(12) UK Patent Application (19) GB (11) 2 035 507 A

(21) Application No **7847900**
(22) Date of filing
11 Dec 1978
(43) Application published
18 Jun 1980
(51) **INT CL³ B62D 3/12**
F16H 19/04 55/26
(52) Domestic classification
F2Q 7A3E 7B
(56) Documents cited
GB 1525760
GB 1324322
GB 1271079
GB 1248982
GB 1248981
GB 976661
GB 279315
(58) Field of search
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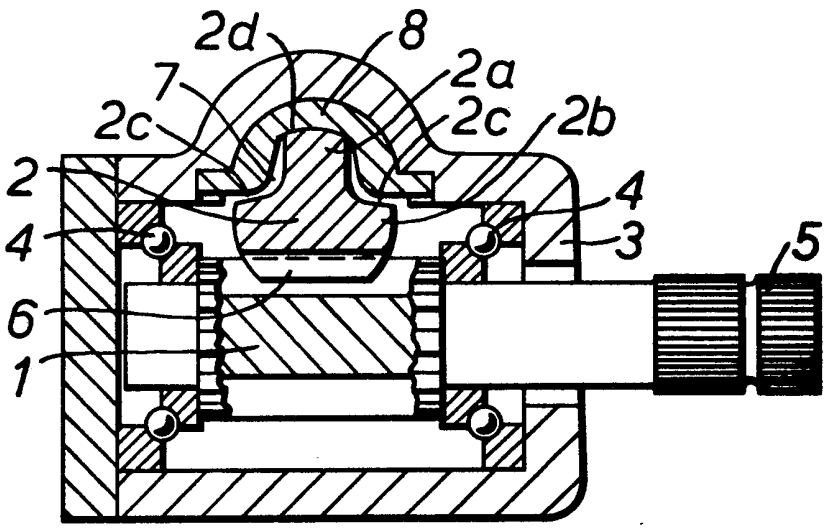
(54) Rack and pinion gear

(57) In a rack and pinion gear assembly, the rack bar 2 is substantially T-shaped in lateral section for roll stabilisation of the rack bar. The cross bar of the T-shape provides a head portion 2*b* and the stem of the T-shape a rail portion 2*a* which rail portion is adapted to slide longitudinally in a recess in a non-rotatable bearing means 8 of the gear assembly. Preferably the bearing means is in the form of a saddle. In the recess of the saddle an end surface of the rail portion remote from the head portion is in contact with the saddle and transversely extending side surfaces 2*c*, of the head portion 2*b* are not in contact with the saddle 8 when the rack bar is not under load, the side surfaces being adapted to contact the saddle when the rack bar is under load.

FIG. 1.



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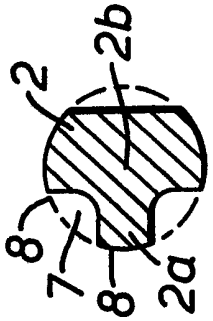


FIG.3.

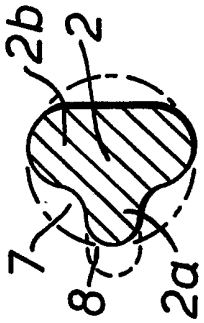


FIG.4.

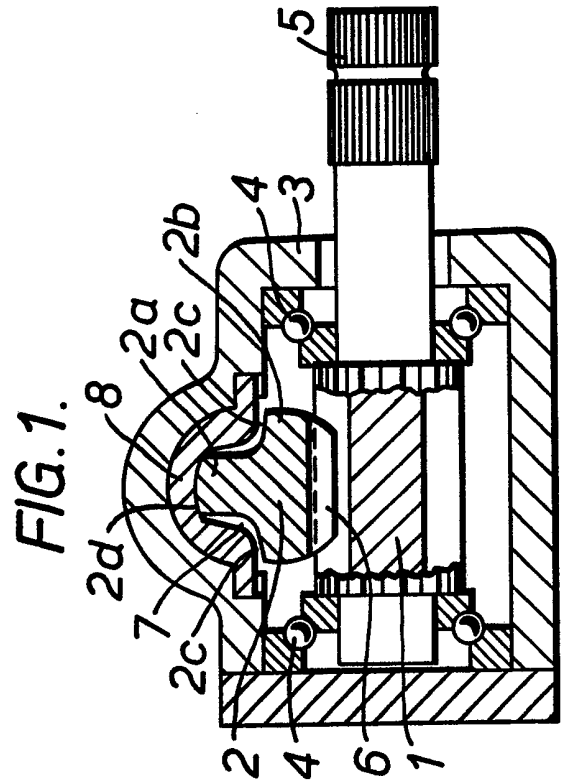


FIG.1.

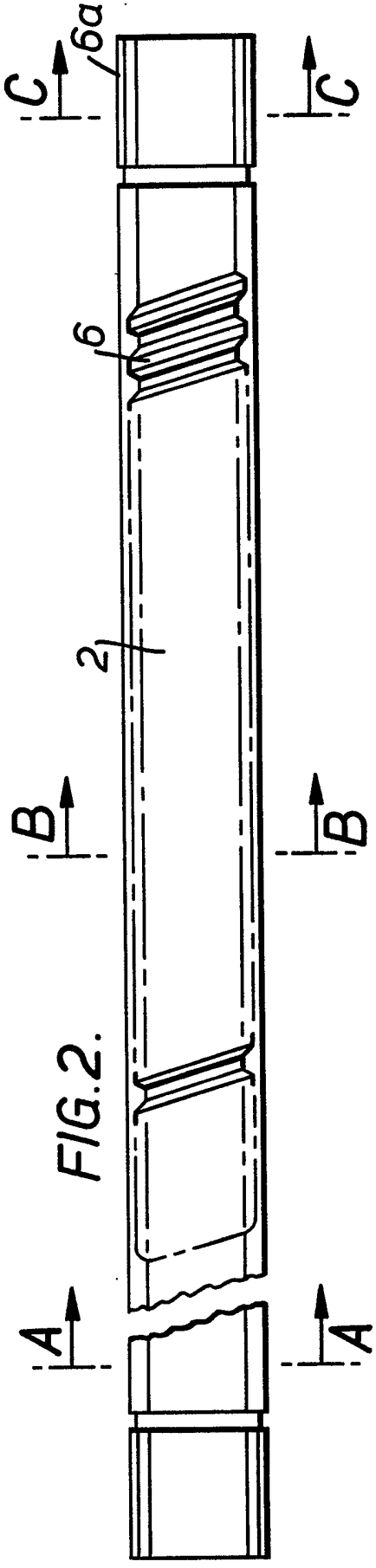


FIG.2.

FIG.5.

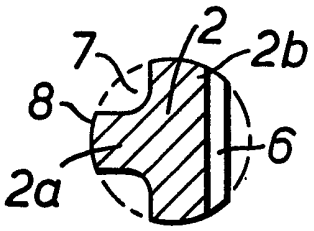


FIG.6.

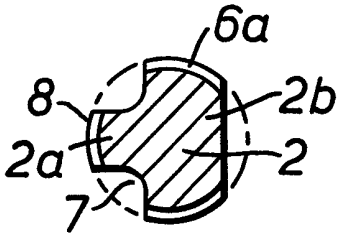


FIG.7.

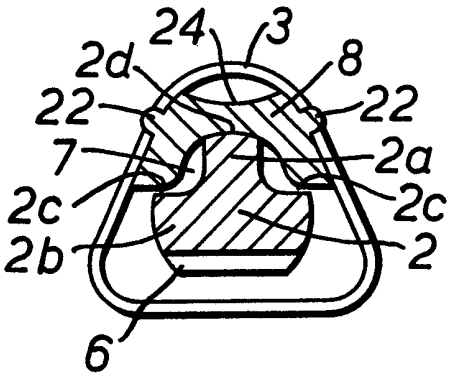
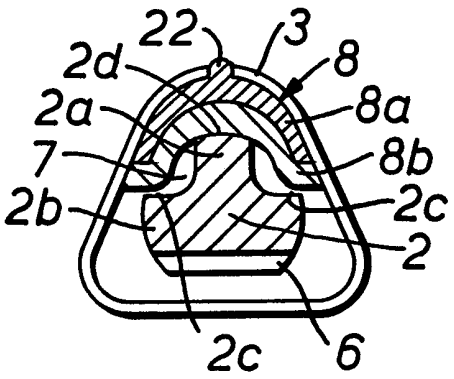


FIG.8.



SPECIFICATION

Rack and pinion gear assembly

TECHNICAL FIELD

The invention relates to rack and pinion gear assemblies, particularly to those which comprise a longitudinally extending rack bar which is longitudinally displaceable in a pinion housing and a pinion rotatably mounted in the housing and engaging an array of teeth on the rack bar so that upon rotation of the pinion the rack bar is displaced longitudinally relative to the housing. Such rack and pinion gear assemblies are defined herein as 'of the kind specified'. Such rack and pinion assemblies are commonly found in a vehicle steering system.

PRIOR ART

Rack and pinion assemblies are known in which there is a rack bar comprising a profiled portion which mates with support means for the rack bar to alleviate lateral movement of the rack (that is movement in the general direction of the axis about which the pinion rotates); however such support means do not alleviate the problem of rack bar roll where the rack bar has a tendency to rotate about its longitudinal axis.

STATEMENT OF INVENTION AND ADVANTAGES

To alleviate the problem of rack bar roll there is provided according to the invention a rack and pinion gear assembly having a rack bar, at least part length of which is substantially T-shaped in lateral section whereby the cross bar of the T-shape provides a head portion and the stem of the said T-shape provides a rail portion adapted to provide a roll stabilising facility and in which the array of teeth on the rack bar is located on the face of the head portion which is on the side thereof remote from rail portion and wherein the rack bar engages with and is longitudinally slidable relative to a non-rotatable bearing means mounted in the pinion housing which bearing means is located on the side of the rack bar remote from the pinion to engage the rail portion and restrains the rack bar against lateral displacement whereby its teeth are maintained in engagement with those of the pinion.

Preferably in a rack and pinion gear assembly according to the invention the bearing means is located substantially in lateral alignment with the region of engagement between the rack and pinion teeth. More preferably the bearing means engages with the rack bar to restrain rotational movement of the rack bar about its longitudinal axis relative to the pinion housing.

Further in a rack and pinion gear assembly according to the invention the bearing means may resiliently bias the rack bar to urge the teeth into engagement with those of the pinion.

Preferably in a rack and pinion gear assembly according to the invention the bearing means is in the form of a saddle member which straddles the rail portion of the rack bar. More preferably the saddle member slidably engages the rail portion on the end face thereof, located at the end of the stem of the 'T' shaped section remote from the head portion and the saddle member also slidably engages the head portion on faces thereof which are located on opposite sides of the rail portion and are on the side of the head portion remote from the rack teeth. Usually clearance is provided between the saddle member and the longitudinally extending opposed side faces of the stem portion which are adjacent to end faces thereof. The saddle member may be restrained from displacement relative to the pinion housing by key engagement therewith.

The saddle member is preferably of a resilient material and the keyed engagement comprises mating projections and recesses cooperation between which is effected by snap engagement of the saddle member with the pinion housing.

A rack and pinion gear assembly according to the invention may furthermore include towards one end a part length of rack bar which is externally screw threaded.

SPECIFIC DESCRIPTION

An embodiment of the invention will now be illustrated by way of example only with reference to the accompanying drawing in which:—

Figure 1 is a cross section through a gear assembly according to the invention;

Figure 2 is a plan of the rack bar of the gear assembly of Fig. 1;

Figure 3 is a cross section through A–A as shown in Fig. 2;

Figure 4 shows a modification of the rack bar of the gear assembly of Fig. 2 through A–A;

Figure 5 is a cross section through B–B of Fig. 2;

Figure 6 is a cross section through C–C of Fig. 2;;

Figure 7 is a cross section showing a modification of the yoke of the gear assembly of Fig. 1, and

Figure 8 is a cross section showing a modification of the gear assembly of Fig. 7.

In Fig. 1 a rack and pinion assembly accordig to the invention is shown having a pinion 1 rotatably mounted on bearings 4 in a housing 3. The pinion 1 is rotatable by means of an input shaft 5 which may be connected to a conventional steering column.

The pinion 1 engages a rack bar 2, which rack bar 2 moves along the longitudinal axis

of the rack bar 2 in response to rotation of the pinion, by engagement with the pinion 1 of a rack 6 to the rack bar 2. The rack bar comprises two portions, a rail portion 2*a* and a head portion 2*b* which together form a substantially T-shaped cross section of the rack bar 2. An end surface 2*d* of the rail portion 2*a* is in contact with a resilient saddle member on yoke 8. Transversely extending side surfaces 2*c* of the head portion are however not in contact with the yoke 8 when the rack bar 2 is not under load, but when a load is applied to the rack bar 2 the rail portion 2*a* is pressed down into the yoke 8 so surface 2*c* contacts the yoke 8. Rail portion 2*a* is adapted to move within a cavity 7 formed within the yoke 8, the yoke 8 fixedly positioned in the housing 3, the rail portion 2*a* being in slidable contact with the walls of yoke 8. The cavity 7 runs substantially parallel with the longitudinal axis of the rack bar 2 and allows the rail portion 2*a*, in slidable contact with the walls of yoke 8, to run freely along the longitudinal axis of the rack 2 within the cavity 7 but impairs any rotation of the rack bar about said longitudinal axis. Therefore, a roll stabilising facility results due to the rail portion 2*a* contacting the wall of the yoke, which wall defines the cavity 7, so impairing rotation of the rack bar 2 abouts its longitudinal axis.

Fig. 2 shows a plan view of the rack bar 2, showing the length of the head portion 2*b* of rack bar 2, and showing rack 6. The distance that rack 6 extends is preferably defined by the two maximum displacements along longitudinal axis of the rack bar 2 that the rack bar 2 can perform. Therefore the rack 6 extends from a position in which the rack 6 engages the pinion 1 at one maximum displacement to a position in which the rack 2 engages the pinion 1 at the other maximum displacement. An external thread 6a is provided to allow the rack bar 2 towards one end of the rack bar 2 to be capable of being attached to a universal point and so incorporated into a steering column apparatus in a conventional manner.

Figs. 3 to 6 show various cross sections taken across rack bar 2 of Fig. 2.

In Figs. 3 and 4 a cross section is taken along A–A and shows the rack bar 2, with the rail portion 2*a* within the cavity 7. As can be seen the rail portion 2*a* contacts the walls of the yoke 8 which define the cavity 7. Fig. 3 differs from Fig. 4 in that the shape of the rail 2*a* and the head 2*b* are different.

In Fig. 5 a cross section is taken along B–B and shows the rack 6 attached to head 2*b* on the side of rack bar 2 remote from the rail portion 2*a*. This is due to B–B being taken across a portion of rack bar 2 within the distance defined by the two maximum displacement positions of the rack bar 2 which engage the pinion 1 at the two maximum longitudinal displacements of the rack bar 2 along its longitudinal axis. The walls of yoke 8 define a cavity 7 and the rack bar 2 can be seen to engage the wall to impair rotation of the rack bar 2 about its longitudinal axis.

In Fig. 6 a cross section is taken along C–C. The rack bar 2 does not have rack 6 extending in this portion. However, an external screw thread 6*a* is located around the rail portion 2*a* and the head portion 2*b* of rack bar 2, so that the rack bar may be attached to a universal joint for incorporation of the rack bar 2 into a steering column apparatus.

Fig. 7 shows a modification of the yoke 8 in the housing 3. In this modification protrusions on dimples 22 from the yoke 8 are provided to enter openings in the housing 3 in order to retain the yoke 8 made of acetal preferably firmly in position in the housing 3 and alleviate the possibility of the yoke 8 turning about the axis of the rack bar in the housing 3. If the yoke 8 turns in the cavity of the housing the cavity 7 of Fig. 1 will cause the rail portion to be displaced about the rotational axis of the rack and therefore the rack 6 of the rack bar 2 will be unaligned and cause stress and possible breakage of the rack 6 when engaging with the pinion. The protrusions 22 may be snap fitted into the openings in the housing 3. The cavity 7 restrains rail portion 2*a* from rotational movement the rail portion being slidably movable along the length of the rack bar in the cavity 7. The depth of the rail portion 2*a* is such that when surface 2*d* contacts a surface of the yoke 8, usually when the rack bar 2 is under load, the depth of the rail portion 2*a* is such that surfaces 2*c* do not contact the adjacent surfaces of yoke 8. Yoke 8 is modified to include a back portion 24 which has been scallopped to allow resistance to be imparted to the yoke 8 so as to receive the rail portion 2*a* when pressed down into the yoke 8.

In the modification shown in Fig. 8 the yoke 8 is resilient so as to allow the rail portion 2*a* to be pressed into the yoke 8 which comprises two layers 8*a* and 8*b*. Layer 8*a* should be formed of a good wearing material for example acetal and layer 8*b* with dimple 22 should have good resilience properties for example rubber.

CLAIMS (11 Dec 1978)

1. A rack and pinion gear assembly of the kind specified in which at least part length of th rack bar is of substantially "T" shape in lateral section whereby the cross bar of said "T" shape provides a head portion and the stem of said "T" shape provides a rail portion and in which the array of teeth on the rack bar are located on the face of the head portion which is on the side thereof remote from the rail portion and wherein the rack bar engages with, and is longitudinally slidable relative to, non-rotatable bearing means mounted in the pinion housing which bearing

means is located on the side of the rack bar remote from the pinion to engage the rail portion and restrain the rack bar against lateral displacement whereby its teeth are maintained in engagement with those of the pinion.

2. A gear assemby as claimed in claim 1 in which the bearing means includes a portion of resilient material.

3. An assembly as claimed in either claim 1 or claim 2 in which the bearing means is located substantially in lateral alignment with the region of engagement between the rack and pinion teeth.

4. An assembly as claimed in claim 1, claim 2 or claim 3 in which the bearing means engages with the rack bar to restrain rotational movement of the rack bar about its longitudinal axis relative to the pinion housing.

5. An assembly as claimed in any one of the preceding claims in which the bearing means resiliently biases the rack bar to urge its teeth into engagement with those of the pinion.

6. An assembly as claimed in any one of the preceding claims in which the bearing means is in the form of a saddle member which straddles the rail portion of the rack bar.

7. An assembly as claimed in claim 6, in which the saddle member slidably engages the rail portion on the end face thereof, which is located at the end of the stem of the "T" shape section remote from the head portion and also slidably engages the head portion on faces thereof which are located on opposite sides of the rail portion and are on the side of the head portion remote from the rack teeth.

8. An assembly as claimed in claim 7 in which clearance is provided between the saddle member and the longitudinally extending opposed side faces of the stem portion which are adjacent to the end face thereof.

9. An assembly as claimed in any one of claims 6 to 8, in which the saddle member is restrained from displacement relative to the pinion housing by keyed engagement therewith.

10. A gear assembly as claimed in any one of claims 6 to 9 in which the rail portion has an end surface remote from the head portion in contact with the saddle member and the head portion has transversely extending side surfaces adjacent to the saddle member not in contact with the saddle member when the rack bar is not under load but adapted to contact the saddle member when the rack bar is under load.

11. An assembly as claimed in claim 9 or claim 10, in which the saddle member is of resilient material and the keyed engagement comprises mating projections and recesses cooperation between which is effected by snap engagement of the saddle member with the pinion housing.

12. An assembly as claimed in any one of the preceding claims, in which the opposed side faces of the head portion which are adjacent to the face of that portion on which are located the rack teeth, and also the end face of the rail portion which is located at the end of the stem of the "T" shape section remote from the head portion, are the convex profiles.

13. An assembly as claimed in claim 12 in which said convex profiles are substantially part cylindrical and are located in the surface of a common notional cylinder the axis of which extends longitudinally.

14. An assembly as claimed in claim 13 in which at least one longitudinal end part length of the "T" shape section of the rack bar is externally screw threaded.

15. An assembly as claimed in any one of the preceding claims in which the part length of the rack bar of substantially "T" shape in lateral section is manufactured by extrusion.

16. An assembly as claimed in any one of the preceding claims in which at least one longitudinal end of the rack bar is of a section other than said "T" shape section and that end is connected to the "T" sectioned part length of the rack bar by welding.

17. A gear assembly as claimed in any one of the preceding claims in which the saddle member has protrusions which enter openings in the housing of the assembly for restraining the yoke from rotational movement in a direction about the axis of the rack bar.

18. A gear assembly as claimed in claim 17 in which the protrusions are adaptd to be snap fitted into openings in the housing.

19. A gear assembly as claimed in any one of the preceding claims in which the back portion of the saddle member between the housing and the yoke and remote from the recess is scallopped.

20. A gear assembly as claimed in any one of the preceding claims in which the saddle member comprises two material portions, the first portion being of resilient material and the second portion being the portion defining the recess in the saddle member through which the rail portion passes, being of hard wearing material.

21. A gear assembly substantially as herein described with reference to the accompanying illustrative drawings.

22. A rack and pinion gear assembly including a gear assembly substantially as herein described with reference to the accompanying illustrative drawings.

CLAIMS (16 Nov 1979)

1. A rack and pinion gear assembly of the kind specified in which

at least part length of the rack bar is of substantially "T" shape in lateral section whereby the cross bar of said "T" shape

provides a head portion and the stem of said "T" shape provides a rail portion,

the array of teeth on the rack bar is located on a front face of the head portion which front face is on the side thereof remote from the rail portion, and the head portion forms with the rail portion transversely extending shoulder portions which are partly defined by a rear face said rear face being substantially parallel with the front face, and

the rack bar engages with, and is longitudinally slidable relative to, non-rotatable bearing means mounted in the pinion housing which bearing means is located on the side of the rack bar remote from the pinion to abut the shoulder portions of the rear face of the rail portion and restrains the rack bar against lateral displacement whereby its teeth are maintained in engagement with those of the pinion.

2. A gear assembly as claimed in claim 1 in which the bearing means includes a portion of resilient material.

3. An assembly as claimed in either claim 1 or claim 2 in which the bearing means is located substantially in lateral alignment with the region of engagement between the rack and pinion teeth.

4. An assembly as claimed in claim 1, claim 2 or claim 3 in which the bearing means engages with the rack bar to restrain rotational movement of the rack bar about its longitudinal axis relative to the pinion housing.

5. An assembly as claimed in any one of the preceding claims in which the bearing means resiliently biases the rack bar to urge its teeth into engagement with those of the pinion.

6. An assembly as claimed in any one of the preceding claims in which the bearing means is in the form of a saddle member which straddles the rail portion of the rack bar.

7. An assembly as claimed in Claim 6, in which the saddle member slidably engages the rail portion on the end face thereof, which is located at the end of the stem of the "T" shape section remote from the head portion and also slidably abuts the head portion on the shoulder portions of the rear face.

8. An assembly as claimed in claim 7 in which clearance is provided between the saddle member and the longitudinally extending opposed side faces of the stem portion which are adjacent to the end face thereof.

9. An assembly as claimed in any one of claims 6 to 8, in which the saddle member is restrained from displacement relative to the pinion housing by keyed engagement therewith.

10. A gear assembly as claimed in any one of claims 6 to 9 in which the rail portion has an end surface remote from the rear face of the head portion, the end surface being in contact with the saddle member and the shoulder portions are two transversely extending side surfaces adjacent to the saddle member but not in contact with the saddle member when the rack bar is not under load but adapted to contact the saddle member when the rack bar is under load.

11. An assembly as claimed in Claim 9 or Claim 10, in which the saddle member is of resilient material and the keyed engagement comprises mating projections and recesses cooperation between which is effected by snap engagement of the saddle member with the pinion housing.

12. An assembly as claimed in any one of the preceding claims, in which the opposed side faces of the hear portion which are adjacent to the face of that portion on which are located the rack teeth, and also the end face of the rail portion which is located at the end of the stem of the "T" shape section remote from the head portion, are the convex profiles.

13. An assembly as claimed in Claim 12, in which said convex profiles are substantially part cylindrical and are located in the surface of a common notional cylinder the axis of which extends longitudinally.

14. An assembly as claimed in Claim 13, in which at least one longitudinal end part length of the "T" shape section of the rack bar is externally screw threaded.

15. An assembly as claimed in any one of the preceding claims, in which the part length of the rack bar of substantially "T" shape in lateral section is manufactured by extrusion.

16. An assembly as claimed in any one of the preceding claims in which at least one longitudinal end of the rack bar is of a section other than said "T" shape section and that end is connected to the "T" sectioned part length of the rack bar by welding.

17. A gear assembly as claimed in any one of the preceding claims in which the saddle member has protrusions which enter openings in the housing of the assembly for restraining the yoke from rotational movement in a direction about the axis of the rack bar.

18. A gear assembly as claimed in claim 17 in which the protrusions are adapted to be snap fitted into openings in the housing.

19. A gear assembly as claimed in any one of the preceding claims in which the back portion of the saddle member between the housing and the yoke and remote from the recess is scallopped.

20. A gear assembly as claimed in any one of the preceding claims in which the saddle member comprises two material portions, the first portion being of resilient material and the second portion being the portion defining the recess in the saddle member through which the rail portion passes, being of hard wearing material.

21. A gear assembly substantially as her-

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22. A rack and pinion gear assembly including a gear assembly substantially as herein described with reference to the accompanying illustrative drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1980.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.