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N. D. PRESTON ET AL
MULTIPLE POSITION ELECTRICALLY
OPERATED DISPLAY INDICATOR
Original Filed March 31, 1944

2,481,780

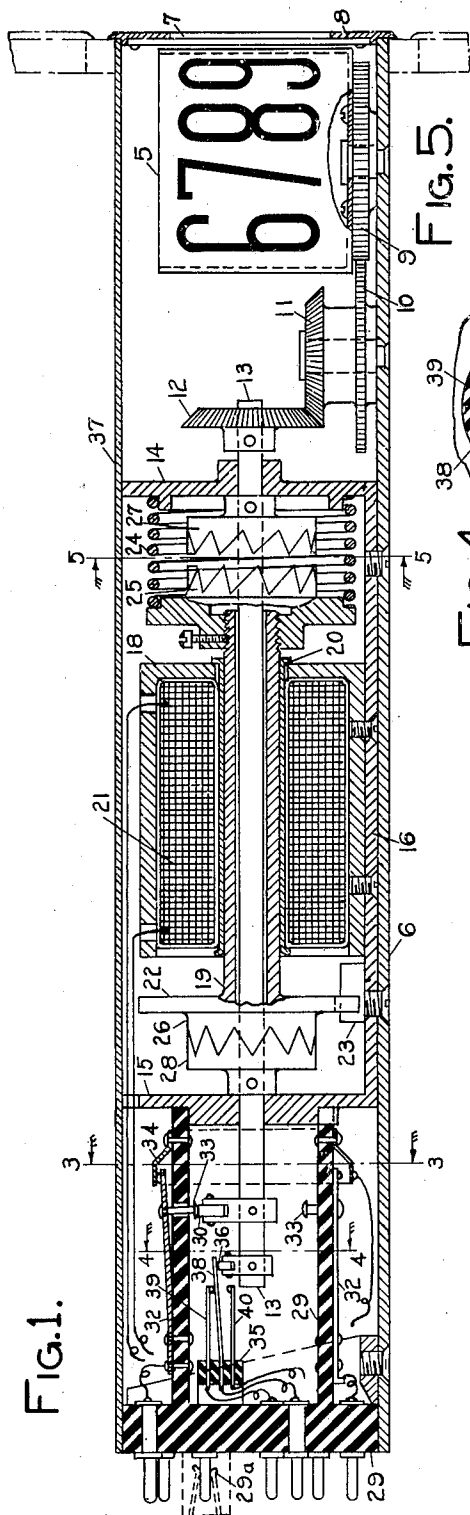


FIG. 1.

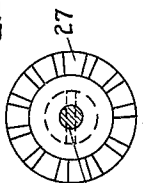


FIG. 5.

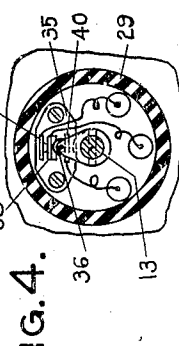


FIG. 4.

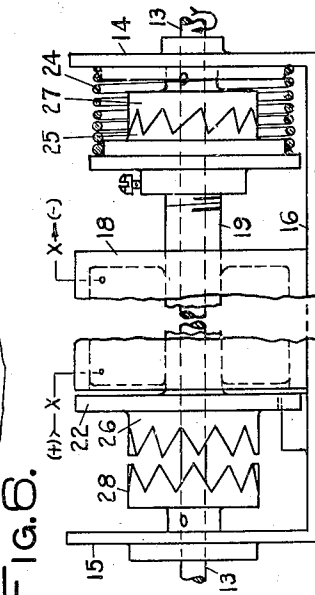


FIG. 6.

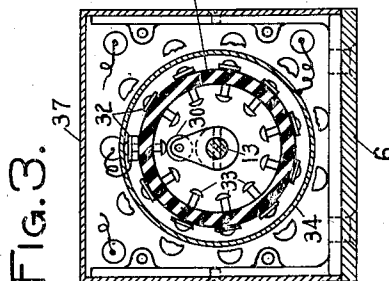


FIG. 3.

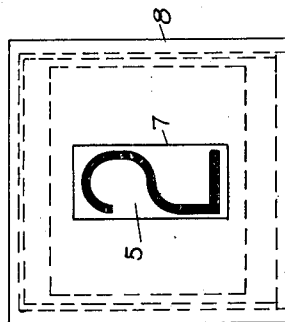


FIG. 2.

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UNITED STATES PATENT OFFICE

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MULTIPLE POSITION ELECTRICALLY OPERATED DISPLAY INDICATOR

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Original application March 31, 1944, Serial No. 528,926. Divided and this application September 20, 1945, Serial No. 617,504

9 Claims. (Cl. 177—328)

1

This invention relates in general to airway traffic control systems, and has more particular reference to an indicator or display unit for use in displaying flight schedule data in connection with such airway traffic control systems.

This application is a division of our prior application Ser. No. 528,926, filed March 31, 1944, now Patent No. 2,439,862, granted April 20, 1948.

In the systems employed for air traffic control, it is convenient to provide flight progress boards for displaying the flight data of the different scheduled flights in such a way that an operator or dispatcher may readily identify the various flights or planes, their computed times of arrival, their over-times, their schedules, altitudes, and the like. The present invention relates to a display unit or indicator adapted to be used as an individual unit in closely related positions to form such a flight progress board, or other display panel, which composite organization of units may suitably be controlled, such as disclosed in our prior application Ser. No. 528,926, filed March 31, 1944 to display the desired information. It is of course to be understood that the changeable indicator unit of the present invention may be used in various types of panels and control systems.

One of the objects of the present invention is to provide a changeable indicator unit which is small and compact in structure and which is positive in action as it is operated step by step to its different positions being adapted to open and close contacts in each of its different positions.

Other attributes, operating characteristics and advantages of the changeable indicator of this invention will be in part apparent and in part pointed out as the description progresses.

In describing the invention in detail, reference will be made to the accompanying drawings, in which similar reference characters are used to designate similar parts throughout the various figures, and in which—

Fig. 1 illustrates a side view of the changeable indicator of the present invention with parts shown in section to more clearly illustrate the structure;

Fig. 2 is a front view of the changeable indicator shown in Fig. 1;

Fig. 3 is a sectional view taken on lines 3—3 of Fig. 1 to illustrate the contact structure;

Fig. 4 is a sectional view of the normal position contacts taken on lines 4—4 of Fig. 1;

Fig. 5 is a sectional view taken on line 5—5

2

of Fig. 1 to show the toothed operating discs; and

Fig. 6 is an abbreviated diagrammatic structural view to show the operated position of the operating mechanism.

The flight progress board of an air traffic control system may be said to be the primary element of the system and the one with which the other component parts are operatively associated. This flight progress board, or other type of display board, has a large number of changeable indicators associated in various relationships to display the desired data. In a flight progress board, this data usually includes the flight number, the scheduled time, the altitude, the over-time and various other such items as may be useful in the handling of air traffic. In such a system, it will be readily apparent that each indicator unit will have on its display drum, letters, figures, or the like, as may be necessary for that particular unit to display the proper information. In the specific embodiment of the present invention, the unit is disclosed as displaying numerals, but any other symbols may be displayed as desired.

The flight progress board comprises a plurality of panels and each panel comprises a plurality of schedule posting portions. These posting portions of a fix panel comprise a number of horizontal rows or tiers of electrically operated indicators depending upon the density of traffic and the maximum number of flight schedules required to be posted at any given time.

The changeable indicators in each registration space in a fix panel are operated electrically by manual or automatic control from normal positions to selected operated positions to display the desired letters, figures or symbols to represent the significant data for a flight schedule. These units are adapted to be located close to each other so as to display the information relating to time, for example, in a readable fashion, and the units used to display such data may be spaced from indicators relating to other data. These units are thus arranged to be mounted on a suitable structure in a suitable way as to assist in supporting one another, as disclosed in the above mentioned prior application Ser. No. 528,926.

With reference to the drawings, one form of a self propelled indicator unit is illustrated in Figs. 1 through 6, and comprises an indicator drum 5 (see Fig. 1) mounted to turn on a vertical axis supported in the lower frame member 6 of the indicator unit. The numbers, letters, or other de-

3

sired symbols on the periphery of this drum are exhibited in its different positions through the opening 7 in a suitable mask 8 forming the face plate of the indicator unit (see Figs. 1 and 2). The indicator drum 5 is connected by spur gears 9 and 10 and also bevel gears 11 and 12 to an operating shaft 13 extending longitudinally of the unit and supported on bearings in the end members 14 and 15 of the operating element 16 secured to the base member 6 by screws or the like. The self propelling driving mechanism or operating element 16 for turning the shaft 13 and the indicator drum 5 to the different positions comprises an operating magnet or solenoid 18 having its core 19 mounted loosely on the driven shaft 13 and supported in a suitable non-magnetic sleeve 20 in the coil or winding 21. The armature 22 at one end of the core is guided by a fixed stop 23 in a notch in said armature, or a similar manner, so that the armature and core are prevented from turning. The armature and core are biased in one direction toward the left as shown, by a coil spring 24. Toothed discs 25 and 26 fastened to the ends of the armature-core cooperate with toothed collars 27 and 28 respectively, which collars are fixed to the driving shaft 13 in such a manner that the energization and deenergization of the solenoid causing reciprocation of the armature-core member will drive the shaft 13 step by step and move the indicator drum 5 to its different active positions.

Figs. 1, 5 and 6 illustrate one arrangement of teeth suitable for this purpose, assuming the indicator to have ten active positions and a blank position, and the cooperating discs 25 and 26 with their respective collars 27 and 28 formed with eleven teeth and eleven spaces, so that each energization and subsequent deenergization of the solenoid will move the indicator drum $\frac{1}{11}$ part of a revolution from one indicating position to the next. The parts are shown in the normally deenergized position of the solenoid in Fig. 1 with the disc 26 on the core cooperating with the collar 28 to hold the indicator in its then existing position. Upon energization of the solenoid and movement of the core toward the right, the teeth on the disc 25 engage the teeth on the collar 27 to turn the shaft through an angle sufficient to bring the points of the teeth on the collar 28 beyond the points of the teeth on the disc 26 in the direction of rotation as shown in Fig. 6. Thus, upon deenergization of the solenoid and movement of the armature core to the left by the spring 24, the toothed disc 26 cooperates with the collar 28 to shift the shaft 13 through an additional angle sufficient to bring the indicator to its next active position.

With reference to Fig. 1, it will be seen that the toothed disc 26 and the toothed collar 28 have teeth which are exact counterparts of each other and each tooth has the same angle of slope on both sides. On the other hand, it will be seen from Figs. 1 and 6 that the toothed disc 25 and the toothed collar 27 have teeth which evenly engage each other, but the angle of slope on one side of a tooth is different than the angle of slope on the other side. This angle is suitably chosen so as to cause the off-setting of the teeth points of 25 and 27 as shown in Fig. 1 while the solenoid is deenergized, and so as to cause the off-setting of teeth points of 26 and 28 as shown in Fig. 6 while the solenoid is energized and the core is moved to the right against the bias of spring 24. Fig. 5 is a section taken on lines 5—5 of Fig. 1 looking in the direction of the arrows with certain

4

parts removed and shows the off-setting of the base of the teeth with respect to their points. The purpose of this difference in the slope on the opposite sides of the teeth on the right hand end of the driving mechanism is to give an inherent direction of rotation to the mechanism.

The indicator unit is provided with one or more sets of position contacts, and empty-full contacts opened and closed as the indicator is moved out of its blank position. The position contacts are preferably of the same type disclosed in the Field and Wight application, Ser. No. 489,776 filed June 5, 1943, which has resulted in Patent No. 2,378,294, dated June 12, 1945, comprising contact fingers arranged in the form of a barrel and supported by an insulated member 29 and operated from the inside by a roller 30 connected to the driving shaft 13. The empty-full contacts may also be supported on the same insulated member 29 and operated by another roller 36.

With reference to Figs. 1 and 3, it will be seen that the contact fingers 32 are located around the barrel portion of the support member 29 which is made of insulating material. Each of these fingers 32 is provided with a pusher arm 33 which is engaged by the roller 30 to move its respective finger. Normally these fingers 32 rest against the barrel portion of support member 29 but when the pusher of a finger is engaged by the roller 30, that finger is pushed outwardly to cause its contact point at the end of the finger to engage a circular ring 34 to make contact for the particular position then assumed by the indicator. Fig. 3 is a sectional figure taken on line 3—3 of Fig. 1 and from these two figures it can be seen that each contact finger is to be connected to a separate plug member mounted on the support member 29, and similarly the circular ring 34 is also connected to a plug member.

The empty-full contacts (or normal position contacts) are supported on a bracket 35 mounted on the support member 29 and the center movable contact 38 is actuated by a separate roller 36 to a position to contact the upper empty contact 39 while the indicator is standing in the blank position illustrated in Figs. 1 and 3. When the indicator assumes any other position, the center movable contact 38 is released by the roller 36 and it assumes a back point position for contacting the full contact 40. The Fig. 4 is a section taken on line 4—4 of Fig. 1 to show an end view of the empty-full contact arrangement. Each of the three empty-full contacts 38, 39 and 40 is suitably connected to a plug member mounted on the support member 29.

It is noted that the base 6 of the indicator unit provides supporting means for the display drum 5, the gear wheels, the drive mechanism 16 and the contact support barrel 29. A cover 37 to which is attached the mask 8 fits over the indicator unit and completely encloses it on the top and both sides, in such a way that the operating mechanism and contact structure are completely enclosed in dust-proof compartments in spite of the fact that the opening 7 does not have a transparent insert. Such a transparent insert may of course be provided if desired, but it is contemplated that the display drum 5 shall be illuminated from an external light source the intensity of which may be readily controlled and transparent inserts are omitted to avoid any possible trouble that might be caused by reflection.

The indicator units for the various rows or spaces of a panel are supported on a suitable frame or mounting structure providing in effect,

5

cells into which the indicator units may be inserted; and each indicator unit is made detachable as a whole for repair or replacement purposes by employing a plug coupler of suitable construction as shown in a diagrammatic manner in Fig. 1 at 29a, so as to connect wires of the indicator units with the external buses and wires of the system.

This same general type of indicator is employed for the various registration and posting spaces of the different display units and panels of the flight progress board, and is also employed in other places in the controlling system to provide position contacts which are positively operated step by step as more specifically disclosed in the above mentioned parent application Ser. No. 528,926.

For the purpose of the present disclosure each indicator structure is considered to have eleven positions as above described, with a display drum bearing the particular data which that indicator is to display. But it is characteristic of all indicator display drums that they have a blank normal position.

The flight number display drums are provided with the numerals 0 to 9 in their operated positions, and this is also true of the unit minutes and unit hours schedule time, as well as over-time unit minutes.

The display drums for the tens of minutes schedule time and the over-time tens of minutes have the numerals 0 to 5, while the tens of hours schedule time have only the numerals 0, 1 and 2.

In the case of the altitude display drums, the numerals 2 to 11 are used, and thus a single indicator can display the levels or altitudes most commonly used for commercial transport purposes, but it is to be understood that two indicators can be used for each space of a posting panel to display the altitude on the basis of units and tens if a greater number of altitudes than ten is desired.

The direction indicator display drums each have four arrows, two for one direction and two for the opposite direction; and for convenience in the disclosure, those arrows pointing to the right are assumed to be next adjacent the blank position in the direction of rotation of the drums, while the arrows pointing to the left are assumed to be in the last two operated positions.

These various indicators which have vacant positions, have bus and circuit connections to the contacts only for those positions that are used, while the vacant positions are merely left disconnected and idle. Because of the control provided for the various indicators, these indicators having vacant positions automatically pass by such positions just as if they were not there.

Having thus described one form of a changeable indicator for use in an airway traffic control system as one specific embodiment of the present invention, it is to be understood that various modifications, adaptations and alterations may be applied to meet the requirements of practice without in any manner departing from the spirit or scope of the invention except as limited by the appended claims.

What we claim is:

1. In a changeable indicator unit, a driving mechanism having a rotatable shaft with spaced notched drive wheels mounted thereon, an armature member having notched wheels movable in a reciprocatory manner between said drive wheels

6

to cause their rotation in a given direction for each of its reciprocating movements, said notched wheels on said shaft and on said armature member having a plurality of equally spaced engageable pointed teeth of comparable depth, each of said teeth on said wheels having both faces sloped with respect to the axis of the shaft, said toothed wheels by the engagement of the sloped faces of their teeth acting to restrain substantial movement of the shaft in either direction during the reciprocatory movement of said armature member, an operating winding associated with said armature member, a multiple position contactor connected to said shaft for actuating a plurality of spring contacts separately in the different positions of said shaft, a display drum operatively connected to said rotatable shaft, and means including a biasing spring effective to seat one of said drive wheels tightly against one of said notched wheels of said armature member when said indicator unit is inactive and thereby hold said drum against rotation in either direction.

2. In an indicator for flight progress boards, a display drum rotatable in a plane at right angles to the length of the indicator, a shaft extending horizontally to the length of the indicator and connected at one end through bevel gears to said drum, a reciprocatory drive mechanism mounted on said shaft and acting to turn said shaft through predetermined angles in the same direction when said mechanism in reciprocated, rotatable contacting means mounted on said shaft at its other end, an operating winding for moving said drive mechanism to one position and a biasing spring for moving it to its other position, and circuit means for intermittently energizing said winding, whereby said display drum and said contacting means are operated step by step to their different positions while said winding is intermittently energized by said circuit means.

3. In a changeable indicator unit, a rotatable drive shaft, a display drum operatively connected to said rotatable drive shaft, a plurality of contacts operatively connected to said drive shaft, and a driving mechanism for said drive shaft comprising a non-rotatable armature movable in a reciprocatory manner on said drive shaft, a pair of toothed discs at each end of said armature, one disc of each pair being attached to the armature and the other disc of that pair being attached to said drive shaft, the two discs of each pair having teeth adapted to engage each other, and the teeth of one pair having substantially equal angles of slope while the teeth of the other pair have unequal angles of slope sufficient to cause rotational movement of said drive shaft in a given direction due to successive engagement of the pairs of discs at the opposite ends of the armature, an energizing winding for actuating the armature to one position when energized, and a biasing spring for actuating the armature to said opposite position when said energizing winding is deenergized.

4. In a changeable indicator unit, a multiple position display drum, a driving mechanism for said drum having a rotatable shaft with a pair of toothed drive wheels mounted thereon and spaced longitudinally along said shaft, an armature member having toothed wheels located between the toothed drive wheels and operable in a reciprocatory manner between said drive wheels, the teeth of said armature wheels matching the teeth of said drive wheels in a manner to cause the rotation of said drive shaft in a particular direction for each reciprocatory movement of said

7

armature member, an operating winding associated with said armature member, a biasing spring for moving said armature member to a particular position from which it may be operated by energization of said winding, and contacts operated by said rotatable shaft so as to distinctively open or close a contact in each position of said shaft when said armature member is not operated.

5. In a changeable indicator unit, a driving mechanism having a rotatable shaft with a pair of toothed drive wheels mounted thereon; a reciprocatory movable armature having a pair of non-rotatable toothed wheels, the teeth of one drive wheel exactly matching the teeth of an armature wheel, the same being true of the other pair of wheels, but in the first case the teeth of said wheels having substantially equal leading and lagging angles of slope but in the second case having unequal leading and lagging angles of slope and the teeth of said two drive wheels being offset with respect to each other, a biasing spring for actuating said armature member to cause the teeth of one wheel to engage its corresponding drive shaft wheel while the other armature wheel is freely disengaged from its associated drive shaft wheel, an energizing winding for actuating said armature member to its operated position against the bias of said spring to cause the engagement of such other armature wheel with its associated drive shaft wheel, a multiple position display drum, and means operatively connecting said drum to said rotatable shaft to thereby operate said drum to its different positions.

6. In an indicator for flight progress boards, a multiple position display drum, a rotatable shaft operatively connected to said drum, drive means attached to said shaft having two sets of teeth which are offset with respect to each other and the two angles of slope for the teeth of one set being different from the two angles of slope for the teeth of the other set, armature actuated means having corresponding teeth to cooperate with the two sets of teeth of said drive means, said armature actuated means being reciprocally operable between predetermined opposite limits to cause rotation of said shaft and means for causing operation of said armature actuated means back and forth within the limits of its movement to thereby cause the operation of said display drum to its different positions.

7. In an indicator for flight progress boards, a multiple position display drum, a rotatable shaft operatively connected to said drum, an armature member non-rotatably mounted with respect to said shaft but slidably located thereon and having oppositely disposed toothed wheels, two toothed drive wheels located on opposite sides of said armature member and positively connected to said shaft, the teeth of said drive wheels matching the teeth of said armature member in a manner to cause the rotation of said shaft in a particular direction for each reciprocatory movement of said armature member, an operating winding associated with said armature member, and a biasing spring for moving said armature member to a particular position from which it may be operated by energization of said winding, whereby each energization of said winding followed by its deenergization operates said display drum to a different position, said biasing spring being effective to normally seat one of said toothed wheels slidable on said armature in full

8

mesh with one of said drive wheels positively connected to said armature to thereby securely hold said drum against rotation in either direction.

8. In an indicator for flight progress boards, a circular display drum having a plurality of display positions, a rotatable shaft operatively connected to said drum, two spaced drive wheels mounted on said shaft and fixed thereto, said drive wheels on their inwardly facing sides having teeth located thereon, a movable armature member slidably mounted on said shaft but having means for preventing its rotation, the armature member having teeth at each end corresponding with the teeth of the associated drive wheel, the teeth of one drive wheel having equal angles of slope and the teeth of the other drive wheel having unequal angles of slope, and the two drive wheels having their teeth offset with respect to each other, an operating winding for said armature member, a biasing spring for causing said armature member to normally engage the teeth of one of the drive wheels, said teeth being of such spacing and said shaft being so related to said display drum as to cause said display drum to be operated to a different position following each energization of said winding.

9. An indicator unit for flight progress boards comprising, a box-like frame, an indicator drum on a vertical axis at one end of the frame, an electromagnet with its axis extending longitudinally within said frame, a shaft extending through the magnet along its axis, means including bevel gears connecting said shaft to said indicator drum, a multiple position contactor connected to said shaft for actuating a plurality of spring contacts separately in the different positions of said shaft, two toothed discs fixed to said shaft, a reciprocatory but non-rotatable armature longitudinally actuated by said electromagnet, said armature having toothed wheels cooperating with said toothed discs to cause rotation of said shaft at both ends of the reciprocatory movement of said armature, one side of the teeth of said wheels and said discs having slopes to promote rotation in a given direction as a result of reciprocatory movement of said armature and the other side of the teeth of said wheels and said discs being also sloped with respect to the axis of said shaft sufficient to permit rotation of said shaft while the teeth of respective wheels and discs at one end of the shaft are being disengaged to allow rotation of said shaft as caused by the other wheels and discs that are coming into engagement.

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