July 6, 1948. W. F. KANNENBERG 2,444,448

PLANETARY GEAR UNIT

Filed Jan. 1, 1945 2 Sheets-Sheet 1

FIG. 1

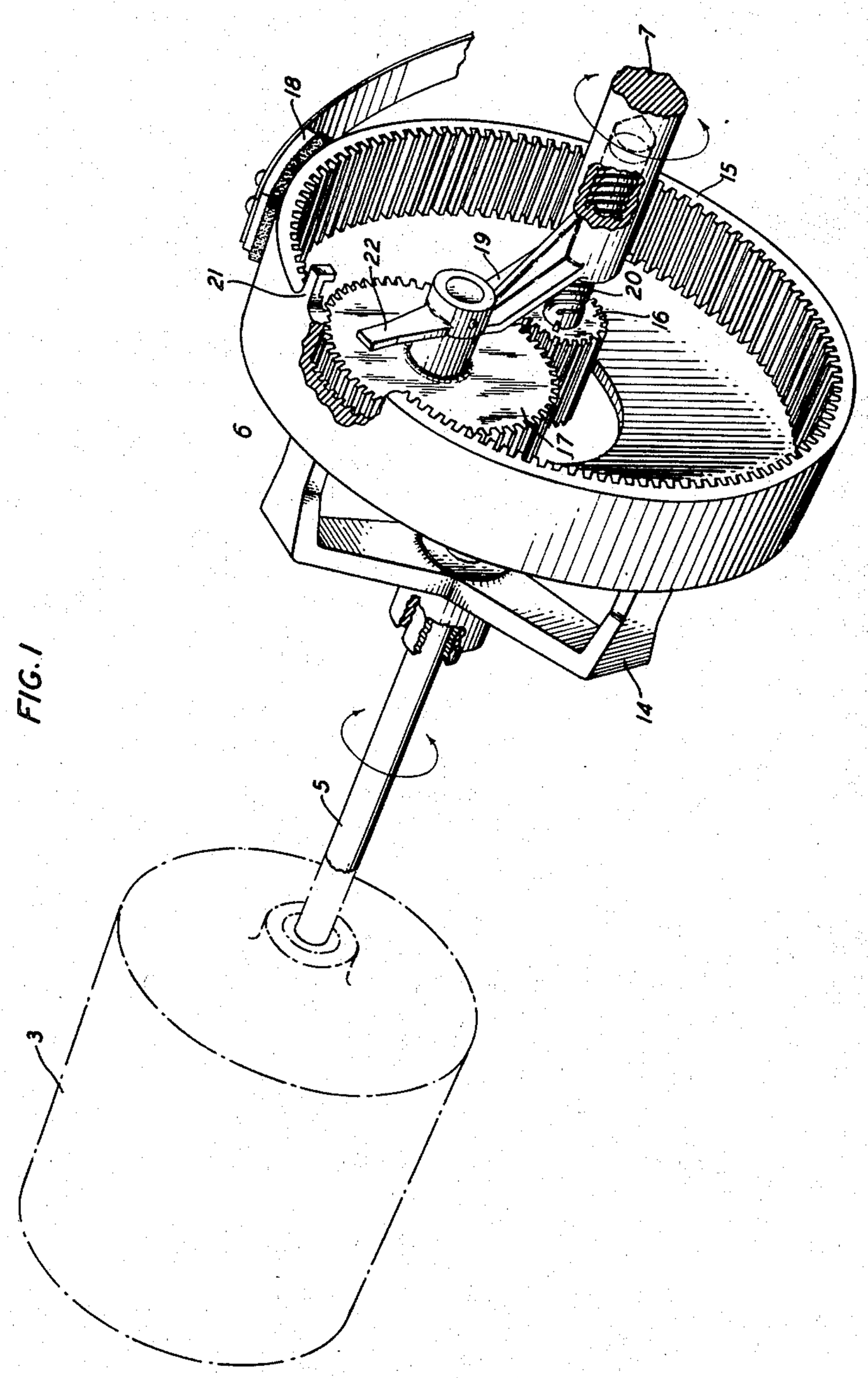

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FIG. 2

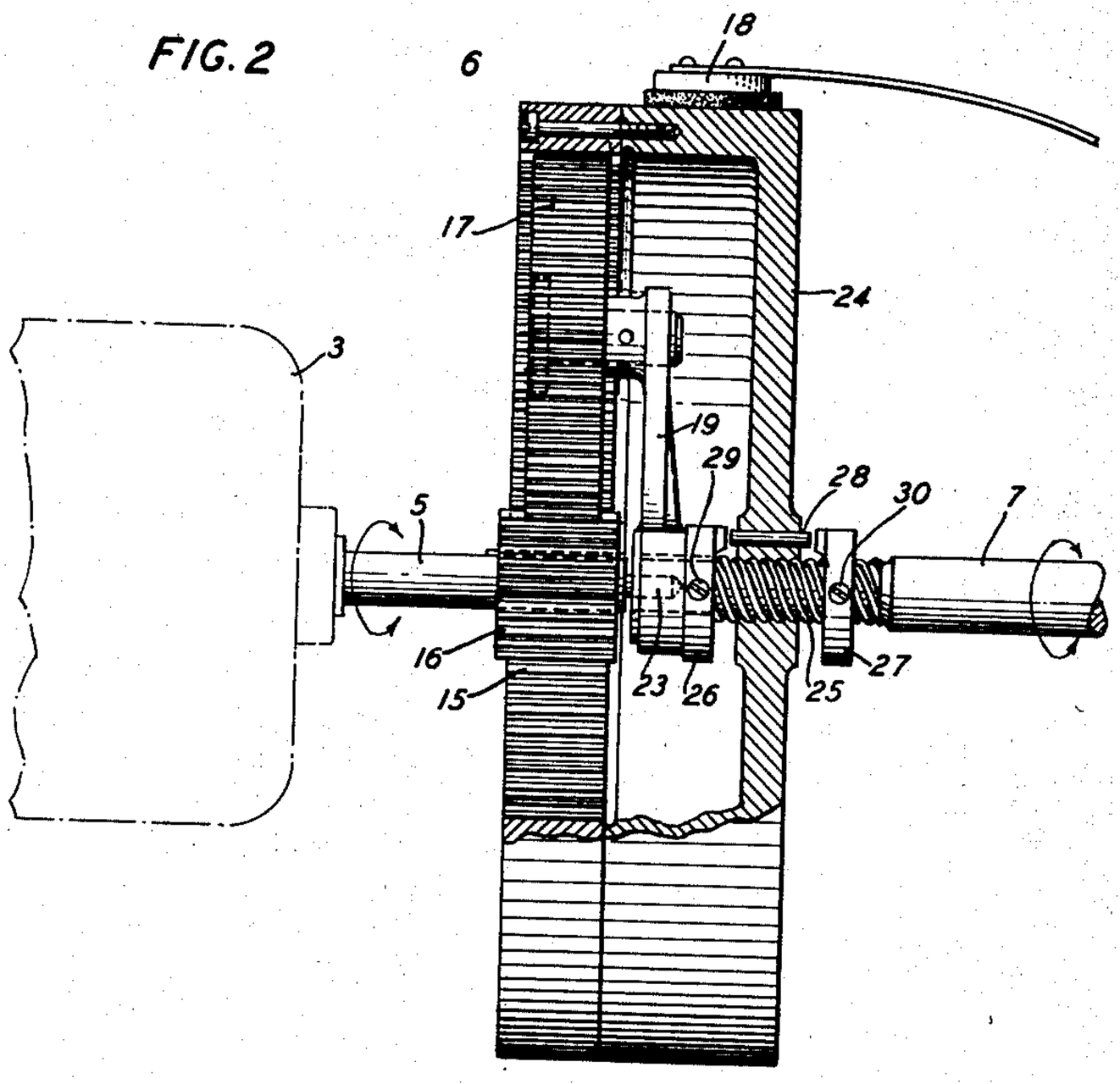
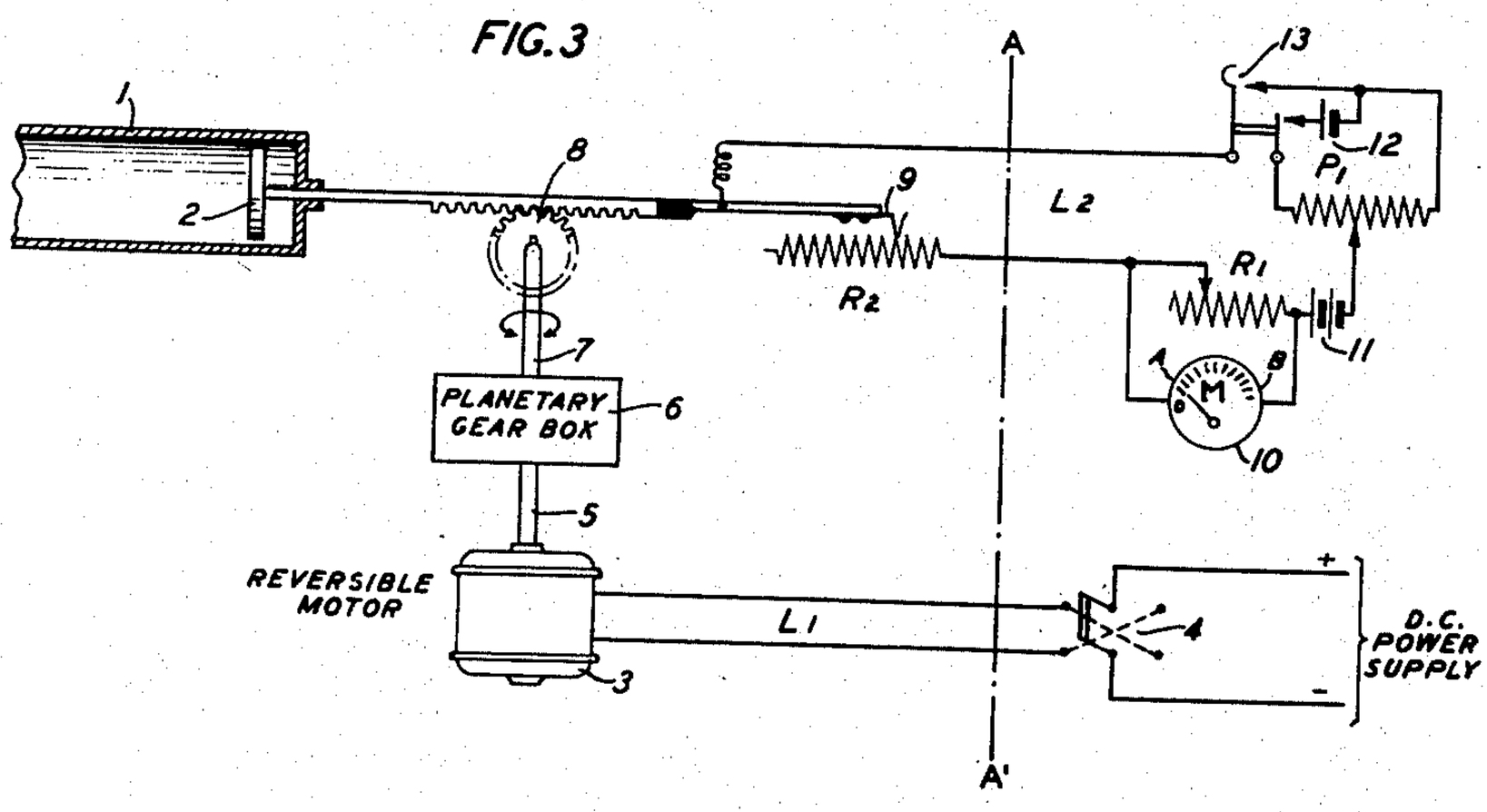


FIG. 3



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2,444,448

PLANETARY GEAR UNIT

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5 Claims. (Cl. 74—291)

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This invention relates to circuit arrangements and apparatus for remotely controlling radio tuning devices and more particularly to gear mechanisms interposed between a reversible motor and the tuning device whereby the speed ratio between the motor shaft and the tuning device is automatically changed from high speed to low speed, or vice versa, for the purpose of rapidly locating the region of the critical tuning point and then slowly scanning the critical region, back and forth, to accurately locate the critical tuning point.

A feature of the invention resides in a planetary gear mechanism whose ring gear is frictionally held to cause the planetary gear, under control of a sun gear on a driving shaft, to drive the tuning device through a driven shaft at slow speed back and forth over a small area of the critical region of the tuning range and, by means of a screw-threaded coupling between the driving and driven shafts to effect lateral displacement of the planetary gear with respect to the ring gear to cause stop means in fixed relation with the driven shaft to engage cooperating means on the ring gear whereby after the tuning device has been moved at slow speed for a predetermined distance in either direction further rotation of the driving shaft in the same direction causes the engagement of said stop means whereby the tuning device is driven at high speed against the retarding effect of the friction applied to the ring gear.

Another feature comprises means for adjustably positioning said stop means whereby the tuning area traversed at low speed can be varied as desired.

The invention will be understood from the following description and accompanying drawings.

Fig. 1 of which shows one embodiment of the invention;

Fig. 2 is a modification of the arrangement of Fig. 1; and

Fig. 3 shows a system for the remote control of the tuning device employing a gear mechanism of the type shown in either Figs. 1 or 2, and also with means for indicating, at the remote control point, the setting or position at any instant of the tuning device.

As shown in Fig. 3 a device 1 adapted to be tuned, by moving a plunger member 2 back and forth within a resonant chamber, is controlled by a reversible motor 3 which is in turn controlled over a line L_1 from a remote control center, at the right of the broken line AA', by means of a pole changing switch 4. Motor 3 is

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coupled to and moves plunger 2 of the device 1 through the medium of a driving shaft 5, a gear mechanism 6 according to the present invention, a driven shaft 7 and a rack and pinion arrangement 8.

An adjustable resistance or rheostat R_2 is associated with the tuning device 1 and has its contact arm 9 connected to and controlled by the plunger 2. A second line L_2 connects the rheostat R_2 with an indicating arrangement at the control point which arrangement comprises a meter 10, a line battery 11, a potentiometer P_1, a rheostat or adjustable resistance R_1, a small battery 12, and a switch 13. A description of the functions of the indicating arrangement and its operation will be given hereinafter.

The gear mechanism 6 will now be described by first referring to the arrangement of Fig. 1 which shows a planetary gear mechanism interposed between a driving shaft 5 and a driven shaft 7, which as shown in Fig. 3, may control any desired device such as an adjustable condenser, resonant chamber or the like. Supported on the driving shaft 5 and freely rotatable thereon by means of a spider 14 is a ring gear 15 having internal gear teeth. Cooperating with the teeth of the ring gear, and also with a sun gear 16 fixedly mounted on the driving shaft 5, is a so-called planet gear 17. Frictional means, shown as a brake 18, engages the periphery of the ring gear and tends to resist its rotation and therefore the planet gear 17 is caused to travel around the inside of the ring gear 15 in a well understood planetary manner. It will be noted that the planet gear 17 is rotatably supported on a crank member 19 fixed to shaft 7 whereby planetary movement of gear 17 causes shaft 7 to revolve at a slower speed than the driving shaft 5, depending on the ratio of the three gears 15, 16 and 17. Shaft 5 also has a reduced diameter threaded portion 20 which screws into a correspondingly threaded bore in shaft 7 whereby rotation of shaft 7 in either direction causes its lateral movement or displacement at a rate determined by the pitch of the thread. Attached to the rim of ring gear 15 is an inverted slotted U-shaped stop member 21, and mounted on the crank member 19 is an extension arm 22 of such dimensions that as the planet gear 17 moves around the inside of gear 15 the arm extension will pass through the slot in member 21 during a predetermined number of revolutions of the shaft 7 depending on the pitch of the thread on the end of shaft 5 but when the lateral movement of shaft 7 moves the crank arm extension

22 so that it will not pass through the slot in the stop member 20, it will abut the stop member, either to the right or left of the slot, thereby preventing further movement of the planet gear with respect to the ring gear 15, in the same direction, and therefore ring gear 15 and shaft 7 will rotate as a unit at the speed of shaft 5 against the retarding effect of brake 18.

The operation of the gear mechanism of Fig. 1 with the system of Fig. 3 is as follows: The attendant at the control station desiring to effect control of the tuning device 1 which is associated with equipment, not shown, as for example radio apparatus, first closes switch 13 and then adjusts the meter 10 to obtain readings for both extreme positions of the plunger 2 of the tuning device by operating reversing switch 4 to a predetermined right or left position to cause the plunger to be moved to its extreme righthand position. Closure of switch 4 energizes motor 3 which rotates shaft 5 together with sun gear 16 which in turn causes shaft 7 to turn at slow speed due to the action of planet gear 17 and at the same time to cause lateral movement of shaft 7 and the crank arm 19 mounted thereon. The number of revolutions of shaft 7 at slow speed following closure of switch 4 will depend on the lateral displacement of crank arm extension 22 at the instant motor 3 is energized, but assuming shaft 7 is in such a lateral position at the start that the crank arm extension passes through the slotted stop member 21 twice before it abuts the stop member, then shaft 7, through the medium of rack and gear 8, will move plunger 2 slowly for a short distance to the right after which due to the crank arm extension 22 coming in contact with stop member 21 the plunger will be moved at high speed for the remainder of its travel thus cutting out the resistance of R_2 from the line L_2 at which time means, not shown, as for example a slipping clutch, may be effective to prevent damage to the apparatus.

The attendant at the control station now observes the reading of meter 10, adjusts potentiometer P_1 to set the needle at a predetermined maximum scale position indicated at B, and then operates switch 4 to its other or second position thereby reversing motor 4 and its shaft 5 whereupon crank arm extension 22 of the gear mechanism backs away from its contact with stop member 21 and shaft 7 again rotates at slow speed in a reverse direction for the number of revolutions determined by the width of the slot in stop member 21 after which extension arm 22 again engages the stop member at the other side of the slot whereupon a one to one ratio between shafts 5 and 7 is effected and plunger 2 now rapidly moves to its extreme left position thereby including the total resistance of rheostat R_2 in the line L_2. The attendant now adjusts rheostat R_1 until the meter reads at a predetermined low point, indicated at A on the scale, which represents the resistance in series with battery 11 at the time. The intermediate points on the meter scale between points A and B now represent definite positions of the plunger 2 of the tuning device. The circuit is now in readiness to check the operativeness of the tuning device which is accomplished by transmitting a check wave of predetermined frequency, by means not shown, and moving the plunger 2 back and forth by operating the motor first in one direction and then in the other until the critical tuning point is passed, then reversing the motor switch 4 whereupon the plunger will be moved at a reduced speed in the opposite direction. By repeatedly reversing the motor during the slow speed operation of the plunger the exact critical tuning point can be located. The position of the plunger 2 at this point will be indicated on the meter.

The modified arrangement of gear mechanism 6, as shown in Fig. 2, will be understood from the following: As before, reversible motor 3 drives the shaft 5 which carries the sun gear 16. Shaft 5 is loosely journaled at 23 in the end of driven shaft 7 which in turn carries a crank arm 19 on which a planet gear 17 is free to rotate which gear cooperates with sun gear 16. An internal toothed ring gear 15 surrounds and cooperates with the planet gear 17. A brake or frictional device 18 retards movement of the ring gear which gear is supported from the shaft 7 by a cup-shaped member 24 having a threaded opening in which a corresponding threaded portion 25 of shaft 7 revolves. Two stop members 26 and 27 are adjustably fixed on the threaded portion 25 and a cooperating stop pin 28 is located in the member 24. Upon rotation of shaft 5 planet gear 17 travels around inside ring gear 15 thereby turning shaft 7 at slow speed which due to its screw-threaded portion 25 causes lateral movement of the ring gear 15 and its supporting member 24 along the axis of the two shafts until stop pin 28 is moved into the path of one of the stop members 26 or 27, depending on the direction of rotation of the shaft 5, whereupon further movement, in the same direction, of planet gear 17 with respect to the ring gear is prevented and the two shafts rotate at the same speed against the friction of brake 18.

The stop members 26 and 27 are held in any desired position by means of set screws 29 and 30 whereby the slow speed movement of plunger 22 of the tuning device can be adjusted to any desired distance.

What is claimed is:

1. In a planetary gear mechanism comprising mutually cooperating sun, planet and ring gears, a driving shaft for rotating said sun gear, a driven shaft coaxial with the driving shaft, braking means for frictionally impeding said ring gear against rotation to cause planetary movement of said planet gear about said shaft axis, means comprising a crank member fixedly mounted on said driven shaft and rotatably supporting said planet gear for causing said planetary movement to rotate said driven shaft, screw-threaded means responsive to rotation of said driven shaft for axially displacing said driven shaft with respect to said ring gear, and other means comprising stop members fixedly associated with said driven shaft and ring gear adapted to cooperate in response to predetermined axial displacement of said driven shaft in either direction, depending on the direction of rotation of said driven shaft, to effect a direct coupling between said two shafts.

2. In a planetary gear mechanism comprising mutually cooperating sun, planet and ring gears, a driving shaft for rotating said sun gear, a driven shaft coaxial with the driving shaft, braking means for frictionally impeding said ring gear against rotation to cause planetary movement of said planet gear about said shaft axis in response to rotation of said driving shaft, means comprising a crank arm fixedly mounted on said driven shaft and rotatably supporting said planet gear for causing rotation of said driven shaft responsive to planetary movement of said planet gear thereabout, and other means com-

prising stop members fixedly associated with said driven shaft and ring gear adapted to cooperate after a predetermined number of revolutions of said driven shaft, in either direction, to cause said driven shaft to rotate at the same speed as the driving shaft against the impeding effect of said braking means on the ring gear.

3. In a gear drive mechanism a driving shaft, a sun gear fixed on said driving shaft, a driven shaft coaxial with said driving shaft, a crank arm mounted on said driven shaft, a ring gear, a planet gear rotatably mounted on said crank arm and engaging both said sun and ring gears, braking means for frictionally retarding rotation of said ring gear to cause rotation of said driven shaft in response to rotation of said driving shaft, means responsive to rotation of said driven shaft for laterally displacing said driven shaft and ring gear with respect to each other in either direction depending upon the direction of rotation of said driving shaft, and stop means associated with both ring gear and driven shaft adapted to engage each other upon a predetermined lateral displacement of said driven shaft to cause said driving and driven shafts to rotate at the same speed against the impeding effect of said braking means on the ring gear.

4. In a gear drive mechanism, a driving shaft, a sun gear fixed thereon, a ring gear rotatably supported on said driving shaft, a driven shaft coaxial with said driving shaft, a crank arm mounted on said driven shaft and rotatable therewith, a planet gear rotatably mounted on said crank arm and engaging both said sun and ring gears, braking means for frictionally retarding rotation of said ring gear to cause rotation of said driven shaft in response to planetary movement of said planet gear, means comprising a screw-threaded portion of said driving shaft cooperating with a correspondingly threaded bore in said driven shaft to axially displace said driven shaft with respect to said ring gear upon rotation of

said driven shaft, a pair of axially spaced stop members on said ring gear, and an extension of said crank arm adapted to engage one or the other of said members upon axial displacement of said arm a predetermined amount, in either direction, to effect a one-to-one speed ratio coupling between said driving and driven shafts.

5. In a planetary gear mechanism, a driving shaft, a sun gear fixed thereon, a driven shaft coaxial with said driving shaft, a ring gear coaxial with said shafts, a supporting member for said ring gear screw-threadedly mounted on said driven shaft, a crank arm fixed on said driven shaft and rotatable therewith, a planet gear rotatably mounted on said crank arm and engaging both said sun and ring gears, braking means for frictionally retarding rotation of said ring gear to cause rotation of said driven shaft in response to planetary movement of said planet gear, and to thereby cause the axial displacement of said driven shaft with respect to said ring gear supporting member, a pair of adjustable axially spaced stop members on said driven shaft and a corresponding pair of stop members on said ring gear supporting member, said pairs of stop members being so positioned that axial displacement of said driven shaft in either direction a predetermined amount causes one member of each pair of stop members to abut each other to effect a one-to-one speed ratio coupling between said driving and driven shafts.

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