Aug. 11, 1959 F. W. ROCKALL 2,899,677

LINKING MECHANISMS

Filed July 22, 1954 4 Sheets-Sheet 1

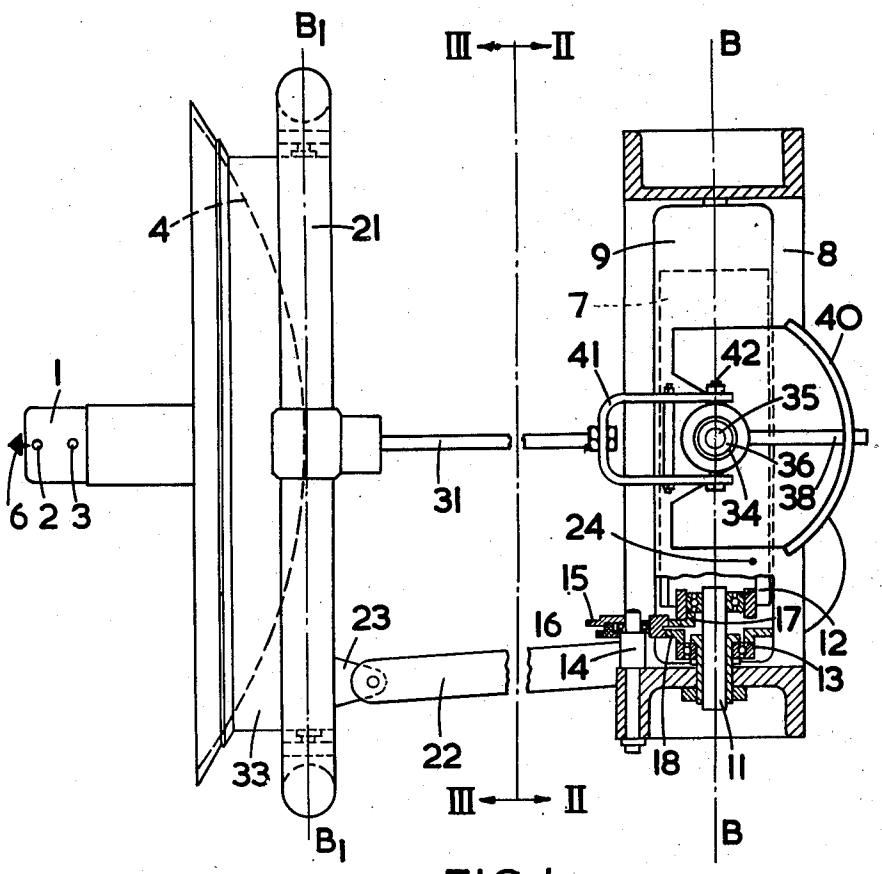


FIG. 1.

INVENTOR
FREDERICK WILLIAM ROCKALL

BY Elyan Sprecher
ATTORNEY

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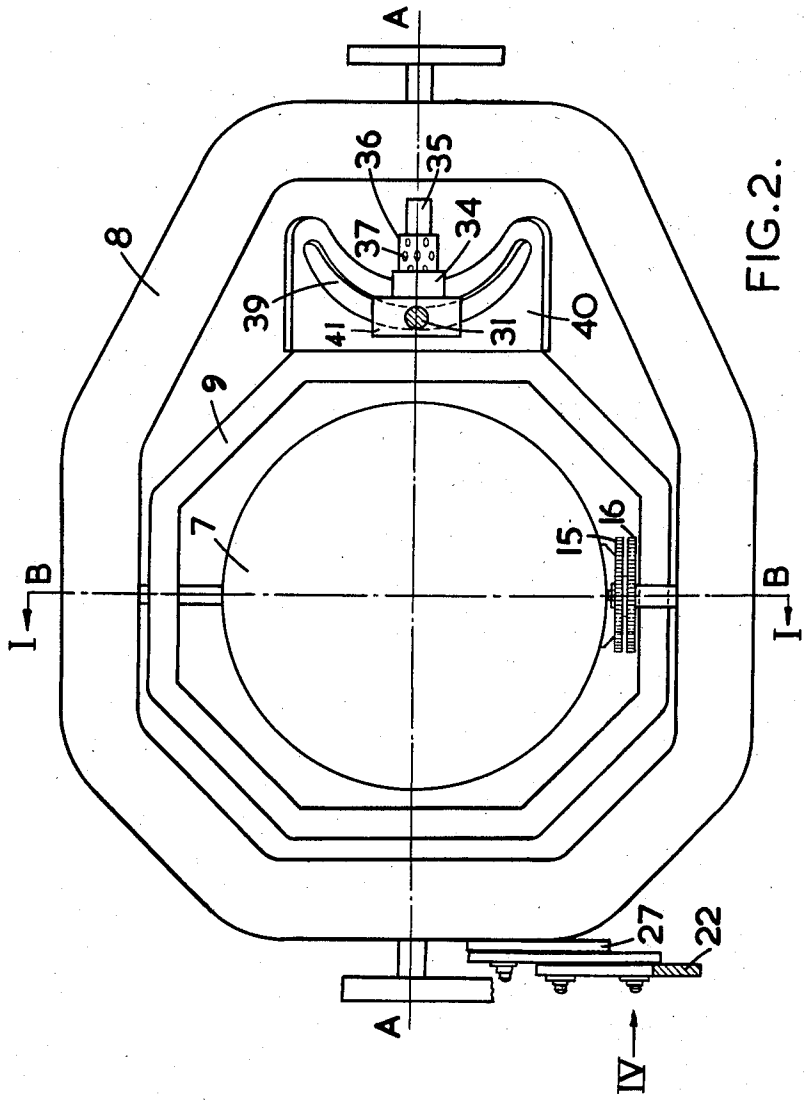


FIG. 2.

INVENTOR
FREDERICK WILLIAM ROCKALL

BY
ATTORNEY

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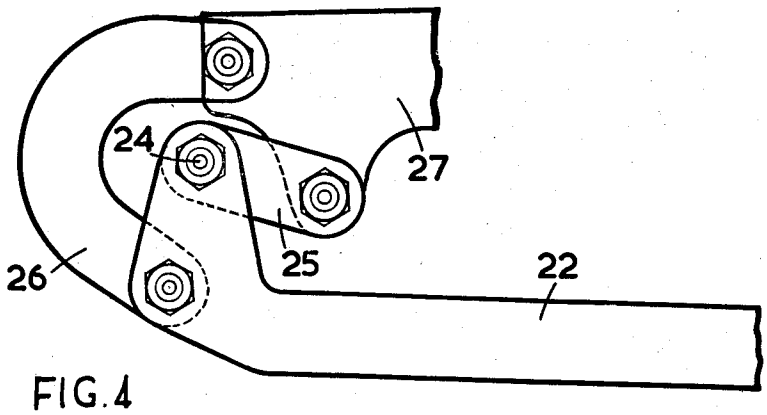


FIG. 4

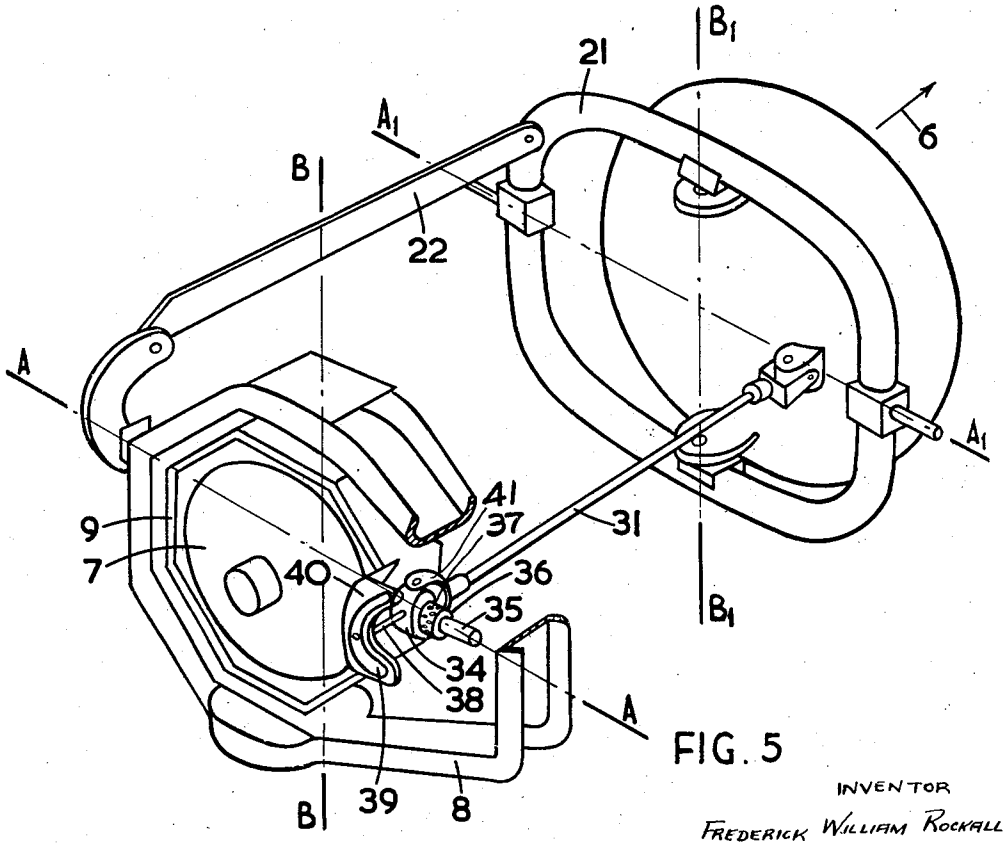


FIG. 5

INVENTOR
FREDERICK WILLIAM ROCKALL
BY Ulysses Bruckstein
ATTORNEY

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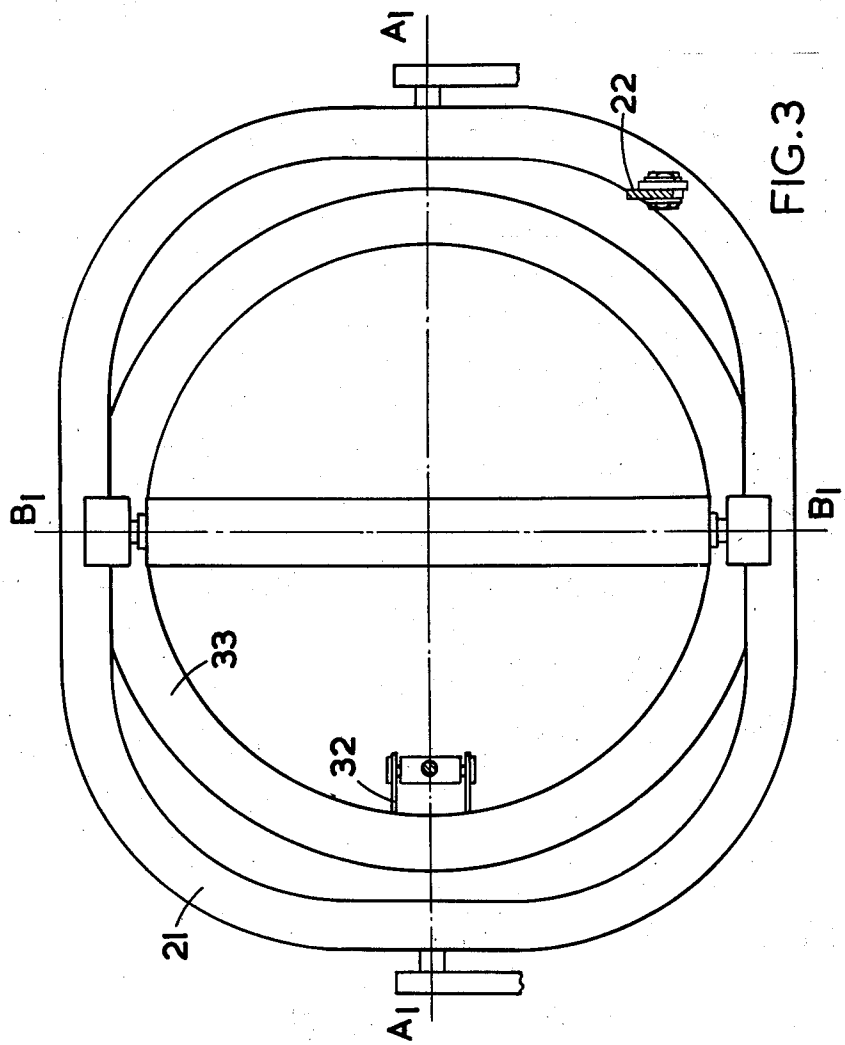


FIG. 3

INVENTOR.
FREDERICK WILLIAM ROCKALL
BY Elyssa Fensterheim
ATTORNEY

United States Patent Office 2,899,677 Patented Aug. 11, 1959

2,899,677

LINKING MECHANISMS

Frederick William Rockall, Harrow Weald, England, assignor to The General Electric Company Limited, London, England

Application July 22, 1954, Serial No. 444,945

Claims priority, application Great Britain July 27, 1953

5 Claims. (Cl. 343—757)

The present invention relates to linking mechanisms.

In certain forms of guided missile it is known to provide the missile with a radar system to enable it to home on to a target. The radar system may have an aerial which comprises a radiator and a paraboloidal reflector, the reflector being mounted so that it can be turned relative to the body of the missile while there is means to rotate the radiator for the purpose of causing the radar system to effect conical scanning, the axis of rotation of the radiator being fixed relative to the body of the missile. During operation, it is required that the radar system shall be beamed generally in the direction of the missile's target. When the target is directly ahead of the missile, the reflector will therefore lie with its axis along the line of flight and when the target is in any other position relative to the missile there will be an angle between the axis of the reflector and the line of flight. Owing to the geometry of the arrangement, the angle between the axis of the reflector and the line of flight should be one half that of the angle between the line of flight of the missile and the direction of the target from the missile, but as a result of practical considerations this ratio is usually slightly greater than one half.

It will be appreciated that, during flight, the direction in which the radar aerial is beamed is required to be fixed in space so as to be substantially independent of pitch or yaw of the missile. For this purpose the missile may be provided with a gyroscope which is arranged to be precessed so that its axis of rotation lies substantially along the direction of the target from the missile. A linking mechanism is required to transmit the two-dimensional movement of the gyroscope relative to the missile body to the aerial reflector with the necessary reduction in angle discussed above.

One object of the present invention is to provide a novel construction of linking mechanism suitable for that purpose.

According to the present invention, a linking mechanism comprises a first part which is mounted for movement about first and second axes which are at right angles to one another, a second part which is mounted for movement about associated first and second axes which are at right angles to one another, a first mechanical linkage between the two parts so that relative movement of the first part about its first axis produces a corresponding movement of the second part about its first axis, and a second mechanical linkage between the two parts so that relative movement of the first part about its second axis produces a corresponding movement of the second part about its second axis, the second linkage including means which is arranged to vary the effective length of an arm of that linkage in dependence upon the position of either the first or second part about its first axis, the arrangement being such that any relative movement of the first part about either of its axes when positioned anywhere within a range of positions produces a coresponding relative movement of the second part only about its appropriate axis.

One example of a linking mechanism which is in accordance with the present invention and which is arranged to control the position of the aerial reflector of a homing radar system on a guided missile will now be described with reference to the five figures of the accompanying drawings.

In the drawings:

Figure 1 shows an elevation partly in section of the aerial system, the structure supporting a gyroscope which controls the direction in which the aerial is beamed and the linking mechanism between this structure and the reflector of the aerial.

Figure 2 is a view taken in the direction II—II in Figure 1, the appropriate part of Figure 1 being a view taken at the line I—I in Figure 2.

Figure 3 is a view taken in the direction III—III in Figure 1.

Figure 4 shows part of the linking mechanism in the direction of the arrow IV in Figure 2.

Figure 5 shows diagrammatically an isometric view of the whole arrangement.

Referring now to Figure 1 of the drawings, the aerial of the homing radar system comprises a radiator **1** which has two dipole elements **2** and **3** in combination with a reflector, the paraboloidal surface thereof being shown by the broken line **4**. During operation of the radar system, the radiator **1** is arranged to be moved over a circular path so as to effect conical scanning but since this does not affect the general direction in which the radar system is beamed, this direction being determined by the position of the reflector, and does not form any part of the present invention, it will not be further described in this specification.

The general arrangement of the linking mechanism for controlling the position of the reflector is illustrated in Figure 5. In that figure, the line of flight of the missile is shown by the arrow **6** (see also Figure 1) and the direction in space in which the radar system is generally beamed is arranged to be controlled as hereinbefore described by a gyroscope of which only the housing **7** is shown. During flight this gyroscope is arranged to be precessed in known manner so that its axis of rotation lies substantially along the direction of the target from the missile. Thus, when the missile's target is directly ahead of the missile, that is to say in the direction of the arrow **6**, the axis of rotation of the gyroscope and the axis of the aerial reflector both lie along the line of flight. In any other position of the target relative to the missile, the axis of rotation of the gyroscope is at an angle θ to the line of flight while the axis of the reflector is required to lie in the plane containing the line of flight and the direction of the target from the missile at an angle

$$\frac{\theta}{1.8}$$

to the line of flight. In the drawings the gyroscope housing **7** and the aerial reflector are shown in the position they assume when the angle θ is equal to zero.

The gyroscope housing **7** is mounted on a gimbal ring **8** for rotation about a pair of axes A—A and B—B which are at right angles to one another, the axis A—A being fixed relative to the body (not shown) of the missile. When the gyroscope is centrally positioned, that is to say when its axis of rotation is along the line of flight of the missile, the plane containing the axes A—A and B—B is at right angles to the line of flight. An auxiliary gimbal ring **9** is provided inside the gimbal ring **8** and is mounted for movement relative thereto about the axis B—B.

The said aerial reflector is supported from a gimbal ring **21** so as to be free to move about axes A_1—A_1 and

B_1—B_1, which are at right angles to one another, the axis A_1—A_1 being fixed relative to the body of the missile and being parallel to the axis A—A. When this reflector is in its central position so that its axis lies along the line of flight, the axes A_1—A_1 and B_1—B_1 both lie at right angles to the line of flight. Movement of the gyroscope housing 7 and thus of the gimbal ring 8 about the axis A—A is arranged to produce a corresponding but smaller movement of the gimbal ring 21 about the axis A_1—A_1 and for this purpose there is provided a linkage between the gimbal rings 8 and 21.

As will hereinafter be described more fully, gearing is provided between the gimbal ring 8 and the auxiliary gimbal ring 9 so that movement of the gimbal ring 8 about the axis B—B produces a smaller movement of the auxiliary gimbal ring 9 about the same axis. Furthermore, a second linkage between the auxiliary gimbal ring 9 and the said aerial reflector is arranged so that movement of the gyroscope housing 7 about the axis B—B gives rise to the required corresponding movement of the reflector about the axis B'—B'.

Considering now the linking mechanism in more detail and referring again to Figure 1, both the gyroscope housing 7 and the auxiliary gimbal ring 9 are supported from the gimbal ring 8 by means of a pair of shafts, of which only the shaft 11 is shown in that figure, which lie on opposite sides of the gimbal ring 8. The gyroscope housing 7 is connected to the shaft 11 through a ball race 12 while the gimbal ring 9 is connected to that shaft through a ball race 13. A rod 14 which is carried on the gimbal ring 8 supports a pair of gear wheels 15 and 16 (see also Figure 2) which are formed integrally with one another. The gear wheel 15 engages with a geared member 17 that is rigidly connected to the housing 7 while the gear wheel 16 engages with a geared member 18 which is rigidly connected to the gimbal ring 9. This arrangement provides an overall gear ratio of 1.8 to 1 between the gyroscope housing 7 and the auxiliary gimbal ring 9 for movement about the axis B—B. When the gyroscope housing 7 is centrally positioned, the planes of the gimbal rings 8 and 9 are coincident (as shown in the drawing) but in all other positions of the gyroscope housing 7 the auxiliary gimbal ring 9 is inclining at a smaller angle to its central position than the housing 7. It will be appreciated that any movement of the gyroscope housing 7 about the axis A—A (see also Figures 2 and 5) produces an equal angular movement of the auxiliary gimbal ring 9 about that axis.

The previously mentioned linkage between the gimbal rings 8 and 21 comprises a member 22 which is pivoted at one end to a part 23 projecting from the ring 21 while the other end of the member 22 is effectively pivoted to the gimbal ring 8 at the point 24. The effective lengths of the arms of this linkage which are formed by the portions of the gimbal rings 9 and 21 between the axes A—A and A_1—A_1 respectively and the member 22 are such that this linkage gives the required 1.8 to 1 reduction between movement of the gyroscope housing 7 relative to the missile body and movement of the aerial reflector relative to the missile body about the axes A—A and A_1—A_1 respectively. It will be appreciated that, when the gimbal ring 8 is moved about the axis A—A from its central position, the effective distances between the member 22 and the axes A—A and A_1—A_1 are reduced and in order to maintain the 1.8 to 1 ratio, the linkage is provided in known manner with means to move the point 24 in order to compensate for this effect. Thus, referring now to Figure 4 which shows this compensation in more detail, the member 22 and an arm 25 are pivoted together at the point 24 while another arm 26, which is also pivoted to the member 22, and the arm 25 are both pivoted to a part 27 which is secured to the gimbal ring 8.

Returning again to Figure 1, movement of the auxiliary gimbal ring 9 about the axis B—B is arranged to

cause an equal angular movement of the aerial reflector about the axis B_1—B_1 through the previously mentioned second linkage. This linkage has a one-to-one ratio when the auxiliary gimbal ring 9 is in its central position and comprises a rod 31 which at one end is coupled to the auxiliary gimbal ring 9 and at the other end is coupled to a part 32 (see Figure 3) projecting from an annular member 33 which carries the said reflector. Referring again to Figure 1, in order that movement of the gyroscope housing 7 about its axis B—B shall produce the desired movement of the reflector about the axis B_1—B_1 for all positions of the housing 7 about the axis A—A without any cross-coupling, it is necessary for the distance between the end of the rod 31 which is coupled to the gimbal ring 9 and the axis B—B to be varied in dependence upon the position of the gyroscope housing 7 about the axis A—A.

For this purpose, referring now to Figures 1, 2 and 5, a collar 34 is slidably mounted on a shaft 35 which is fixed to the auxiliary gimbal ring 9 and which is co-axial with the axis A—A when that gimbal ring is centrally positioned. In fact a cage 36 which holds captive a plurality of ball-bearings 37 is provided between the collar 34 and the shaft 35. This collar 34 has a rod 38 secured thereto, this rod lying perpendicular to the axis of the shaft 35 and passing through a shaped slot 39 in a member 40 which is also secured to the auxiliary gimbal ring 9. This collar 34 is restrained from rotating about the shaft 35 as will be apparent hereinafter so that movement of the gyroscope housing 7 and thus of the auxiliary gimbal ring 9 about the axis A—A cause longitudinal movement of the collar 34 along the shaft 35.

The coupling between the collar 34 and the rod 31 for the purpose of the linkage under consideration is effected through a forked member 41, this member 41 being pivoted to the collar 34. Since the member 41 is pivotally connected to the gimbal ring 21, no rotation of the collar 34 about the shaft 35 is possible.

In all positions of this second linkage, the rod 31 lies approximately parallel to the line of flight. The coupling to the two ends of the rod 31 are such that a universal coupling is provided between the gimbal ring 9 and the member 33.

The slot 39 in the member 40 is shaped so that the collar 34 and thus the associated end of the rod 31 is closest to the axis B—B when the gyroscope housing 7 is in its central position. Movement of the gyroscope housing 7 about the axis A—A in either direction from the central position causes the collar 34 to move away from the axis B—B and thereby to vary the ratio of the linkage transmitting the position of the auxiliary gimbal ring 9 about the axis B—B to the said aerial reflector.

This arrangement ensures that movement of the gyroscope housing 7 about the axis A—A when in any operational position produces a corresponding movement of the said aerial reflector only about the axis A_1—A_1, that is to say there is no cross-coupling to produce movement about the B_1—B_1 axis, while movement of the gyroscope housing 7 about the axis B—B produces a corresponding movement of the reflector only about the axis B_1—B_1.

I claim:

1. A linking mechanism comprising a first part which is mounted for movement about first and second axes which are at right angles to one another, a second part which is mounted for movement about associated first and second axes which are at right angles to one another, a first mechanical linkage between the two parts so that relative movement of the first part about its first axis produces a corresponding movement of the second part about its first axis, and a second mechanical linkage between the two parts so that relative movement of the first part about its second axis produces a corresponding movement of the second part about its second axis, the second linkage including an arm and means which is

arranged to vary the effective length of said arm in dependence upon the position of either the first or second part about its first axis, the arrangement being such that any relative movement of the first part about either of its axes when positioned anwhere within a range of positions produces a corresponding relative movement of the second part only about its appropriate axis.

2. A linking mechanism according to claim 1 wherein the first axis of the two parts are parallel.

3. A linking mechanism comprising a main gimbal ring, means to support the main gimbal ring for rotation about a first axis, a gyroscope housing, means to support the gyroscope housing from the main gimbal ring for rotation about a second axis that is at right angles to the first axis, an auxiliary gimbal ring, means to support the auxiliary gimbal ring from the main gimbal ring for rotation about the second axis, gearing between the gyroscope housing, the main gimbal ring and the auxiliary gimbal ring so that rotation of the gyroscope housing relative to the main gimbal ring about the second axis produces a smaller rotation of the auxiliary gimbal ring relative to the main gimbal ring about the second axis, a further gimbal ring, means to support the further gimbal ring for rotation about a third axis that is parallel to the said first axis, an aerial system having a reflector, means to support the said reflector from the further gimbal ring for rotation about a fourth axis that is at right angles to the third axis, a first mechanical linkage between the main gimbal ring and the said reflector so that rotation of the main gimbal ring about the first axis produces a corresponding smaller rotation of the reflector about the third axis, and a second linkage between the auxiliary gimbal ring and the said reflector

so that rotation of the auxiliary gimbal ring about the second axis produces a corresponding rotation of the reflector about the fourth axis, the second linkage including an arm and means which varies the length of said arm in dependence upon the angular position of the gyroscope housing about the first axis so that movement of the gyroscope housing about the first and second axes when positioned anywhere within a range of positions produces a corresponding smaller movement of the reflector about the third and fourth axes respectively without any cross-coupling.

4. A linking mechanism according to claim 3 wherein the second linkage comprises a coupling part, means to pivot one end of the said coupling part to the said reflector, a shaft, means to mount said shaft coaxially with the said first axis, a member slidably mounted on said shaft, means to pivot the other end of said coupling part to said member, and a device to control the position of the said member along the said shaft in dependence upon the position of the gyroscope housing about the first axis.

5. A linking mechanism according to claim 4 wherein the said device comprises a part which has a shaped slot and which is secured to the auxiliary gimbal ring and a rod which is secured to the said member and which projects into the said slot.

References Cited in the file of this patent

UNITED STATES PATENTS

1,932,469	Lieb et al.	Oct. 31, 1933
2,411,472	Slobod	Nov. 19, 1946