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M. UNGER ET AL.
METHOD AND MEANS FOR FACILITATING THE LANDING AND
TAKE-OFF OF AIRPLANES FROM MOVABLE RUNWAYS
Filed April 1, 1942

2,375,449

2 Sheets-Sheet 1

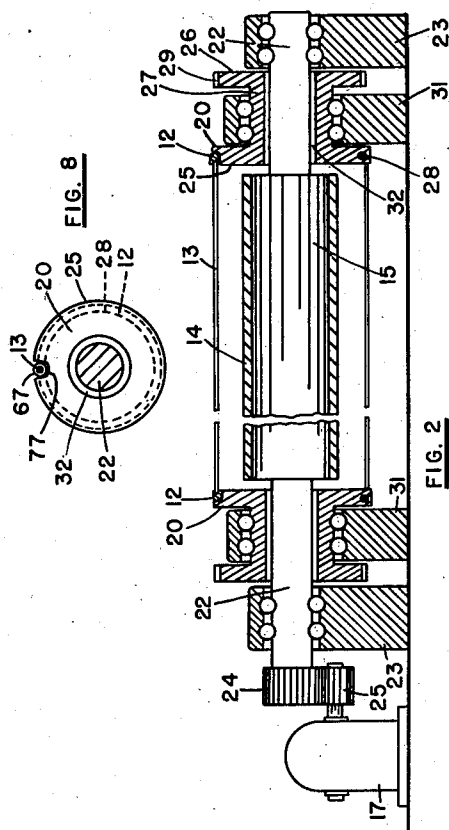


FIG. 2

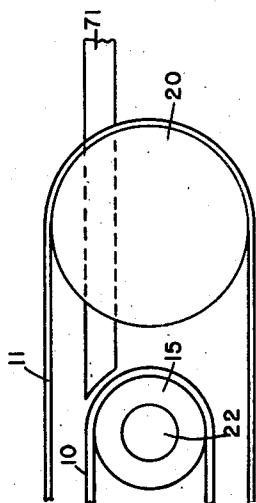


FIG. 4

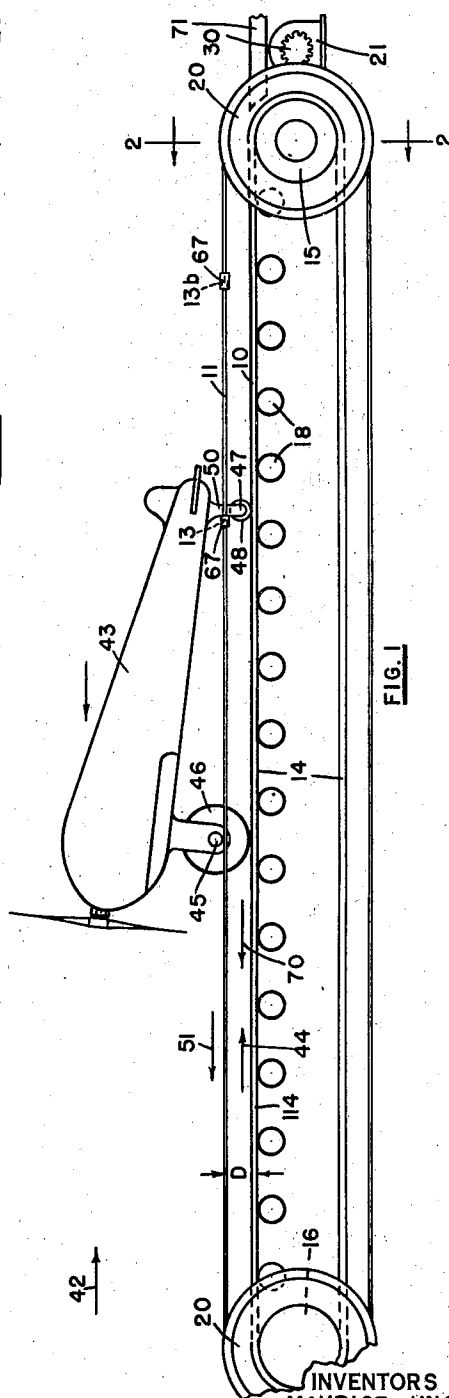


FIG. 1

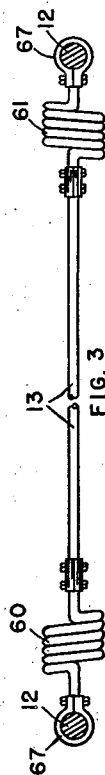


FIG. 3

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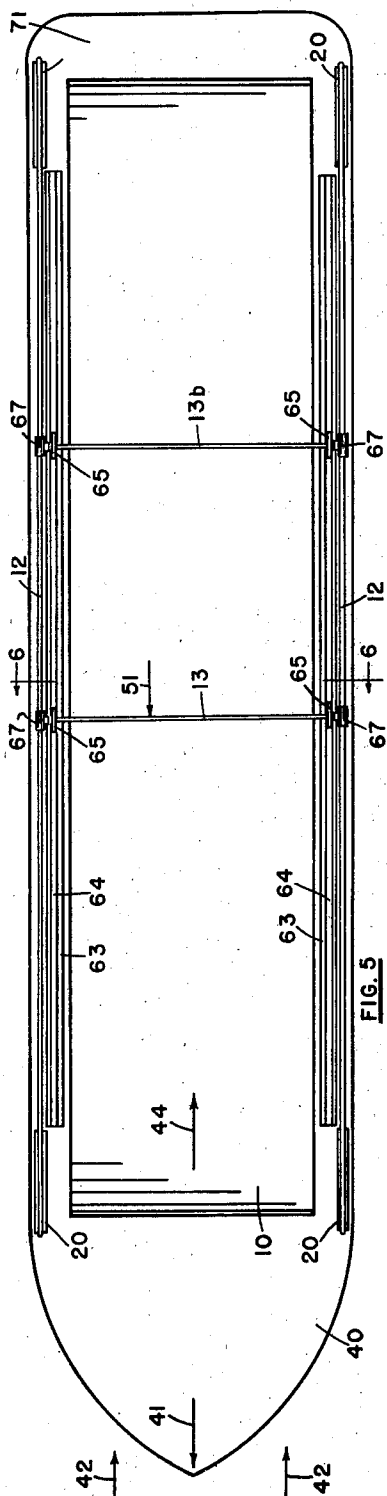
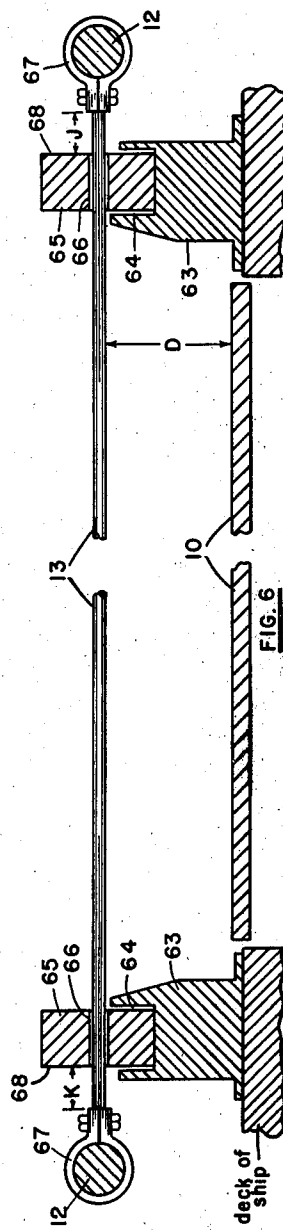
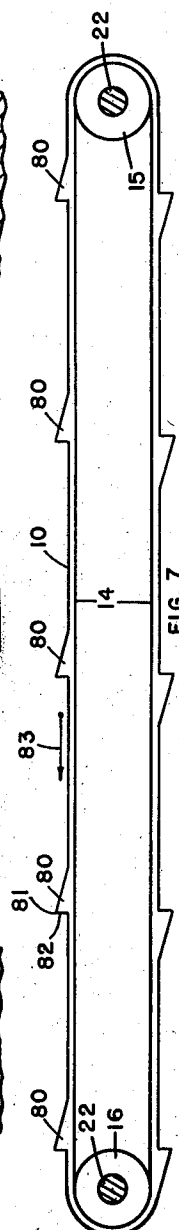
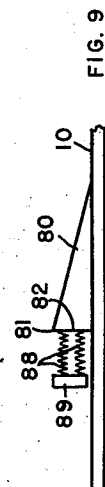
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UNITED STATES PATENT OFFICE

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METHOD AND MEANS FOR FACILITATING
THE LANDING AND TAKE-OFF OF AIR-
PLANES FROM MOVABLE RUNWAYSMaurice Unger and William Ockrant,
Cincinnati, Ohio

Application April 1, 1942, Serial No. 437,176

11 Claims. (Cl. 244—63)

This invention relates to an improvement in the method and means for facilitating the landing and take off of airplanes from a movable runway, as set forth in our copending United States patent application, Serial No. 425,762, filed January 6, 1942.

One of the primary objects of the present invention is to provide one or more barrier members which are movable relative to and entirely independently of a movable, plane supporting runway, at speeds greater than, equal to, or less than the speed of a plane supported upon said runway, for augmenting the effectiveness of said runway incident to the landing on and launching of airplanes therefrom.

Another object of the present invention is to provide a movable plane supporting runway and a plane engaging movable barrier member having the hereinabove enumerated characteristics, wherein the runway and barrier members may be operated in such a manner as to reduce to a practical minimum the amount of power required to land and/or launch a plane.

Another object of the present invention is to provide a barrier member which is characterized by its flexibility of speed control, being quickly accelerated or decelerated in either of two opposite directions.

Another object of the present invention is to provide a barrier member having the hereinabove enumerated characteristics, which is adapted to travel parallel to and above the plane supporting surface of a movable runway.

A further object of the present invention is to provide a barrier member which is designed so as to engage the rear wheel mounting or tail skid device of a plane, but which will not engage the front wheel structure of a plane.

Still another object of the invention is to provide a movable barrier member engageable by planes landing on a movable runway of the type disclosed in our hereinabove identified copending patent application, and wherein the movement imparted to the barrier by a landing plane is utilized to operate a control device which regulates the rate of travel of the movable, plane supporting runway.

Still a further object of the invention is to provide a movable barrier member having the above enumerated characteristics, which is structurally simple, inexpensive in cost, yet highly efficient in operation.

These and other objects are attained by the means described herein, and as disclosed in the accompanying drawings, in which:

Fig. 1 is a schematic side view of a device embodying the teachings of the present invention with a plane supported thereon.

Fig. 2 is a vertical sectional view through the device of Fig. 1 taken on line 2—2 thereof.

Fig. 3 is a side plan view of a barrier member which comprises a detail of the present invention.

Fig. 4 is a schematic side view of one end of a modified form of the device of Fig. 1.

Fig. 5 is a top view of the deck of a ship provided with a modified form of the device of Fig. 1.

Fig. 6 is a vertical sectional view through the device of Fig. 5 taken on line 6—6 thereof.

Fig. 7 is a schematic side view of a movable runway which comprises a detail of the present invention.

Fig. 8 is an end view of drive pulley member 20 of Fig. 2.

Fig. 9 is an enlarged view of a modified form of tread member of Fig. 7.

With reference now to Figs. 1, 2, 5 and 6, it will be observed that the present device comprises, broadly speaking, a movable plane supporting runway or member 10, and a movable barrier device 11 which comprises a pair of spaced drive members 12 which are interconnected at spaced intervals by transversely extending plane engaging barrier elements 13.

The movable plane supporting member 10 may comprise an endless belt 14 fabricated from any suitable material or combination of materials having the requisite characteristics of tensile strength, durability, frictional coefficient, and the like, whereby to provide a movable runway capable of not only supporting a plane, but also of withstanding the stresses and strains induced incident to the movement of a plane thereover incident to landing and stopping the forward motion of a plane. Belt 14 may be suitably supported by and between a pair of spaced pulleys 15 and 16, one or both of which may be driven by means of an electric motor 17 of Fig. 2, or the like. If desired, a plurality of rollers 18 may be provided between pulleys 15 and 16 for supporting the upper reach 114 of belt 14 in such a manner as to provide a substantially flat surface adapted to facilitate the landing on and launching or take off of aircraft therefrom.

The various barrier elements 13 may be fabricated from any suitable flexible material, such as by way of example rope, chain, cable, or a rigid member such as a rod or the like, having such characteristics as to withstand the stresses and strains induced incident to checking the forward motion of a plane landing upon belt 14. As best

disclosed in Figs. 5 and 6, it will be observed that barrier elements 13 extend transversely across belt 14, being spaced above said belt by a dimension denoted by the character D. The opposite ends of barrier elements 13 are securely anchored to drive members 12, each of which comprise an endless chain, cable or the like suitably supported by and between a pair of spaced drive pulleys 20, each of which may be driven by means of variable speed, reversible electric motor 21.

The present invention is not directed to, nor particularly concerned with any specific type or arrangement of drive means, however, solely by way of example, one type or form of drive means is disclosed in Fig. 2 which may be used in those instances where the axis of rotation of the belt drive pulleys 15 and 16 is on a common center with the axis of rotation of the barrier elements drive pulleys 20. The belt drive pulleys may be rotatably supported by and between a pair of shafts 22 each of which may be supported for rotation relative to their respective bearing-support members denoted generally by the numerals 23. One or both of shafts 22 may be provided with a gear 24 which is adapted to be driven by motor 17 through intermeshing gear 25.

The barrier element drive pulleys 20 may comprise an inner flange 25 and an outer flange 26 interconnected by a central portion 27 of reduced diameter. The circumference of the inner flange may be recessed as at 28 whereby to provide a peripheral track for drive member 12, whereas the circumference of the outer flange may be provided with gear teeth 29 which are engageable by gear wheel 30 of drive motor 21. The central portion 27 of each of the barrier drive pulleys may be suitably supported for rotation relative to the bearing support member 31, whereas a bore 32 is provided axially through pulleys 20 through which shafts 22 of the drive belt pulleys 15 and 16 loosely extend in such a manner as to permit independent rotation of pulleys 20 and pulleys 15 and 16 and their respective shafts 22.

If desired the barrier element drive pulleys 20 may be located beyond the belt drive pulleys 15 and 16, as disclosed in Fig. 4 thereby simplifying the structural details of the drive mechanism of Fig. 2.

With reference now to Figs. 1 and 5, the operation of the device when used to land planes will be described assuming that the device is mounted on the deck of a boat 40 which, it will be assumed, is moving in the direction denoted by the headed arrow 41, at a net speed of 25 miles per hour into a headwind of 10 miles per hour, denoted by the arrows 42. If the necessary flying speed of plane 43 be 60 miles per hour, then the ground speed of the plane relative to the deck of boat 40 will be 25 miles per hour, that is, the ground speed will equal the flying speed less the total of forward speed of the boat and the speed of the headwind, wherein the term ground speed denotes the horizontal component of the velocity of the plane relative to the boat.

With these assumed facts it is apparent that if belt 14 is stationary, plane 43 will travel an indefinite distance over the belt until its ground speed is reduced a certain predetermined value. However, if belt 14 is moved toward the oncoming plane in a direction indicated by headed arrow 44 at a speed not exceeding the ground speed of the plane, then the forward travel of the plane relative to the boat proper will be materially reduced, whereby the length of runway required for dissipating the ground speed of the plane will be

substantially reduced, as more fully set forth in our hereinabove identified copending patent application.

The present invention contemplates the use of one or more barrier elements 13 which extend transversely across belt 14 and which are spaced above said belt by dimension D which locates the barrier elements below the axis of rotation 45 of the front wheels 46 of plane 43 and above the axis of rotation 47 of the rear wheels 48 whereby the front wheels 46 will easily pass over barriers 13 whereas the barriers will positively engage the rear wheel support member 50, as disclosed in Fig. 1. It should be understood that on those planes provided with a tail skid member in lieu of a rear wheel assemblage, barrier 13 will engage said tail skid member whereby the operating characteristics of the device will be substantially the same as with a plane having a rear wheel assemblage.

If barrier member 13 is caused to move in the direction of plane travel, denoted by the headed arrow 51, at a speed not exceeding the ground speed of plane 43, which in the example is 25 miles per hour, said barrier will engage the forward, or left side of the rear wheel support 50. The forward speed of barrier 13 may then be checked by manipulating a suitable control unit, not illustrated, of motor 21 whereby the braking effect of belt 14 will be materially increased and the forward travel of the plane required to dissipate its forward ground speed will be considerably shortened. Therefore since the forward travel of a plane after landing has been shortened, the overall length of the movable runway 10 may be of a dimension considerably less than the length required when the barrier member is not used.

The use of barrier elements 13 permits belt 14, hereinafter referred to as the movable plane supporting runway, to be operated at a substantially uniform rate of speed at all times and inasmuch as the mass of the runway is considerable, a great saving in power consumption will be effected by operating it at a substantially constant speed.

It will be observed that as soon as the ground speed of the plane is equal to the speed of the movable plane supporting runway the plane will be stationary relative to the boat proper, and when the forward or ground speed of the plane is less than the speed of the runway the plane will be moved rearwardly relative to the boat in the direction of runway travel. Such a rearward travel of the plane relative to the boat proper may be counteracted by operating the motor of the plane to overcome it, or by providing a second barrier member such as 13b which will engage the rear face of the rear wheel support 50 for pushing the plane forward against the counter effect of the moving runway.

If desired suitable means, such as springs 60 and 61 of Fig. 3 may be interposed between the ends of the transverse barrier elements 13 and the drive members 12 in order to lessen the impact shock induced when the front plane wheels pass over a barrier element or when such an element engages the rear wheel support member 50.

In some instances it may be desirable to provide means for precluding drive members 12 from being drawn together incident to the application of a load to a barrier element. Such means may comprise a pair of spaced, parallel longitudinal tracks 63 which may include a longitudinal channelway 64 in which a follower wheel 65 is adapted to travel, as disclosed in Figs. 5 and 6. Wheels 65 may be provided with an axial bore 66 of a

diameter greater than the diameter of barrier element 13 which extends therethrough. Such construction allows the barrier drive members 12 to be drawn together by a dimension equal to the sum of distances J and K or until the barrier clamps 67 engage the outer face 68 of their respective follower wheels.

It will be observed that the mass of the barrier elements 13, including their drive members 12 is quite small compared with the mass of the movable runway wherefore the speed and direction of travel of the barrier elements may be quickly, easily and accurately controlled. The speed and direction of travel of the movable runway cannot be so easily controlled, wherefore we propose to operate it at a substantially constant speed.

From the foregoing it is apparent that the barrier elements 13 are used to increase or augment the ability of the movable runway to dissipate the forward speed component of a landing plane, first by acting as a brake to reduce the ground speed of the plane to a negligible factor, and then by acting as a pusher to move the plane off of the movable runway which, it will be observed continues to operate at a substantially constant speed.

In those instances where the present device is used to facilitate the take off of a plane from runway 10 the following procedure may be followed: The movable plane supporting runway 10 may be operated in the direction of take off as indicated by the headed arrow 70, of Fig. 1; the wheels of plane 43 may be blocked, or its brakes set on apron 71 and its engines operated at full speed; the blocks or brakes may then be released whereupon the plane will move forward under its own power onto the movable runway 11; barrier element 13 may be moved toward the plane so as to engage the rear wheel support member 50 (or the tail skid) after which the barrier element may be rapidly accelerated so as to push the plane forwardly over the movable runway. In this manner the required flying speed of the plane may be rapidly reached with a minimum amount of horizontal travel of the plane relative to the boat proper. The air speed of the plane will be equal to the sum of the forward speed of the boat, the speed of the headwind 42, the speed of the movable runway, and the forward speed of the plane or the barrier element relative to the runway depending upon which has the greater relative forward speed.

In some instances it may be desirable to provide a plurality of spaced tread members 80 transversely of the movable runway 10 in order to augment the frictional engagement between a plane and the runway. Each tread member may, by way of example, be wedge shaped and taper upwardly from the top surface of belt 14 to an apex 81 at a substantially vertical forward wall 82. Tread member 80 may include resilient means, such as springs 88 interposed between forward wall 82 and a bumper element 89 for lessening the impact of a plane therewith. When the runway is operated to facilitate the take off of a plane, that is, in the direction indicated by the headed arrow 83, the vertical walls 82 will engage the rear wheel or tail skid of a plane for preventing the plane from slipping relative to the runway during take off. When tread members are used the movable runway would be operated at a speed sufficient to augment the forward speed of the plane as developed by its motors whereby

to impart to the plane an air speed sufficient for take off.

It should be observed that tread members 80 will not adversely affect the hereinabove described operating characteristics of the movable runway when it is operated in the direction of headed arrow 44 for dissipating the forward speed component of a landing plane.

In some instances it may be desirable to provide a special type of skid member having an enlarged foot portion adapted to frictionally engage the movable runway for increasing the retarding effect of the usual type of skid member usually provided on planes. If desired the movable runway may be provided with suitable indentations, or the like which may be complementary to the enlarged foot portion of a skid member, for augmenting the ability of the runway to drive a plane forwardly incident to take off.

As disclosed in Fig. 8 the inner face of flange 25 may be cut away as at 77 for accommodating clamp member 67. The cut away portion 77 likewise prevents slippage between the barrier element drive members 12 with the recessed track-like portion 28 of drive pulley 20.

In some instances the barrier elements may be utilized as a control unit for governing the rate of lineal travel of the movable plane supporting runway 10, by interposing a suitable device, not shown, between pulleys 20 and 15-16 which device is adapted to translate the impact speed with which a plane 43 engages a barrier element 13 to that speed of travel of the movable runway necessary to most effectively dissipate the forward speed component of the landing plane.

Such a device would operate as follows with reference to Figs. 1 and 2. If it be assumed that plane 43 has an air speed of 60 miles per hour, that boat 40 is moving into a 10 mile an hour headwind at a speed of 25 miles per hour, and that the movable runway is normally moving in the direction indicated by the headed arrow 44 at a speed of 20 miles per hour, it is apparent that the ground speed of the plane is 25 miles per hour greater than the boat proper, but only 5 miles per hour greater than the movable plane supporting runway. Under these assumed facts, plane 43 will engage barrier element 13, which may be stationary or slowly moving in the direction of headed arrow 51, and if the ground speed of the plane relative to the runway is greater than the speed of the barrier element the speed of rotation of pulleys 20 will be increased, thereby driving motor 21 which would then function as a generator. The current thus generated by motor 21 may be utilized to operate any well known control circuit for increasing the speed of the movable runway drive motor 17 until the rate of travel of said runway will equal, or be a certain predetermined ratio of the ground speed of the landing plane. In this manner the barrier elements may be utilized to automatically operate the movable runway 10 at an optimum speed for the particular plane landing thereon.

In lieu of the electrical control means hereinabove described for using the barrier elements to control the speed of the movable runway, a mechanical drive means may be interposed between pulleys 20 and pulleys 15-16 whereby the speed and force with which a barrier element is driven by a landing plane may be utilized to drive the movable runway at speeds greater than its normal operating speed.

It should be understood that certain changes in the structural details of the device may be

made, such as by way of example, substituting a plurality of drive rollers in lieu of the endless belt 14 for providing a movable runway, or by providing an auxiliary tail skid device or special landing hook of the general type used by the United States Navy to engage the movable barrier members, and the like, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed is:

1. In a device of the class described the combination of a supporting surface, a plane supporting runway movable relative to said supporting surface, and a plane engaging barrier member movable relative to and independently of said movable runway, said barrier member adapted to augment the ability of the runway to retard the forward speed component of a plane landing on said runway.

2. In a device of the class described the combination of a supporting member, a plane supporting runway movable relative to said supporting member, and a plane engaging barrier member movable relative to and independently of said movable runway, said barrier member adapted to augment the ability of the movable runway in accelerating a plane supported on said runway to a take off speed.

3. In a device of the class described the combination of a supporting member, a movable plane supporting runway, means for imparting a linear motion to said runway relative to said supporting member, a plane engaging barrier element disposed above said runway, means for controlling the rate of travel of said barrier, said barrier adapted to augment the ability of the runway to retard the forward speed component of a plane landing on said runway when said barrier is operated to brake the forward speed of the plane independently of and in addition to the braking effect of said runway.

4. In a device of the class described the combination of a movable plane supporting runway, means for imparting a linear motion to said runway in a direction opposite to the direction of travel of a landing plane, a movable barrier device, said device comprising a plane engaging barrier element spaced above and extending transversely across said runway and means disposed on opposite sides of said runway for supporting said barrier element, means for imparting a linear motion to said last mentioned means for moving the barrier element relative to and independently of said runway, said barrier when moved in the same direction as the direction of travel of a landing plane but at a speed less than the ground speed of said plane, adapted to be engaged by said plane, said barrier element adapted to be operated to brake the forward speed of the plane thereby augmenting the ability of the runway to retard the forward speed component of a landing plane.

5. The method of dissipating the ground speed of a landing airplane, which comprises the steps of imparting a linear motion to a plane supporting runway, wherein the direction of linear motion of said runway is opposed to the direction of travel of the landing plane and wherein the rate of lineal travel of said runway is not greater than the ground speed of the landing plane, moving a plane engaging barrier element relative to and in an opposite direction to the direction of travel of said runway and at a rate of travel less than the ground speed of the landing plane whereby the plane will engage said movable barrier ele-

ment, and of then decelerating the rate of travel of the barrier element until the ground speed of the plane approximates the rate of travel of the movable runway.

6. The method of dissipating the ground speed of a landing airplane, which comprises the steps of imparting a linear motion to a plane supporting runway in a direction opposed to the direction of travel of the landing plane and at a rate of travel less than the ground speed of the plane, of moving a plane engageable barrier in a direction opposite to the direction of travel of the runway and at a rate of travel less than the ground speed of the landing plane whereby the plane will quickly engage said movable barrier, of then decelerating the rate of travel of said barrier whereby the ground speed of the plane approximates the rate of travel of the movable runway, and of then moving said barrier relative to the plane whereby to push said plane from said movable runway.

7. The method of imparting air speed to an airplane incident to take off, which comprises the steps of imparting a linear motion to a plane supporting runway in the direction of take off, and at a rate of travel approximating the air speed of the plane, of moving a plane engageable barrier in the direction of take off at a rate of travel greater than the initial forward rate of travel of the plane upon being released for forward movement with its motors wide open whereby the barrier will engage the moving plane, and of then rapidly accelerating the rate of travel of said barrier to push the plane whereby the forward motion of the plane will equal and then exceed the rate of travel of the movable runway for effecting take off of the plane.

8. In a device of the class described the combination of a plane, a movable plane-supporting runway, said runway comprising an endless belt, means for supporting the upper reach of said belt whereby to provide a substantially flat, plane supporting surface and means for imparting a lineal motion to said belt, and a plane engaging barrier, said barrier comprising a transverse element which extends laterally across and above said belt, the opposite ends of said barrier being supported by and secured to a pair of parallel, spaced endless cables, means for mounting said endless cables on opposite sides of said runway and means for imparting a lineal motion to said cables for moving said barrier relative to said runway, and means for selectively controlling the rate of lineal motion of said barrier, said runway adapted to be given a lineal motion toward the direction of travel of an incoming plane which is adapted to land thereon, said barrier adapted to be moved in the same direction as the landing plane and at a rate of travel less than the ground speed of the plane, said barrier adapted to be engaged by said plane after which the lineal motion of the barrier may be decelerated for retarding the forward speed component of the plane.

9. The method of dissipating the ground speed of a landing airplane, which comprises the steps of imparting a linear motion to a plane supporting runway in a direction opposed to the direction of travel of said plane and at a rate of travel less than the ground speed of the plane, of providing a movable barrier in the path of said plane which is engageable by the plane after landing upon said runway, and of utilizing the motion thus imparted to said barrier for controlling the rate of lineal travel of said runway.

10. In a device of the class described the combination of a movable plane supporting runway, means for imparting a linear motion to said runway in either of two directions; a flexible plane engaging barrier element mounted above said runway and movable relative thereto, means for imparting a linear motion to said barrier element in either of two directions at speeds less than, equal to, or greater than the rate of linear travel of said runway, said runway adapted to be moved at a substantially uniform rate of speed in one direction for launching an airplane and in the opposite direction for retarding the forward roll of a landing plane, said barrier element adapted to be moved in the same direction as the runway for pushing a plane over the runway at a rate of speed greater than the rate of linear travel of the runway for augmenting the ability of the runway to impart a sufficient air speed to the plane for take off, said barrier element adapted to be moved in an opposite direction to the direction of travel of the runway for retarding the forward roll of a landing plane by

exerting an independent braking effect on the plane for augmenting the ability of the runway to retard the forward roll of a landing plane.

11. In a device of the class described the combination of a plane including means for supporting the forward end of the plane on a supporting surface and other means disposed at the other end of the plane for supporting the rear portion thereof, a movable plane supporting runway, means for imparting a linear motion to said runway, a plane engaging barrier element movable relative to the runway, said barrier element extending transversely of and being spaced above the runway by a dimension adapted to preclude engagement with the first mentioned means and to positively engage the second mentioned means which supports the rear portion of said plane, and means for imparting a linear motion to said barrier element at speeds less than, equal to or greater than the rate of linear travel of a plane supported on said runway.

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