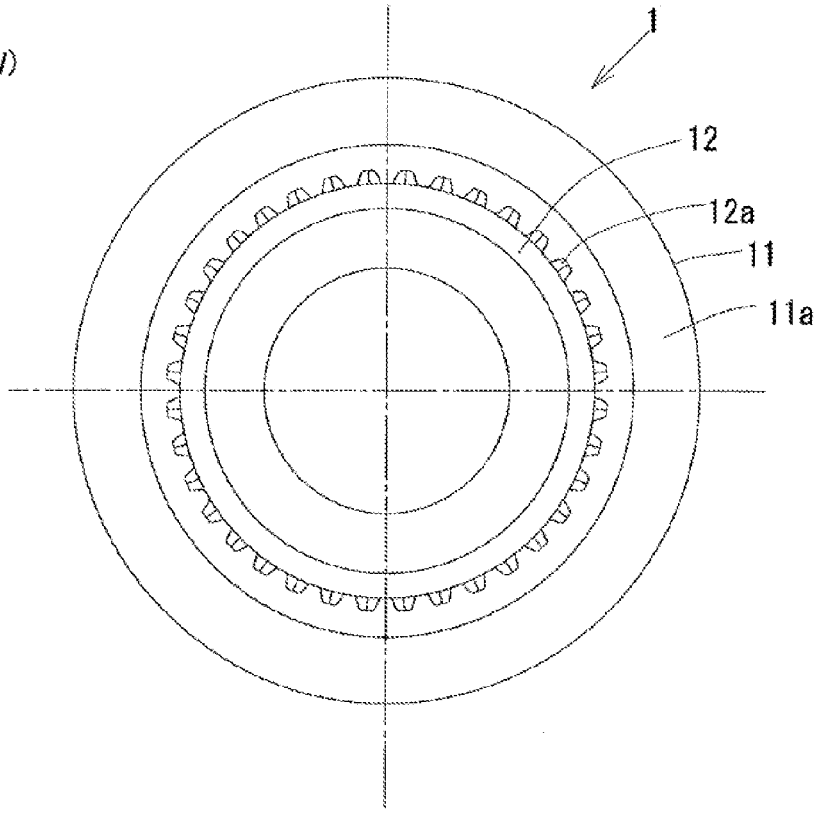


FIG. 3(A)

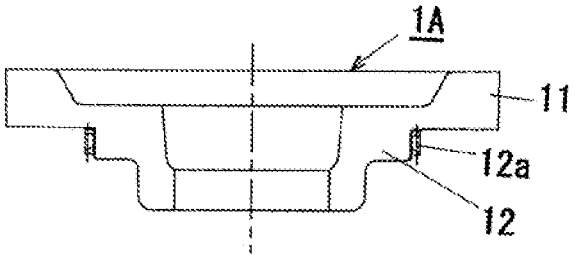


FIG. 3(B)

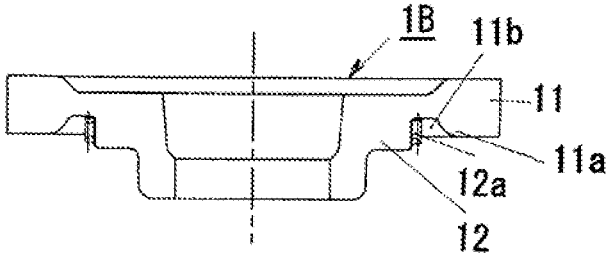
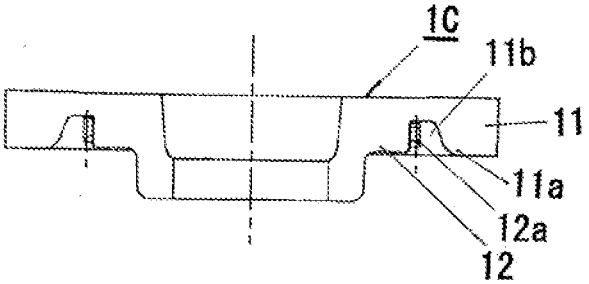


FIG. 3(C)



MANUFACTURING METHOD OF GEARS FOR A SPEED CHANGE DEVICE AND ITS APPARATUS

TECHNICAL FIELD

[0001] The present invention relates to a manufacturing method of gears for a speed change device and its apparatus, and more particularly to a manufacturing method of gears for a speed change device having a large end and a small end forming teeth with a reverse taper on an outer circumference thereof, and having the small end provided in a rim of the large end and its apparatus.

BACKGROUND ART

[0002] Conventionally, as shown in FIG. **3** (*a*), comprising a large end **11** and a small end **12** used in a synchro-mesh mechanism, a reverse-tapered tooth part **12***a* is formed on the outer circumference of the small end **12** to compose a gear **1**A for a speed change device, separate large-end gear and small-end gear are integrated by electron beam welding or spline fitting means, and an integral structure is formed by forging or the like (see, for example, patent document 1).

[0003] In particular, the gears integrated by electron beam welding require an assembling process, and adverse effects due to welding strain may be considered, or in the case of the gears integrated by spline fitting means, an assembling process is needed, and splines must be formed, and the spline forming process is complicated, and generally the gears are integrally formed by forging.

[0004] On the other hand, from the viewpoint of downsizing and compact design of an automobile, as shown in FIGS. **3** (*b*) and (*c*), for reduction of thickness, a small end **12** forming a reverse-tapered gear part on the outer circumference is provided in a rim **11***a* of a large end, and gears **1**B, **1**C for a speed change device of so-called sink type are widely employed.

[0005] Incidentally, since the reverse-tapered tooth part **12***a* is formed by a die which projects horizontally from the outside of the radiation direction toward the center, out of such sink type gears **1**B, **1**C, as shown in FIG. **3** (*b*), in the case of the gear **1**B smaller in the degree of sink, and larger in the groove width of an annular groove **11***b* formed between the reverse-tapered tooth part **12***a* and the rim **11***a*, by using a hook-shaped die bent so as to avoid the rim **11***a*, it is possible to form integrally by forging, but as shown in FIG. **3** (*c*), in the case of the gear **1**C smaller in the groove width of an annular groove **11***b* formed between the reverse-tapered tooth part **12***a* and the rim **11***a*, and larger in the degree of sink in order to reduce the thickness, it was impossible to form by forging.

[0006] To solve this problem, a new manufacturing method of gears for a speed change device is proposed, in which a large end and a small end are overlapped in a stepped doughnut shape, a reverse-tapered tooth part is formed on the outer circumference of the small end to manufacture a primary formed part, and a range excluding the small end including the reverse-tapered tooth part, and the rim forming portion at the large end continuous to the small end is confined, and the peripheral wall thickness at the large end is extruded to the small end side, and by this extruded wall thickness portion, a rim surrounding the small end concentrically is formed (see, for example, patent document 2), but since a large load is generated when extruding the peripheral wall thickness at the large end toward the small end side, the manufacturing apparatus becomes larger in size, and deformation of gears is deviated locally, and strains are likely to occur in the gears.

PRIOR ART DOCUMENTS

Patent Documents

[0007] [Patent document 1] Japanese Patent Application Laid-Open No. 52-61162

[0008] [Patent document 2] Japanese Patent Application Laid-Open No. 2002-113543

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0009] The present invention is devised in the light of solving the problems of the manufacturing method of gears for a speed change device discussed above, and it is hence a primary object thereof to present a manufacturing method of gears for a speed change device and its apparatus capable of manufacturing gears for a speed change device by using a manufacturing apparatus small in load when forming, and small and simple in structure, and capable of obtaining gears for a speed change device not localized in gear deformation positions, small in generation of strain due to fluidization of metal texture, and large in strength.

Means for Solving the Problems

[0010] To achieve the object, the manufacturing method of gears for a speed change device of the invention relates to a manufacturing method of gears for a speed change device having a large end and a small end forming a revere-tapered tooth part on an outer circumference thereof, and having the small end provided in a rim of the large end, in which the small end has spline teeth parallel to the gear axial line provided in the large end and the outer circumference, and a plurality of dies slidably held along an inclined axial line in a holding member having a radial shape and an inclination angle to the gear axial line are, to the spline teeth of an intermediate material with the small end provided in the large end, slid from the outside of the radiation direction toward the center along the inclined axial line by a pushing cam mechanism, thereby pushing in a reverse-tapered blade part formed at the leading end of the dies, and spline teeth are formed in the reverse-tapered tooth part, and the dies are slid from the center of the radiation direction toward the outside along the inclined axial line by an extracting mechanism.

[0011] The manufacturing apparatus of gears for a speed change device of the invention is a manufacturing apparatus of gears for a speed change device having a large end and a small end forming a revere-tapered tooth part on an outer circumference thereof, and having the small end provided in a rim of the large end, including a die forming a reverse-tapered blade part at a leading end, a holding member for holding a plurality of the dies slidably along an inclined axial line having a radial shape and an inclination angle to the gear axial line, a pushing cam mechanism having a small end forming spline teeth in the large end and the outer circumference parallel to the gear axial line, for pushing the reverse-tapered blade part formed at a leading end of the dies, by sliding the small end to the spline teeth of an intermediate material provided in the rim of the large end, thereby forming the spline teeth in the reverse-tapered tooth part, and an

extracting mechanism for sliding the dies from the center of the radiation diction toward the outside along the inclined axial line.

[0012] In this case, a provisional holding mechanism may be provided, that is, the intermediate material is provisionally held so as to be rotatable on the gear axial line, so that the spline teeth of the intermediate material and the reverse-tapered blade part formed at the leading end of the dies can be positioned.

Effects of the Invention

[0013] According to the manufacturing method of gears for a speed change device and its apparatus of the invention, having a large end and a small end forming a revere-tapered tooth part on an outer circumference thereof, to spline teeth of an intermediate material having the small end provided in a rim of the large end, a plurality of dies slidably held along an inclined axial line in a holding member having a radial shape and an inclination angle to the gear axial line are slid from the outside of the radiation direction toward the center along the inclined axial line by a pushing cam mechanism, thereby pushing in a reverse-tapered blade part formed at the leading end of the dies, and spline teeth are formed in the reverse-tapered tooth part, and the dies are slid from the center of the radiation direction toward the outside along the inclined axial line by an extracting mechanism, and therefore by using a manufacturing apparatus (press apparatus) small in the load when forming, small in size, and small and simple in structure, the gears for a speed change device can be manufactured, and the gear deformation positions are not limited locally, generation of strain is small, and the gears for a speed change device large in strength can be obtained.

[0014] In addition, by employing a provisional holding mechanism for positioning the spline teeth of an intermediate material and the reverse-tapered blade part formed at a leading end of the dies, by holding the gear axial line provisionally so as to be rotatable on the center, the spline teeth of an intermediate material and the reverse-tapered blade part formed at a leading end of the dies can be positioned easily.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is an explanatory diagram showing an embodiment of a manufacturing apparatus of gears for a speed change device of the invention.

[0016] FIGS. **2**(A)-**2**(D) are explanatory diagrams showing gears for a speed change device manufactured by a manufacturing method of gears for a speed change device of the invention, in which FIG. **2**(A) is a sectional view of gears for a speed change device, FIG. **2**(B) is its bottom view, FIG. **2**(C) is a magnified view of a reverse-tapered tooth part of the gears for a speed change device, and FIG. **2**(D) is a magnified view of spline teeth of an intermediate material.

[0017] FIGS. **3**(A)-**3**(C) are explanatory diagrams showing various gears for a speed change device.

BEST MODE FOR CARRYING OUT THE INVENTION

[0018] Embodiments of a manufacturing method of gears for a speed change device and its apparatus of the invention are specifically described below by referring to the accompanying drawings.

[0019] FIG. **1** shows an embodiment of a manufacturing apparatus of gears for a speed change device of the invention.

[0020] This manufacturing apparatus **2** of gears for a speed change device includes, as shown in FIG. **2**, a large end **11** and a small end **12** forming a reverse-tapered tooth part **12***a* on an outer circumference thereof, and is designed to manufacture gears **1** for a speed change device having the small end **12** provided in a rim **11***a* of the large end **11**, and in particular it is preferably used for manufacture of the gears **1** for a speed change device (gears **1**C for a speed change device shown in FIG. **3** (*c*)) small in the groove width of an annular groove **11***b* formed between the reverse-tapered tooth part **12***a* (reverse taper angle a: approx.. 3° to 5°) and the rim **11***a,* and large in groove depth (degree of sinking) for the sake of reduction of thickness.

[0021] The manufacturing apparatus **2** of gears for a speed change device includes a die **21** forming a reverse-tapered blade part **21***a* at a leading end, a plurality of (usually same as the number of grooves formed in the reverse-tapered tooth part **12***a* formed in the small end **12**) holding members **22** having a radial shape and an inclination angle θ to a gear axial line L**1** for holding slidably to an inclined axial line L**2**, a large end and a small end forming spline teeth S parallel to the gear axial line on an outer circumference, and also includes a pushing cam mechanism **23** for sliding the die **21** from the outside of the radiation direction toward the center along the inclined axial line L**2**, to the spline teeth S of the intermediate material W having this small end provided in the rim of the large end, and thereby pushing the reverse-tapered blade part **21***a* formed at the leading end of the die **21**, and forming the spline teeth S in the reverse-tapered tooth part **12***a*, and an extracting mechanism **24** for sliding the die **21** from the center of the radiation direction toward the outside along the inclined axial line L**2**.

[0022] In this case, the die **21** forming the reverse-tapered blade part **21***a* at the leading end is shaped like a bar, and is held by the holding member **22** so as to contact between a rear end face **21***b* and an inclined cam face **23***a* of the pushing cam mechanism **23**.

[0023] The holding member **22** has a plurality of dies **21** (usually same as the number of grooves formed in the reverse-tapered tooth part **12***a* formed in the small end **12**) provided in holding holes **22***a* having a radial shape and an inclination angle θ to a gear axial line L**1** for holding slidably to an inclined axial line L**2**, and is designed to be divided along the holding holes **22***a*.

[0024] This holding member **22** is installed movably in a tubular guide member **25** in the vertical direction, with the die **21** held in the holding holes **22***a,* and is supported on a lower platform **31** of a press device **3**, by way of an elastic support mechanism **26** made of a spring member (or a hydraulic mechanism), and is pressed by a punch **28** provided in an upper platform **32** of the press device **3** through an intermediate material W, and is moved downward by resisting the thrusting force of the elastic support mechanism **26**.

[0025] Incidentally, the size of the inclination angle θ (the inclination angle of the inclined axial line L**2** to the horizontal plane) is determined by the shape of the gear **1** for a speed change device, but specifically it is determined by various factors such as the size of the gear **1** for a speed change device, the groove width and groove depth of the annular groove **11***b* formed between the reverse-tapered tooth part **12***a* and the rim **11***a* (including the degree of sinking), and the tooth length of the reverse-tapered tooth part **12***a,* but as the size of the gear **1** for a speed change device becomes smaller, or as the groove width of the annular groove **11***b* formed between the reverse-

tapered tooth part **12***a* and the rim **11***a* becomes narrower, or as the groove depth (the degree of sinking) becomes deeper, or as the tooth length of the reverse-tapered tooth part **12***a* becomes longer, the inclination angle θ must be set larger.

[0026] However, as the inclination angle θ becomes larger, a greater pressing force of the press device **3** is needed for forming the spline teeth S of the intermediate material W in the reverse-tapered tooth part **12***a*, and at the same time it is required to increase the strength of the materials of the die **21**, holding member **22**, the guide member **25**, and others.

[0027] Accordingly, it is preferable to set the inclination angle θ as small as possible depending on the shape of the gear **1** for a speed change device, and it is more preferable to set at 70° or less at most (60° in this embodiment). Meanwhile, the minimum value of the inclination angle θ is not particularly specified, but if the inclination angle θ is less than 15°, the gear **1** for a speed change device in an applicable shape can be usually manufactured by employing a conventional manufacturing method.

[0028] The pushing cam mechanism **23** pushes the holding member **22** to move downward by a punch **28** of the press device **3** by way of the intermediate material W, the die **21** is slid from the outside of the radiation direction toward the center along the inclined axial line L**2**, with respect to the spline teeth S of the intermediate material W, and the reverse-tapered blade part **21***a* formed at the leading end of the die **21** is pushed in, thereby forming the spline teeth S in the reverse-tapered tooth part **12***a*, and therefore, in the embodiment, the inner circumference of a lower part of a guide member **25** installed in a vertical movable direction of the holding member **22** is composed by forming in an inclined cam face **23***a* of a shape reducing in diameter downward, contacting with a rear end face **21***b* off the die **21**.

[0029] The extracting mechanism **24** is for sliding the die **21** from the center of the radiation direction toward the outside along the inclined axial line L**2** after forming the spline teeth S in the reverse-tapered tooth part **12***a* by the moving cam mechanism **23**, and therefore, in the embodiment, it is composed of a knock pin **24***a* planted in a rear part of the die **21**, and a spring member **24***b* for thrusting this knock pin **24***a* from the center of the radiation direction toward the outside.

[0030] The side of the lower platform **31** of the press device **3** is provided with a knock-out pin **27** for pushing up the holding member **22** after forming the spline teeth S in the reverse-tapered tooth part **12***a* by the pushing cam mechanism **23**.

[0031] The side of the upper platform **32** of the press device **3** is provided with a provisional holding mechanism **4** for positioning between the spline teeth S of the intermediate material W and the reverse-tapered blade part **21***a* formed at the leading end of the die **21**, by provisionally holding the intermediate material W so as to be rotatable about the gear axial line L**1**.

[0032] This provisional holding mechanism **4** is composed of a plurality of thin bar-shaped punches **41** disposed at equal angular intervals on the outer circumferential side of the punch **28**, and a spring member **42**.

[0033] Accordingly, prior to fixing of the intermediate material W between the punch **28** and the holding member **22**, the intermediate material W provisionally held so as to be rotatable about the gear axial line L**1** against the holding member **22** by the provisional holding member **4** is automatically rotated by positioning with the reverse-tapered blade part **21***a* formed at the leading end of the die **21**, so that positioning may be easily achieved between the spline teeth S of the intermediate material W and the reverse-tapered blade part **21***a* formed at the leading end of the die **21**.

[0034] Next is explained the manufacturing method of the gear **1** for a speed change device by employing this manufacturing apparatus **2** of gears for a speed change device.

[0035] First of all, comprising a large end and a small end forming spline teeth parallel to the axial line on its outer circumference, an intermediate material W forming the small end in a rim of the large end is prepared, and this intermediate material W is installed in the holding member **22** of the manufacturing apparatus **2** of gears for a speed change device, with the small end forming the spline teeth S set downward.

[0036] In this state, by operating the press device **3**, when the upper platform **32** side is lowered, the intermediate material W is, prior to being fixed between the punch **28** and the holding member **22**, provisionally held so as to be rotatable about the center of the gear axial line L**1** against the holding member **22** by the provisional holding mechanism **4**, and is rotated automatically as being positioned with the reverse-tapered blade part **21***a* formed at the leading end of the die **21**, so that the spline teeth S of the intermediate material W is positioned with the reverse-tapered blade part **21***a* formed at the leading end of the die **21**.

[0037] Further, when the upper platform **32** side is lowered to the spline teeth S of the intermediate material W, the intermediate material W is fixed between the punch **28** and the holding member **22**, and the holding member **22** is pressed by the punch **28** of the press device **3** by way of the intermediate material W and is moved downward, and therefore the plurality of dies **21** held by the pushing cam mechanism **23** so as to be slidable along the inclined axial line L**2** to the holding member **22** having a radial shape and an inclination angle θ to the gear axial line L**1** are slid from the outside of the radiation direction toward the center along the inclined axial line L**2**, and thereby the reverse-tapered blade part **21** a formed at the leading end of the die **21** is pushed into the gap of the spline teeth S, so that the spline teeth S are formed in the reverse-tapered tooth part **12***a*.

[0038] In this manner, after the spline teeth S are formed in the reverse-tapered tooth part **12***a*, the upper platform **32** side is moved upward, and the holding member **22** is pushed up by the action of the elastic support mechanism **26** and the knock-out pin **27**, and at the same time, by the extracting mechanism **24**, the dies **21** are slid from the center of the radiation direction toward the outside along the inclined axial line L**2**, and the reverse-tapered blade part **21***a* extracts the dies **21** pushed into the gap of the spline teeth S.

[0039] As a result, the gear **1** for a speed change device can be manufactured by using the manufacturing apparatus **2** (press device **3**) of small load in forming and small and simple structure, which makes it possible to obtain the gear **1** for a speed change device not limited in gear deformation positions, small in generation of strain, and large in strength.

[0040] Herein, the manufacturing method of gears for a speed change device and its apparatus of the invention are described on the basis of its embodiment, but it must be noted that the invention is not limited to the illustrated embodiment alone, but may be changed and modified in the structure within a scope not departing from its true spirit.

INDUSTRIAL APPLICABILITY

[0041] The manufacturing method of gears for a speed change device and its apparatus of the invention are capable

of manufacturing gears for a speed change device small in load when forming, and small and simple in structure, thereby obtaining gears for a speed change device not limited in the gear deformation positions, small in generation of strain due to fluidization of metal texture, and large in strength, and therefore as shown in FIG. **2**, it is intended to manufacture gears for a speed change device comprising a large end **11** and a small end **12** forming a reverse-tapered tooth part **12***a* on its outer circumference, and having the small end **12** provided in a rim **11***a* of the large end **11**, and in particular, it is preferable for manufacturing the gear **1** for a speed change device (the gear **1**C for a speed change device shown in FIG. **3** (*c*)) small in the groove width of an annular groove **11***b* formed between the reverse-tapered tooth part **12***a* and the rim **11***a,* and large in the groove depth (the degree of sinking) for reduction of wall thickness.

DESCRIPTION OF THE REFERENCE NUMERALS

[0042] **1** gear for a speed change device
[0043] **11** large end
[0044] **11***a* rim
[0045] **12** small end
[0046] **12***a* reverse-tapered tooth part
[0047] **2** manufacturing apparatus of gears for a speed change device
[0048] **21** die
[0049] **21***a* reverse-tapered blade part
[0050] **22** holding member
[0051] **23** pushing cam device
[0052] **24** extracting mechanism
[0053] **25** guide member
[0054] **26** elastic supporting mechanism
[0055] **27** knock-out pin
[0056] **28** punch
[0057] **3** press device
[0058] **31** lower platform
[0059] **32** upper platform
[0060] **4** provisional holding mechanism
[0061] L**1** gear axial line
[0062] L**2** inclined axial line
[0063] θ Inclination angle
[0064] W intermediate material
[0065] S spline teeth

1. A manufacturing method of gears for a speed change device, being a manufacturing method of gears for a speed change device comprising a large end and a small end forming a revere-tapered tooth part on an outer circumference thereof, and having the small end provided in a rim of the large end, wherein the small end has spline teeth parallel to the gear axial line provided in the large end and the outer circumference, and a plurality of dies slidably held along an inclined axial line in a holding member having a radial shape and an inclination angle to the gear axial line are, to the spline teeth of an intermediate material with the small end provided in the large end, slid from the outside of the radiation direction toward the center along the inclined axial line by a pushing cam mechanism, thereby pushing in a reverse-tapered blade part formed at the leading end of the dies, and spline teeth are formed in the reverse-tapered tooth part, and the dies are slid from the center of the radiation direction toward the outside along the inclined axial line by an extracting mechanism.

2. A manufacturing apparatus of gears for a speed change device, being a manufacturing apparatus of gears for a speed change device having a large end and a small end forming a revere-tapered tooth part on an outer circumference thereof, and having the small end provided in a rim of the large end, comprising a die forming a reverse-tapered blade part at a leading end, a holding member for holding a plurality of the dies slidably along an inclined axial line having a radial shape and an inclination angle to the gear axial line, a pushing cam mechanism having a small end forming spline teeth in the large end and the outer circumference parallel to the gear axial line, for pushing the reverse-tapered blade part formed at a leading end of the dies, by sliding the small end to the spline teeth of an intermediate material provided in the rim of the large end, thereby forming the spline teeth in the reverse-tapered tooth part, and an extracting mechanism for sliding the dies from the center of the radiation diction toward the outside along the inclined axial line.

3. The manufacturing apparatus of gears for a speed change device according to claim **2**, further comprising a provisional holding mechanism for positioning between the spline teeth of the intermediate material and the reverse-tapered blade part formed at the leading end of the die, by provisionally holding the intermediate material so as to be rotatable about the center of the gear axial line.

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