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JUNE 15, 1943.

BY A. P. C.

K. PAPELLO ET AL

DEVICE FOR DIRECTING AND CALCULATING APPARATUS

Filed Feb. 8, 1940

Serial No.

318,000

6 Sheets-Sheet 1

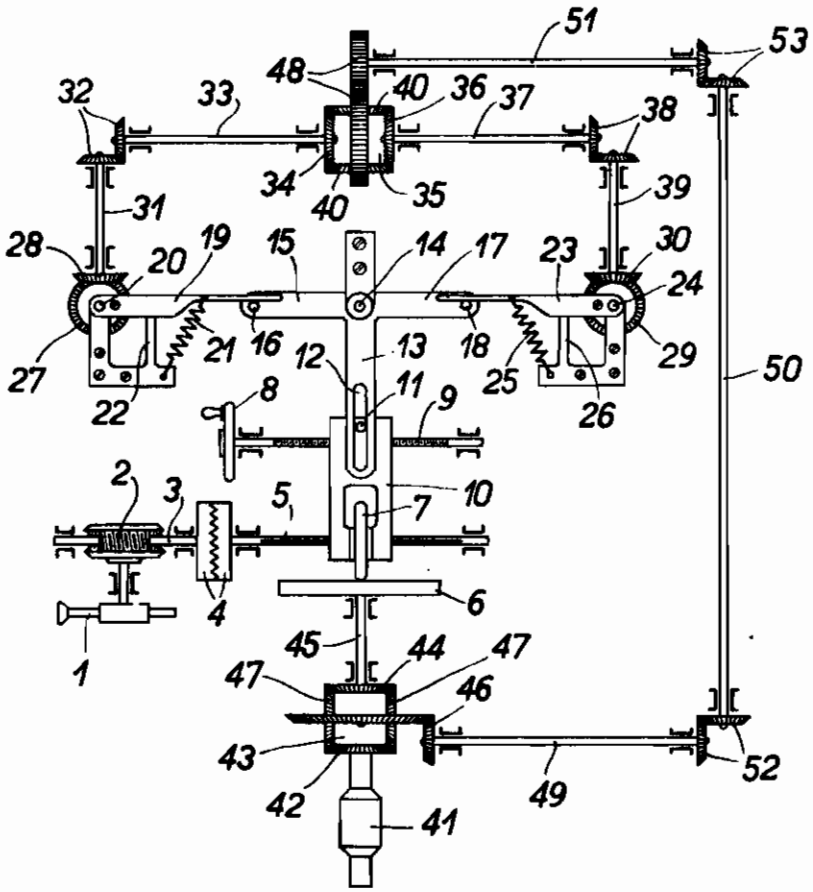

Fig. 1

Inventors:

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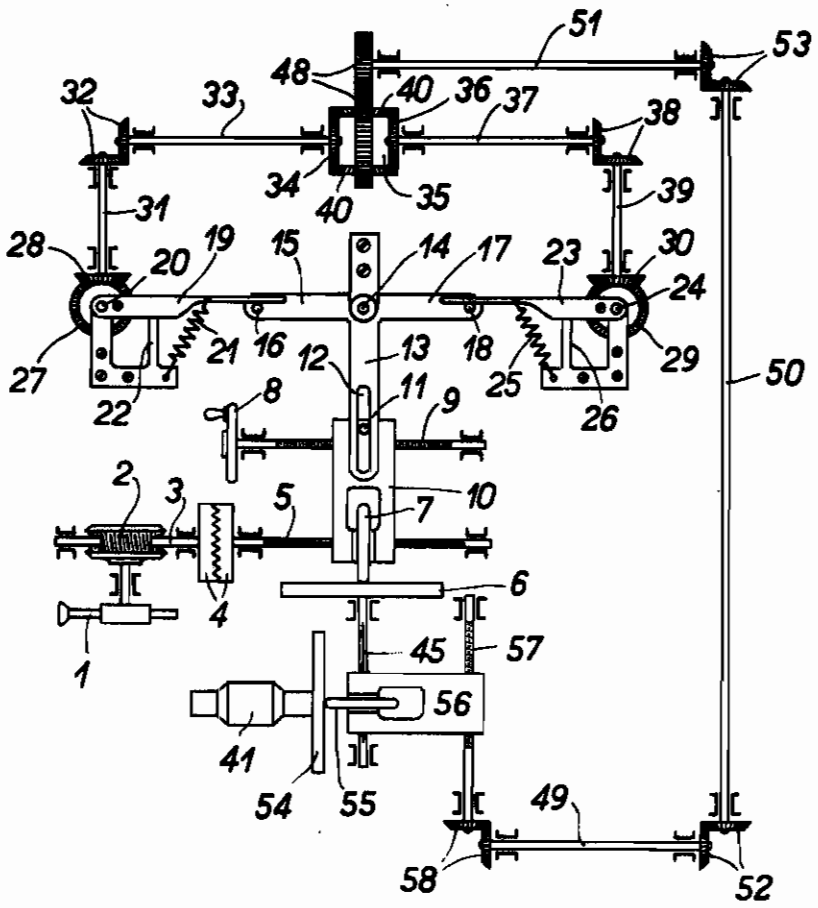

Fig. 2

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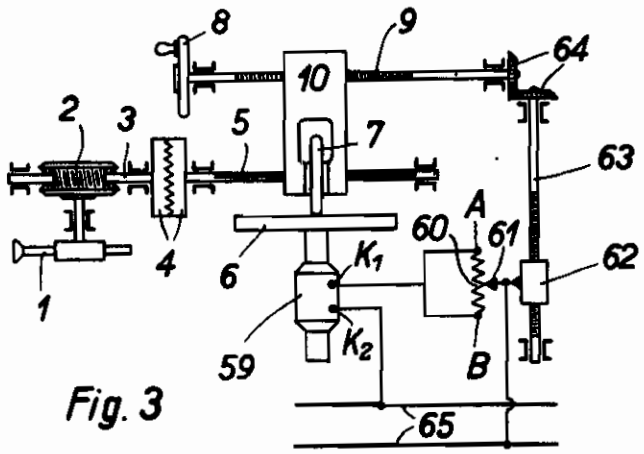

Fig. 3

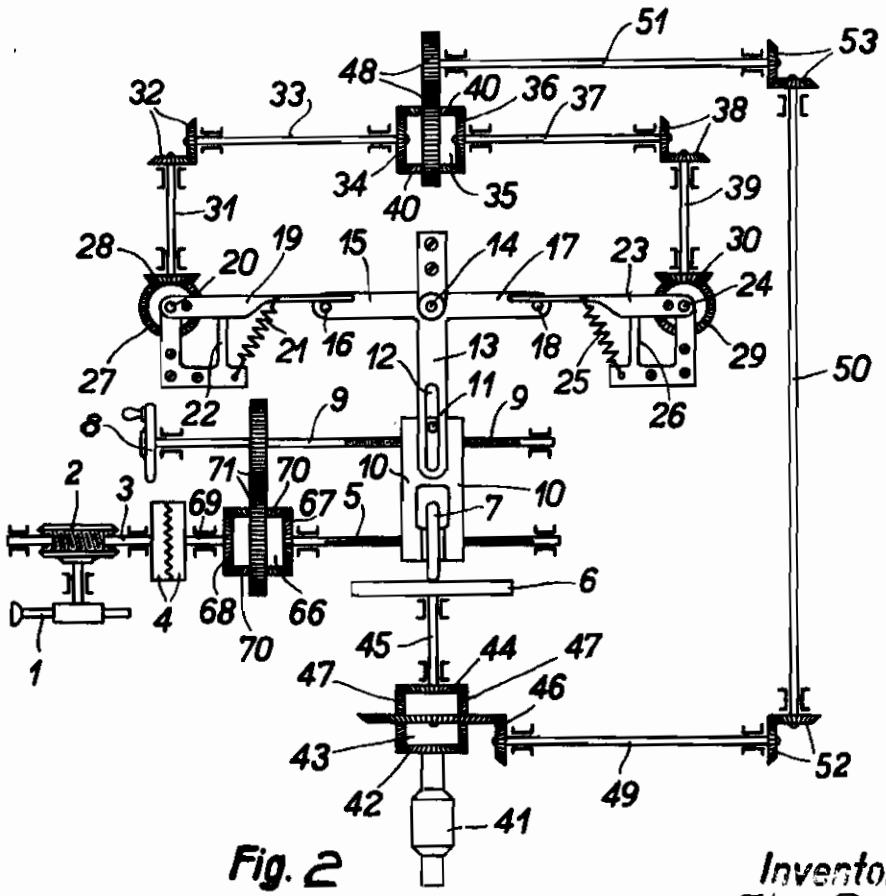

Fig. 2

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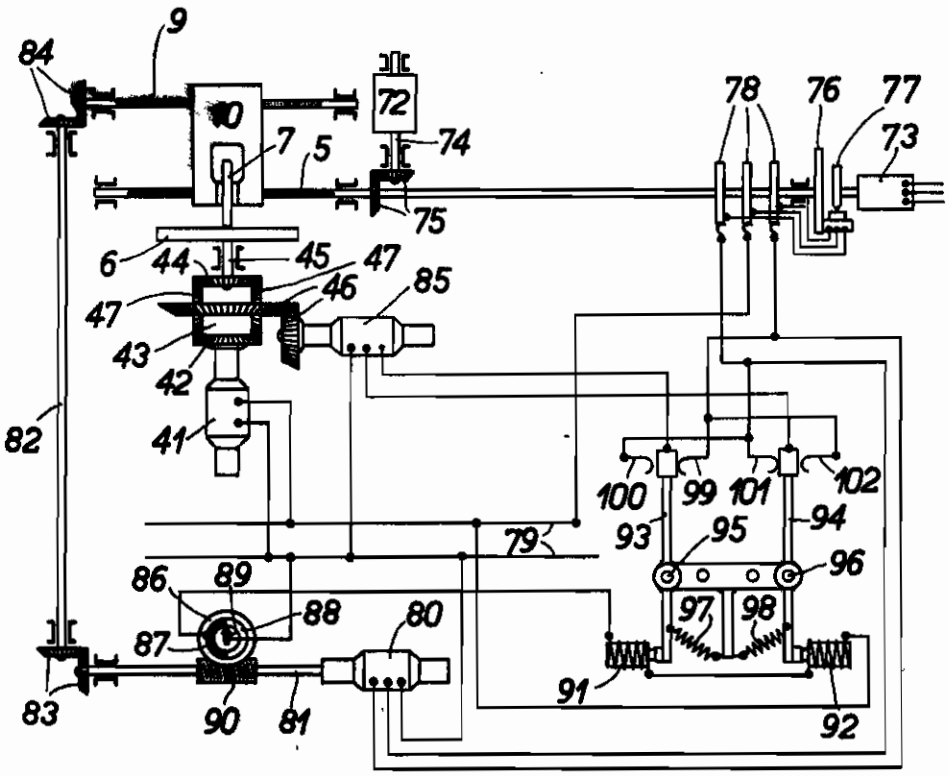

Fig. 3

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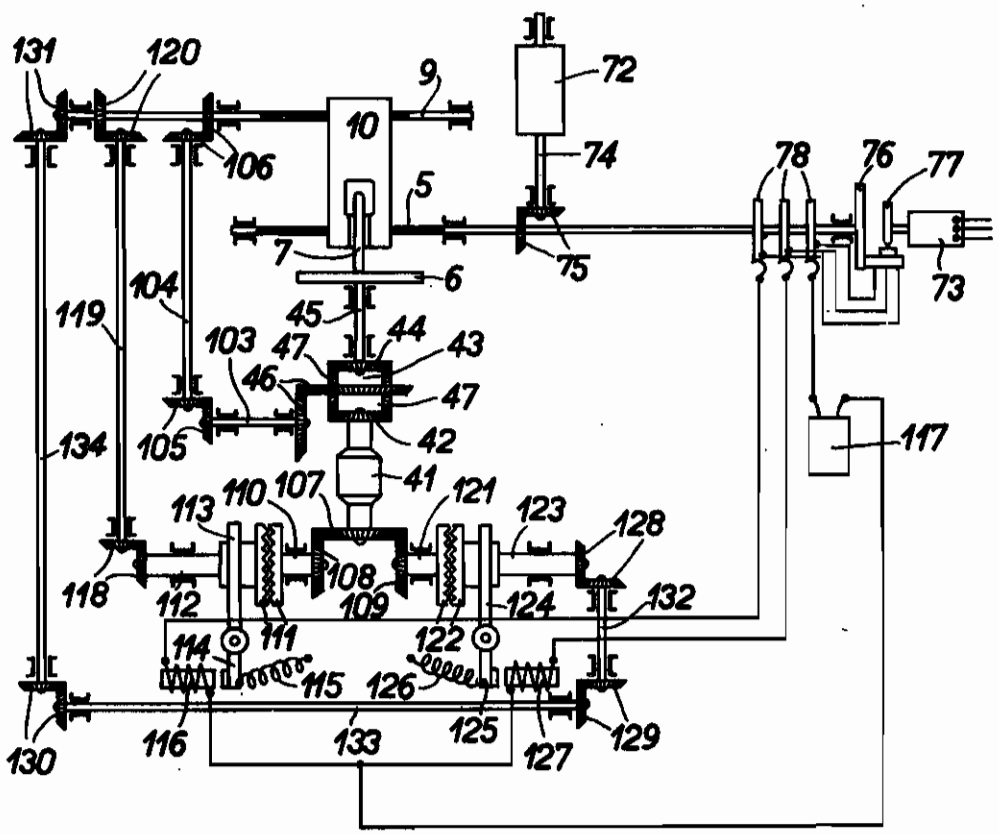

Fig. 4

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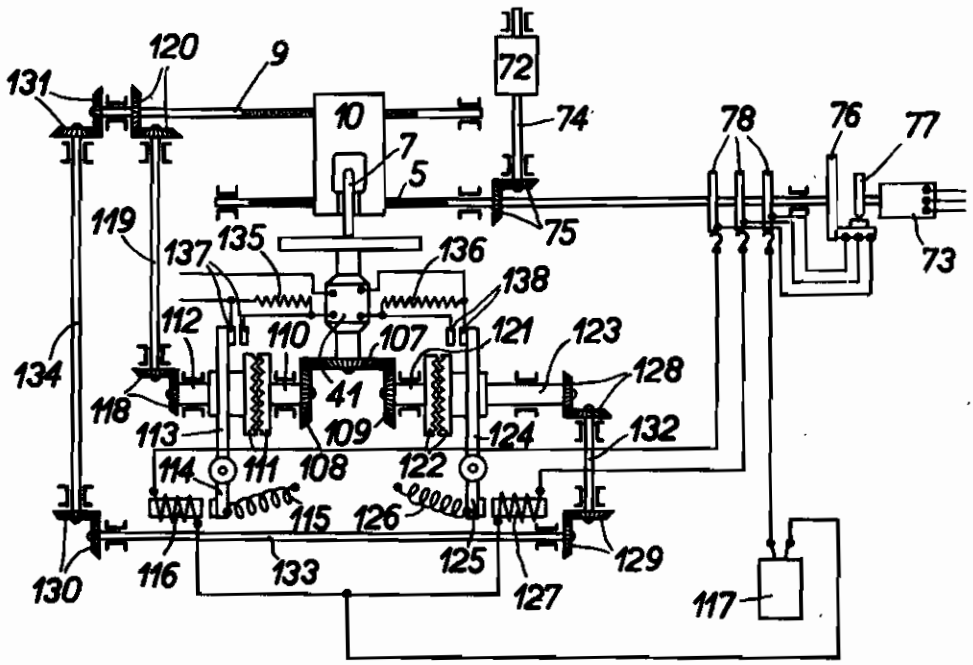

Fig. 7

Inventors:
Karl Papello

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ALIEN PROPERTY CUSTODIAN

DEVICE FOR DIRECTING AND CALCULATING APPARATUS

Karl Papello and Willy Sander, Jena, Germany; vested in the Alien Property Custodian

Application filed February 8, 1940

Devices for displacing a body according to the movement of another body of variable speed, as employed in connection with directing and calculating apparatus, are known which are on the one hand equipped with a speed changing gear connected with a source of energy and where the driven shaft of said speed changing gear is coupled with the body to be displaced and which, on the other hand, contain a control gear coupled with the adjusting device of the speed changing gear as well as with the body to be displaced, so that the latter can be simultaneously and directly actuated by the said source, via the speed changing gear, and by the control gear and that every alteration in the angular speed imparted to the object body via the speed changing gear results in an additional displacement of the object body. Devices of this kind are very well suitable, for instance, for following up aircraft with the aid of hand-controlled sighting telescopes or for the tele-control of bodies with the aid of a transmitting and receiving system where the speed of the bodies to be displaced is relatively low, while the said devices are less satisfactory where a higher speed of displacement is required.

According to the present invention devices of the said kind are obtained, i. e. devices which may be less satisfactory for lower speeds, but excellent for higher speeds of displacement, if means influenced by the control gear are provided for the purpose of altering the angular speed of the speed changing gear driving shaft in accordance with the changes the angular speed of the driven shaft of the speed changing gear experiences under the action the control gear exerts upon the adjusting device. If the adjustability of the speed changing gear is required to be such that its power-driven shaft is to rotate in both directions, provision would have to be made to the effect that the action of the control gear upon the driving shaft of the speed changing gear be reversed at the moment when the driven shaft changes its direction of rotation. Towards this end a mechanical or electrical contrivance could be employed with advantage.

In the new devices as suggested, same as in the known devices of the aforesaid kind the action exerted by the control gear upon the adjusting device is such that the displacement effected by the adjusting device during the action of the control gear and the change thereby effected in the angular speed of the driven shaft of the speed changing gear are preserved when the aforesaid action ceases. There are two possibilities however of producing an action of the control gear upon the driving shaft of the speed changing gear, both possibilities leading to useful devices. The said action can either be of such a nature that the angular speed of the driving shaft remains the same after the action of the control gear has ceased, or of such a nature that after the cessation of the control gear action the angular speed differs from the angular speed before such action by an amount depending upon that action.

For the first of these two cases a simple solution is arrived at by coupling the driving shaft of the speed changing gear with the source of energy and with the control gear by means of a differential.

For the second case a suitable solution is arrived at if provision is made for a second speed changing gear whose driving shaft is in connection with the source of energy and whose driven shaft in connection with the driving shaft of the other speed changing gear, while its adjusting device is coupled with that of the other speed changing gear for common adjustment.

Devices according to both of the aforementioned instances can be used for displacing a body in accordance with the movement of the receiver of an electric tele-transmitting system. In doing so the provision is recommended of a follower mechanism of whose two mutually adjustable parts one is in a known fashion coupled with the body to be displaced and the other with the receiver, the purpose of the follower mechanism being to operate the adjusting device of the speed changing gear when a difference should arise between the speed of these two parts, and to change the angular speed of the driving shaft of that gear. A useful model of a similarly designed device is obtained if provision is made for two clutch couplings, by means of which the source of energy can be brought to act upon the adjusting device of the speed changing gear in one or the other sense, as well as for two electromagnets each of which is to operate one of the two clutch couplings, and furthermore, if provision is made for electrical means to render operative one or the other of the two electromagnets when the relative speed between the mutually adjustable parts of the follower mechanism should experience an increase or a reduction, and thus, by means of the respective clutch coupling operate the said adjusting device in such a manner that the angular speed of the speed changing gear driving shaft is accelerated or retarded.

If the source of energy is equipped with a reg-

ulating device means can be usefully provided for causing the control gear to act upon this regulating device in such a manner that the angular speed of the shaft of the said source changes in the same sense as does the angular speed of the driven shaft of the speed changing gear under the influence the control gear exerts upon the adjusting device of the speed changing gear. In this connection the action of the control gear upon the regulating device of said source is governed by the corresponding conditions as apply in the aforementioned action of the control gear upon the driving shaft of the speed changing gear, i. e., the said action can either be of such a nature that the angular speed of the shaft of said source after the control gear has ceased to operate is the same as before said operation, or of such a nature that after the cessation of the control gear action the angular speed differs from the angular speed prior to such control gear action by an amount depending upon such action.

If the device is intended for displacing a body in accordance with the movement of the receiver of an electrical tele-transmitting system a useful solution is arrived at in the first of said two cases by the provision of a follower mechanism of whose two mutually adjustable parts one is in a known fashion coupled with the body to be displaced and the other with the receiver, as well as by the provision of two clutch couplings by means of which the source of energy can be caused to act in one or the other sense upon the regulating device of the speed changing gear, furthermore, by two electro-magnets, each of which serves for operating one of the two clutch couplings, and by the provision of electrical means to render operative one or the other of the two electro-magnets when the relative speed between the said two parts of the follower mechanism experiences an increase or reduction and thus, by means of the respective clutch coupling act upon the regulating device of the power-source in such a manner that the angular speed of the shaft of said source changes in the same sense as does the angular speed of the driven shaft of the speed changing gear under the influence the follower mechanism exerts upon the adjusting device of the speed changing gear.

The new devices as described in the aforegoing and which, as pointed out before, only give satisfactory results where the bodies in question are to be displaced at high speeds, can be still further so improved that they are well suited also for lower displacing speeds in that,—similar as in the case of the known gears of the aforementioned kind—the control gear is so coupled with the body to be displaced that the latter during the operation of the control gear is additionally displaced.

In the accompanying drawing diagrammatical illustrations are given of seven constructional examples of a device according to the invention. In Figs. 1, 2, 3 and 4 directing apparatus are illustrated for following up an aircraft by means of a sighting telescope, and in Figs. 5, 6 and 7 devices for adjusting a body in accordance with the movement of the receiver of an electrical tele-transmitting system.

The directing apparatus according to Fig. 1 embodies a sighting telescope 1 which, by means of a worm gearing 2, is actuated through a shaft 3 which, with the aid of a clutch coupling 4, can be coupled with the driven shaft 5 of a speed changing gear. The latter is a friction gearing containing a friction disc 6 and a friction wheel 7. The friction wheel 7 is disposed displaceably along the shaft 5 which is provided with a groove. A spindle 9 which is actuated by means of hand wheel 8 and which, by means of a thread, engages a carrier 10 for the friction wheel 7, serves for displacing this wheel. The carrier 10 is provided with a pin 11 engaging in a slot 12 of arm 13 of a triple arm lever. This lever is pivotally mounted around a permanent pin 14 in such a way that it experiences a rotation about the axis of pin 14 when the carrier 10 is displaced by the manipulation of hand wheel 8. Each of the two other arms 15 and 17, of the said lever is fitted with a pin 16 and 18, respectively. Pin 18 cooperates with a lever 19 pivotally mounted around a permanently disposed pin 20. The lever 19 does not experience any rotations about the pin 20, unless the carrier 10 moves in such a manner that the friction wheel 7 occupies positions between its central position, as illustrated in the drawing, where it touches the centre of the friction disc 6 and that respective end position where it touches the left edge of the friction disc 6. By means of spring 21 the lever 18 is held in engagement with the pin 16 until it lies against a permanent arresting stop 22, which will be the case when the friction wheel 7 occupies its central position. The pin 18 cooperated with a lever 23 which is pivotally disposed around a permanently fitted pin 24. The lever 23 does not experience any rotations about the pin 24, unless the carrier 10 moves in such a manner that the friction wheel 7 occupies positions between its central position and that respective end position where it touches the right edge of the friction disc 6. By means of a spring 25 the lever 23 is held in engagement with the pin 18 until it lies against a permanent arresting stop 26, which will be the case when the friction wheel 7 occupies its central position. With the lever 18 is firmly connected a bevel gear 27 meshing with a bevel gear 28. With the lever 23 a bevel gear 29 meshing with a bevel gear 30 is firmly connected. By means of a shaft 31 as well as by a pair of bevel gears 32 and by a shaft 33 the rotations of the bevel gear 28 are imparted to a crown wheel 34 of a differential 35 whose other crown wheel 36—by means of a shaft 37 by a pair of bevel gears 38 and by a shaft 39—is coupled with the bevel gear 30 in such a way that the planet pinions 40 of the differential 35 with equal and opposite displacements of the friction wheel 7 from its central position, are rotated by equal amounts and in the same rotational sense about the coinciding axes of the crown wheels 34 and 36. For driving the friction gearing 6, 7 a motor 41 having a constant number of revolutions is provided for which actuates the one crown wheel 42 of a differential 43 whose other crown wheel 44 is disposed on the shaft 45 of the friction disc 6. The differential 43 is so coupled with the differential 35 that with displacements of friction wheel 7 out of the centre of friction disc 6 the crown wheel 44 is rotated in the same sense as by the motor 41. For this purpose a pair of bevel gears 46—which are intended to impart to the planet pinions 47 of the differential 43 a rotation about the coinciding axes of the crown wheels 42 and 44—by means of three shafts 48, 50 and 51 and two pairs of bevel gears 52 and 53 is coupled with a pair of spur wheels 48 intended to impart to the planet pinions 40 of the differential 35 a ro-

tation about the coinciding axes of the crown wheels 34 and 36.

In use the telescope 1—with disengaged clutch coupling 4—is to be pointed to the aircraft to be followed. This done, the clutch coupling 4 is to be engaged and the telescope 1 kept pointed to the aircraft by manipulating the hand wheel 8.

The directing apparatus according to Fig. 2 differs from that shown in Fig. 1, merely by omission of differential 43. To the friction gearing 8, 7 is coordinated a second friction gearing whose friction disc 54 is driven by the motor 41 and whose friction wheel 55 is disposed on the shaft 45 of the friction disc 6. The shaft 45 is provided with a groove. The carrier 56 for the friction wheel 55 is actuated by a spindle 57 with left handed thread, which is driven by a pair of bevel gears 58 coupled with the shaft 49 in such a manner that the friction wheel 55—with displacements of the friction wheel 7 out of the centre of the friction disc 6—experiences a displacement out of the centre of friction disc 54 towards that particular edge of said friction disc adjoining the friction disc 8.

The difference between the effects of the two described apparatus is that in the apparatus according to Fig. 1, the angular velocity of shaft 45 of the friction disc 6 is invariably the same when the hand wheel 8 is idle, while in the case of the apparatus according to Fig. 2 a certain definite angular velocity of shaft 45 is alotted to each position of the hand wheel 8.

Classified according to effect the apparatus shown in Fig. 3 belongs to the type shown in Fig. 2. It differs from the latter mainly by the omission of the second friction gearing 54, 55 and by a motor 58 with regulatable number of revolutions being provided to drive the friction disc 5. This motor is provided with a rheostat 60 connected in front of the armature winding. A sliding contact 61 displaceable relative to said rheostat is attached to a female carrier 62 which engages a threaded spindle 63 and is guided parallel to said spindle. The spindle 63 is coupled with spindle 9 by means of a pair of bevel gears 64. In the centre position of friction wheel 7 as shown in the drawing, where the friction wheel touches the centre of the friction disc 6, the sliding contact stands in the centre between the two ends A and B of the rheostat 60. Both ends A and B are conductively connected with the one armature terminal K_1 of the motor 58. The other armature terminal K_2 is in connection with the one wire of a circuit 65 whose other wire is connected with the sliding contact 61, the result of this arrangement being that every displacement of the friction wheel 7 out of the centre of the friction disc 6—irrespective whether this takes place towards the right or to the left—brings about an increase in the number of revolutions of the motor 59.

The apparatus as shown in Fig. 4 and which according to effect, belongs to the type of apparatus according to Fig. 1, differs from the latter only in a differential 66 being interposed between clutch coupling 4 and the grooved shaft 5. One of the crown wheels, 67, of the said differential is mounted upon shaft 5, while the other crown wheel 68 is fitted to shaft 68 supporting one section of clutch coupling 4. By means of a pair of spur gears 71 the planet pinions 70 of the differential 66 are so coupled with the spindle 8 that the angular velocity of shaft 69 is greater than that of the grooved shaft 5 when a displacement of the friction wheel 7 out of the centre of the friction disc 6 takes place.

The device according to Fig. 5 serves for adjusting a member 72 according to the adjustments of the receiver 73 of an electric tele-transmitting system. Those parts of the said device which are identical with those of the apparatus according to Fig. 1 are designated same as the latter. The member 72 is disposed on a shaft 74 which is coupled with the driven shaft 5 of the friction gearing 6, 7 by means of a pair of bevel gears 75. Shaft 5 carries the one member 76 of a following device whose other member 77 is mounted on the receiver 73. Via a slip ring arrangement 78 and a circuit 79 the following device 76, 77 controls a reversing motor 80 in such a manner that, with an acceleration of the member 77 relative to the member 76, it runs in one direction and, when retarded, in the other, while it is at rest when the two members are in uniform movement. The motor 80 is coupled with the spindle 8 by means of two shafts 81 and 82 and of two pairs of bevel gears 83 and 84. A reversing motor 85 serves for driving the pair of bevel gears 46 to give the planet pinions 47 of the differential 43 a rotation about the coinciding axes of the two crown wheels 42 and 44 and an additional rotation therefore to the shaft 45 driven by motor 41. The reversing motor 85 is required to alter its sense of rotation on the one hand when changing between the acceleration and retardation of the member 77 reitive to the member 76 takes place, and on the other, when in its displacement relative to the friction disc 8 the friction wheel 7 passes through the centre of the friction disc 6.

To satisfy this requirement the following arrangement is provided for. On a permanently disposed disc 86 an annular copper strip 87 and an annular insulating strip 88 are arranged in such a manner that both strips form a complete ring. Said ring and a contact lever 89 rotatable about the axis of said ring form a switching device. The contact lever 89 is so attached to a worm gear (not shown in the drawing) meshing with a worm 90 fitted to the shaft 81 that it coincides at the point of contact between the two strips 87 and 88 when the friction wheel 7, as shown in the drawing, touches the centre of friction disc 6. The described switching device is so connected with the circuit 78 and with two electromagnets 91 and 92 that the magnets—according to whether the contact lever 89 touches the copper strip 87 or the insulating strip 88—are charged with current or are dead. The magnets 91 and 92 cooperate with the contact levers 93 or 94, respectively, each of which is pivotally disposed around a permanently fitted pin 95, or 96, respectively, and each of which is subjected to the action of a spring 97, or 98, respectively, counteracting the respective magnets. Depending upon whether the magnet 91 carries current or not the contact lever 93 closes a contact 99 or 100 and, depending upon whether the magnet 92 carries current or not, the contact lever 94 closes a contact 101 or 102. The contact levers 93 and 94, as well as the contacts 89, 180, 101 and 102, the reversing motor 85 and the slip-ring arrangement 78 are so connected by electric wires that the aforesaid requirement is satisfied.

The devices according to Figs. 6 and 7 are intended for the same purpose as the device according to Fig. 5. They differ from the latter by the controlling gear being of another design, one motor only being required for operation. For the sake of simplicity the sense of rotation of

the receiver 73 has been assumed to remain the same for both of the devices. What is required therefore is that the friction wheel is adjusted relative to the friction disc 6 merely between the centre and the one edge of the latter so that the device provided for in Fig. 5, viz., for changing the rotational sense of the additional rotation of the friction disc 6 in connection with the position of the friction wheel 7 relative to the friction disc 6 can be dispensed with. The designations of Fig. 5 have been maintained as far as possible.

In Fig. 6 the pair of bevel gears 46 is coupled with the spindle 9 by means of two shafts 103 and 104, as well as by two pairs of bevel gears 105 and 106. On the shaft of the motor 41 a bevel gear 107 meshing two bevel gears 108 and 109 is mounted. The bevel gear 108 is mounted on a shaft 110 carrying the fixed part of a clutch coupling 111. The movable part of this clutch coupling is guided on a shaft 112 by means of slot and key. The one arm 113 of a two-arm lever pivotally mounted around a permanent axis engages a ring groove of the said movable part, while the other arm 114 is subjected to the action of a spring 115 which tends to hold the lever 113, 114 in that respective position where the clutch coupling 111 is disengaged. Co-acting with the arm 114 is a magnet 116 which when exited overcomes the tension of the spring 115 and brings the lever 113, 114 into that respective position where the clutch coupling engages. With the one coil-end the magnet 116 is connected to the slip-ring arrangement 78 and with the other coil-end to a pocket-lamp battery 117 which is likewise in connection with the slip-ring arrangement 78. The magnet 116 is exited when the member 77 accelerates relative to the member 76 of the follower mechanism. By means of a pair of bevel gears 118 as well as of a shaft 119 and of a pair of bevel gears 120 the shaft 112 is so coupled with the spindle 9 that the carrier 10—with the clutch coupling 111 engaged—experiences a displacement in the direction of the arrow as shown in the drawing, whereby as a result of the spindle 9 being coupled with the pair of bevel gears 46 the crown wheel 44 of the differential 43 experiences a rotation in the same sense as under the effect of the motor 41. The bevel gear 109 is mounted upon a shaft 121 carrying the fixed part of a clutch coupling 122. The movable part of this clutch coupling is keyseated on a shaft 123. The one arm 124 of a two-arm lever pivotally mounted around a permanent axis engages a ring groove of the said movable part, while the other arm 125 is subjected to the action of a spring 126 which tends to hold the lever 124, 125 in that respective position where the clutch coupling 122 is disengaged. Co-acting with the arm 125 is a magnet 127 which when excited overcomes the tension of a spring 126 and brings the lever 124, 125 into that respective position where the clutch coupling is engaged. With the one coil-end the magnet 127 is connected to the slip-ring arrangement 76 and with the other coil-end to the pocket lamp battery 117. The magnet is excited when the member 77 is retarded relative to the member 76 of the following mechanism. By means of four pairs of bevel gears 126, 129, 130 and 131, as well as by three shafts 132, 133 and 134 the shaft 123 is so coupled with the spindle 9 that the carrier 10—with clutch coupling 122 engaged—experiences a displacement in a direction opposite to that indicated by the arrow in the drawing.

The device according to Fig. 7 mainly differs from that shown in Fig. 6 by the omission of the differential 43 and by the number of revolutions of the motor 41 being regulatable. The shaft of motor 41 carries the friction disc 6. The motor 41 is equipped with a rheostat 135 in front of the armature and with a rheostat 136 in front of the field winding. The arm 113 of the lever 113, 114 co-acts with a switch 137 in such a manner that with the switch 137 open the armature current flows through the rheostat 135, while, with the switch 137 being closed, the rheostat 135 is short-circuited, involving an increase in the angular speed of the shaft of motor 41. The closing of the switch 137 takes place simultaneously with the engaging of clutch coupling 111, i. e., when the member 77 accelerates relative to the member 76 of the follower mechanism. The arm 124 of lever 124, 125 cooperates with a switch 138 in such a manner that, with the switch 138 open, the exciting current flows through the rheostat 136, while with the switch 138 closed, the rheostat 136 is short-circuited, involving a reduction in the angular speed of the shaft of motor 41. The closing of the switch 138 takes place simultaneously with the engaging of the clutch coupling 122, i. e., when the member 77 is retarded relative to the member 76 of the follower mechanism.

KARL PAPELLO.
WILLY SANDER.