May 19, 1959 M. A. JACKSON 2,887,195

GROUND ANCHORAGE

Filed Oct. 23, 1956

FIG. 1

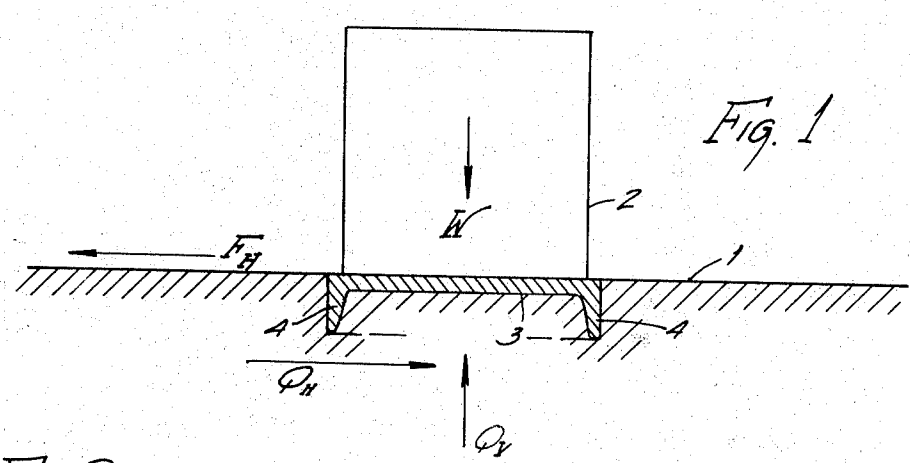


FIG. 2

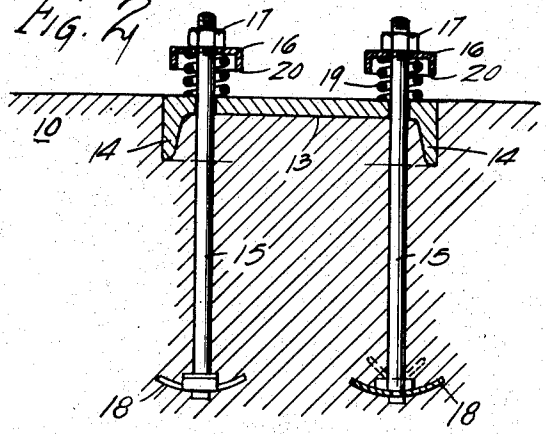
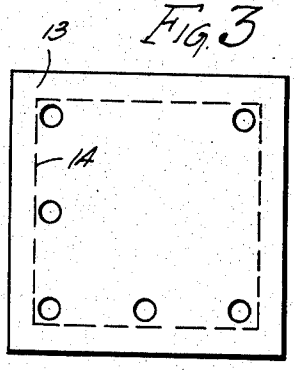


FIG. 3



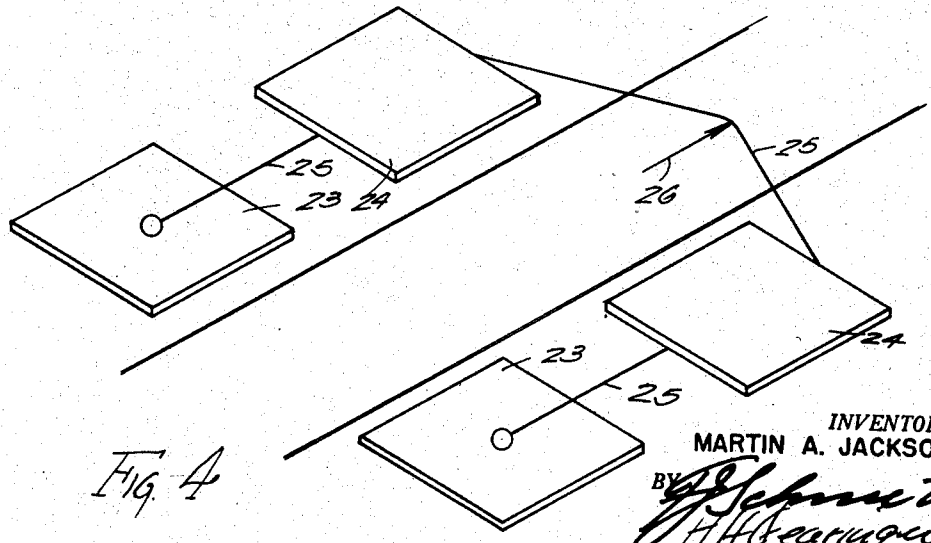


FIG. 4

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GROUND ANCHORAGE

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1 Claim. (Cl. 189—90)

This invention relates to portable arresting gear systems or to arresting systems which can be improvised at faraway location sites with a minimum of effort.

It is frequently a problem with aircraft, for example, in outpost stations of the military or in newly conquered areas, that insufficient landing area is provided, which area cannot be built immediately or is impossible geographically to do so or it is not desired to extend or enlarge such area due to the military operations involved. At the same time, conventional arresting gear cannot be provided at such landing strips due to the same military necessities. As a result, means must be provided wherein a simple arresting gear can be transported to such areas or can be built on the landing strip sight.

It is therefore an object of this invention to provide a portable arresting gear means which can be transported great distances, as by aeroplane, due to its relatively light weight.

It is a secondary object of this invention to provide a basic, readily-transported arresting gear system which can be converted to a complete gear system at the landing sight utilizing materials native to the locality.

It is a further object of this invention in providing an arresting gear system which utilizes the shearing properties of the natural terrain.

These and other objects will be readily apparent to those skilled in the art from an examination of the following description and the accompanying drawings wherein:

Figure 1 is a first modification of the instant invention and illustrates the basic principles involved,

Figure 2 depicts a second modification of the instant invention,

Figure 3 is a plan view of the base plate of Figure 2, and

Figure 4 illustrates the use of the present invention in a complete arresting gear system.

Referring to Figure 1 for an explanation of the basic principles utilized in this invention, a weight **2** is placed upon a plate **3**. The plate is imbedded in the ground **1** by means of the projections **4** on the plate thereby anchoring the plate and allowing only the shear force of the ground to come into play as the limiting factor when a longitudinal force is applied to the weight assuming the weight and plate area unitary structure. The projections **4** extend around the plate as shown in Figure 3.

By a summation of forces, it is seen from Figure 1 that

$$Fh=Qh$$

$$W=Qv$$

where

Fh=the applied horizontal force
Qh=the resisting shearing force of the ground
W=weight of the load
Qv=Plate and ground reaction to the load.

It has also been found that for low values of normal pressures (Fn), the equation $Fs=Fn(\tan 30°)=.578\ Fn$ gives values of allowable shearing stress which are conservative for most soils where Fs=the shearing force.

If the maximum side force desired to be absorbed is say 121,000 lbs., then since

$$Fh=Qh=121{,}000 \text{ lbs.}=.578\ W$$

W then becomes equal to 210,000 lbs.

Thus, a vertical load of this magnitude will react, by means of the shearing strength of the soil, a horizontal load of 121,000 lbs.

The bearing capacities of various soils can be found in various handbooks. Thus, in Mark's M. E.'s Handbook (fifth edition), a few of the various soils have been chosen to illustrate the range of bearing capacities.

Nature of soil:	Safe bearing cap. lbs./ft.²
Solid ledge of rock (granite etc.)	50,000–200,000
Hardpan, cemented sand and gravel	16,000– 20,000
Hard clay	8,000– 10,000
Gravel, coarse sand	8,000– 10,000
Loose, med. coarse sand; fine compact sand	6,000– 8,000
Medium clay	4,000– 8,000
Fine loose sand	2,000– 4,000
Soft clay	2,000

These values are conservative and in view of the short time use envisaged for the arresting gear, it is quite proper safety-wise to double the capacities without excessive settlement occurring. It is further contemplated that conditions corresponding to "fine, loose sand" in the above table will be about as poor as will be encountered. Based upon the above facts, an allowable bearing pressure of 6,000 lbs./ft.² is considered a reasonable minimum value.

Consequently the area needed to support the vertical load is equal to 210,000 lbs. $(W)/6{,}000$ lbs./ft.²=35 ft.².

Instead of using a dead weight to provide the vertical load, it is more practical and convenient to use some means of securing the base plate to the ground. For example, in Figure 2, ground anchors **18** imbedded in ground **10** are connected to the base plate **13** by tie rods **15**. Nuts **17** screwed on the ends of the tie rods bear against the flange **16** and springs **19**. Projections **14** on the plate aid in securing the plate to the soil. Consequently, by tightening up on the nuts the plate is pulled firmly against the soil. In this manner, the pull-out strength of the anchors is used as a vertical reaction instead of the dead weight.

The number of anchorages utilized may vary; in the designs built to date, their number varied from 4 to 6. Regardless of the number of ground anchors used, it is essential that the specified vertical load on each anchor be maintained during arresting operations, as otherwise the base plate will not develop the required lateral resistance. Consequently, spring **19** is a calibrated spring and the lips **20** of the flanges **16** are turned down toward the base plate forming an open box or cup. Upon adjustment of the nut **17**, flange **16** rides with the nut; when the lip **20** touches the base plate, the proper preloading is maintained. Obviously many other gauge systems may be used to indicate the compression of the spring; the instant arrangement, however, has been found to be very simple, very inexpensive, and maintains the required accuracy.

The ground anchor used is one that is commercially available for guying heavy transmission lines; in the anchor, the plates **18** (Figure 2) are of the expanding type such that any tension applied to the rod to extract it from the ground will bend the plates outwardly to en-

gage the ground whereby any vertical movement is resisted. With such an anchor, it has been found that in the instant design the holding strength of the soil is increased as the anchors are located beneath the base plate, which plate bears down upon the soil surrounding the anchors. Consequently, in order for the anchor to pull out of the ground, it must somehow displace a prism of soil directly above itself and beneath the plate. Thus, more load is required to pull out the anchor than with a free ground surface.

Referring to Figure 4, a basic example is illustrated of how the instant arrangement may be utilized. Each of the base plates **23** is anchored as aforementioned. A cable **25** is strung across the landing strip, strung through the reeving and dampening systems **24**, and anchored to the plates **23**. The plane's hook, denoted by force arrow **26**, grabs the cable at its approximate mid-point and the pull exerted on the cable is taken up by the reeving and dampening systems; with the ends of the cable being anchored by the plate **23**, the last shock or force of the cable is absorbed thereat.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claim the invention may be practiced otherwise than as specifically described.

What is claimed is:

An arresting gear system adapted to provide a portable arresting gear, which can be converted to a complete gear system at a landing sight utilizing materials native to the locality and the shearing properties of the natural terrain to arrest the flight of aircraft, comprising the combination of a base plate having a flanged surface imbedded in the ground; a ground anchor positioned in the ground below the base plate; a connecting rod secured at one end to the anchor, the other end of the rod extending through an aperture in the base plate for securing the base plate to the ground; a cup-shaped flange slipped over said other end of the rod; an adjusting nut on said other end of the rod for positioning the cup-shaped flange; and a spring calibrated according to the various shearing stresses of the ground and responsive to the flange and nut so that a vertical load of a designated magnitude can be placed upon the base plate to react by means of the shearing strength of the soil a horizontal thrust engendered by a landing aircraft.

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