May 2, 1967 H. LEIBER 3,317,157

TENSION MAINTAINING DEVICE

Filed May 12, 1965 3 Sheets-Sheet 1

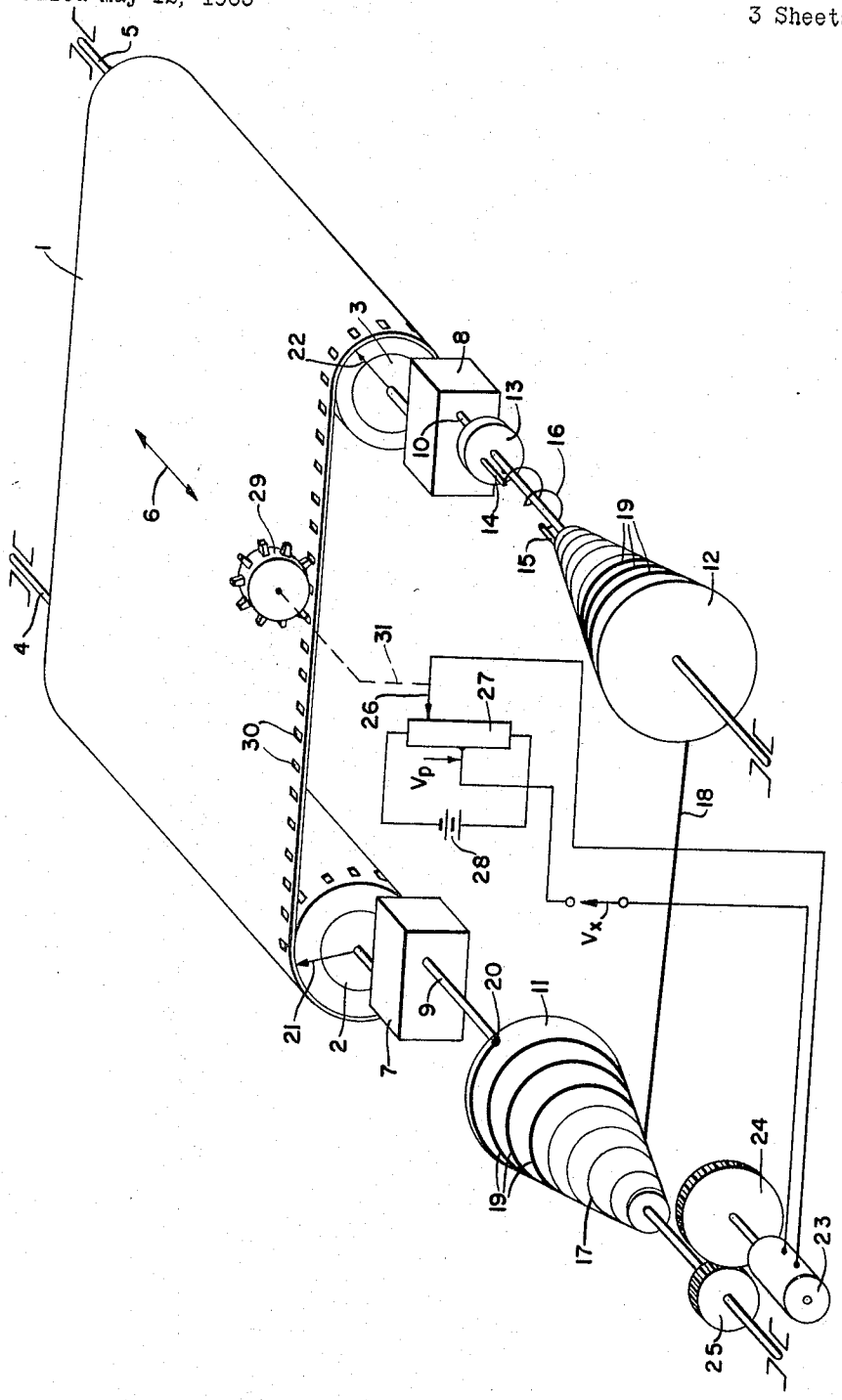


FIG. 1.

INVENTOR

Heinz Leiber

BY Spencer & Kaye

ATTORNEYS

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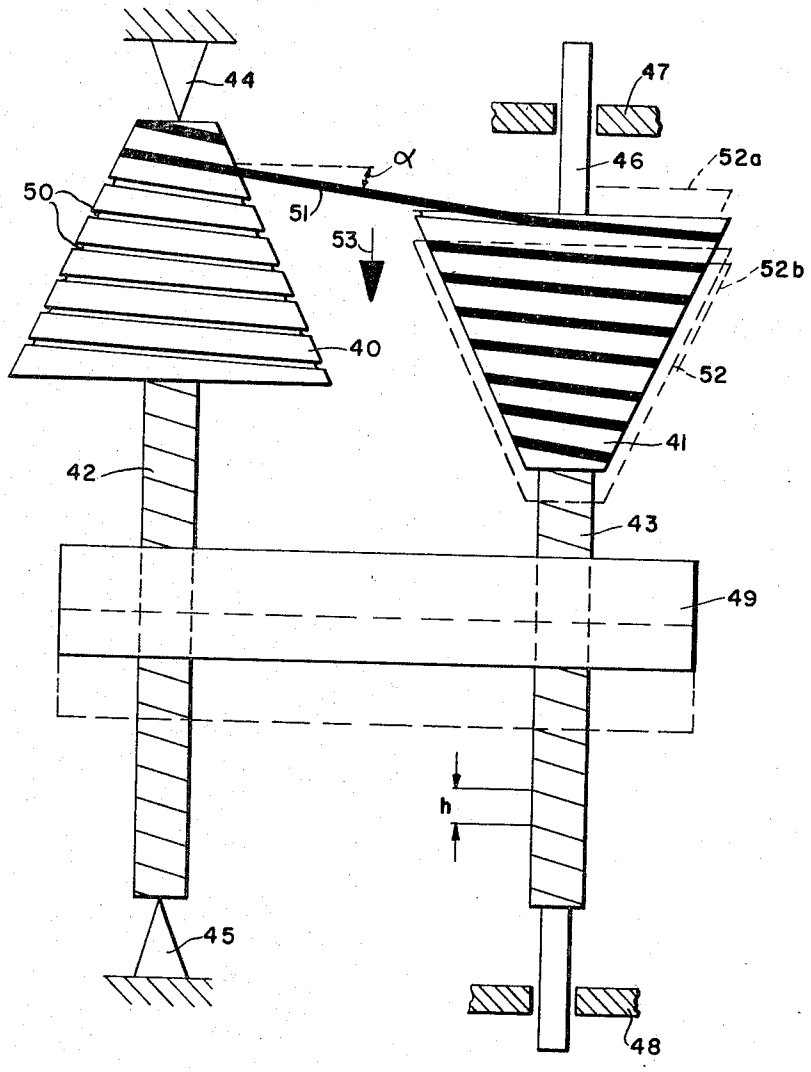


FIG. 2.

INVENTORS
Heinz Leiber

BY Spencer & Kaye
ATTORNEYS

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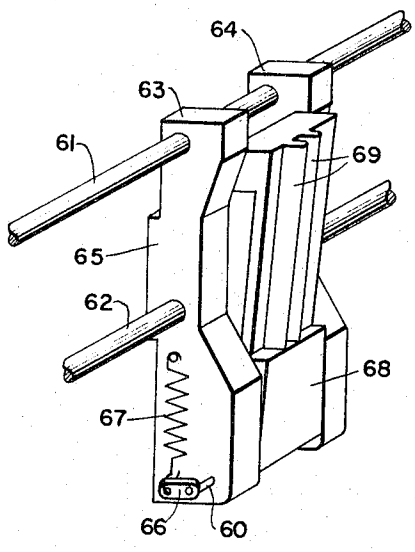


FIG. 3.

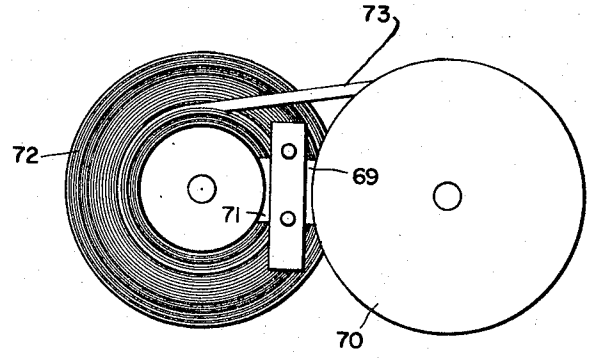


FIG. 4.

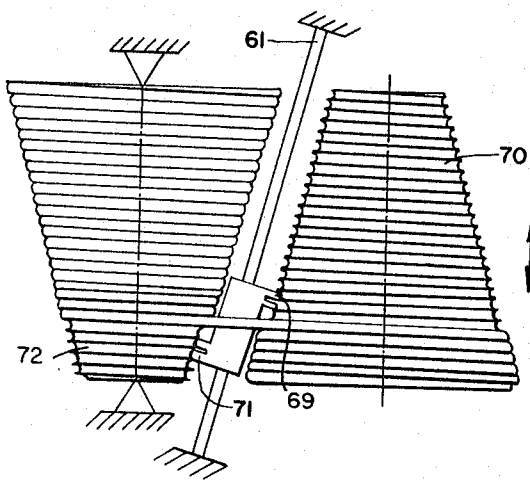


FIG. 5.

INVENTOR

Heinz Leiber

BY Spencer & Kaye

ATTORNEYS

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TENSION MAINTAINING DEVICE

Heinz Leiber, Liemen, Germany, assignor to Teldix Luftfahrt-Ousrustungs G.m.b.H., Heidelberg-Wieblingen, Germany

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9 Claims. (Cl. 242—75.5)

The present invention relates generally to a device for maintaining the tensile stress of a material which is wound on two drums and, more particularly, to a device for maintaining the tensile stress of a material stretched between two drums when winding in the form of an Archimedean spiral, for example, which may automatically result when winding strips and foils on cylindrical drums.

It is already known to stress strips which are wound on drums by producing opposite moments on the drums by means of two separate elements which are mainly electrical torque producing elements, but which require a continuous power supply. In order to move the strip in its stressed condition, driving and braking moments of different magnitudes are needed. Also, in this arrangement, the power supply is higher than is actually needed for acceleration of the masses involved and to overcome friction. In order to adjust the driving and braking moments with respect to each other, voluminous control devices are necessary. A further disadvantage of the electrical tensioning system is that upon failure of the power supply or interruption of the line, the tensile stress of the strip is not assured and in such an event, the drums can move accidentally.

With this in mind, it is a main object of the present invention to provide a device for maintaining the tensile stress of a strip which is wound on drums without the need for a continuous supply of energy.

Another object of the invention is to provide a device of the character described wherein the tensile stress of the strip wound on drums can be maintained while the arrangement is at a standstill as well as during rewinding at any speed.

A further object of the invention is to provide such an arrangement which does not exert any power exteriorly of the system and for which only a small driving motor need be provided for overcoming the moments of acceleration and friction which occur.

These objects and others ancillary thereto are accomplished in accordance with preferred embodiments of the invention wherein two conical rope pulleys are provided for the positioning of a rope or tape. These pulleys have a spiral or threaded groove in their conical surfaces. The rope or tape has its ends fixed to the conical pulleys and is partly wound around the rope pulleys and disposed in the grooves. By this means, the torsional force of the grooves and the arrangement of the rope pulleys is such such that with both pulleys rotating in the same direction, the tendency of variation of the effective levers constituted by the conical rope pulleys, are opposite to each other. Also, the drum on which the strip is wound is connected by gearing with the rope pulley from which the rope is unwound. Furthermore, the drum from which the strip is unwound is connected by gearing with the rope pulley onto which the rope is wound, and at least one torsion spring element is connected into the operative connection which is thereby formed.

As the rope falls into the grooves obliquely and can, under certain circumstances, wear out, a further feature of the invention porvides an increase in the reliability of operation. This is performed by having one pulley so arranged that it can be displaced axially. A linearly movable guide member is provided which is threadedly connected with the rope pulleys. By this means, the rope pulleys are axially displaced relative to each other in such manner that the rope does not rub on the edges of the grooves.

Additional objects and advantages of the present invention will become apparent upon consideration of the following description when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a diagrammatic perspective view of the present invention.

FIGURE 2 is a diagrammatic partial sectional view illustrating a simple device to provide for axial movement of one of the two rope pulleys.

FIGURE 3 is a diagrammatic perspective view of the cam of a further embodiment of the invention.

FIGURE 4 is a diagrammatic side elevational view of the cam together with the rope pulleys.

FIGURE 5 is a diagrammatic plan view of the cam together with the rope pulleys.

With more particular reference to the drawings, FIGURE 1 illustrates an embodiment of the invention wherein a film strip **1** is wound on and disposed between two cylindrical drums **2** and **3**. The film strip **1** is stretched between the drums which are mounted on two rotatable shafts **4** and **5**. The strip **1** is a transparent film which has a map imprint thereon, although the details of the indicia of the map are not shown. A "bug" or other type of marking device can be moved in the direction of the double arrow **6** to indicate the position of a vehicle or the like on the map. The bug is not shown. If the vehicle moves on the map at a right angle to the direction of arrow **6**, the two drums are rotated accordingly so that the correct portion of the map is placed under the bug. For an exact indication, it is necessary that the film with the map thereon does not flutter, even though the entire apparatus may vibrate. The tensile must not fall below a predetermined minimum value at any time.

Two identical gearing arrangements **7** and **8** are connected with shafts **4** and **5**, respectively. The driving shafts **9** and **10** of these gears reduce the rotations of these shafts **4** and **5**. The direction of rotation of the drive and driven shaft is the same. A conical pulley **11** is mounted on shaft **9** and an identical pulley **12** is loosely mounted on shaft **10**. Pulley **12** can thus rotate about the shaft **10**. A disc **13** is fixed to the shaft **10** and has an eccentric pin **14** mounted thereon. A torsion spring **16** is connected between this pin **14** and a corresponding eccentric pin **15** mounted on the smaller end of rope pulley **12**.

A groove **17** is provided in each of the rope pulleys and this groove extends from one end to the other and has a clockwise spiral or right-hand thread. These grooves serve for guiding the rope **18** which is connected to the end of the grooves. The rope is connected to the larger diameter ends of the cones. Those grooves which are filled with rope are indicated **19**. The rope is fastened to the rope pulley **11** at point **20**. The gearing ratio of the gears **7** and **8** and the pitch of the grooves are adjusted in such manner that the radii **21** and **22** of the drums **2** and **3**, respectively, and the radii of the grooves of the rope pulleys **11** and **12** from which and into which the rope is wound, are always proportional.

The torsional force of the grooves and the arrangement of the rope pulleys is such that with both pulleys rotating in the same direction, the tendency of variation of the effective levers constituted by the conical rope pulleys, are opposite to each other.

Torsion spring **16** is under an initial stress and always applies moments of rotation of equal magnitude on the rope pulley **12** and the disc **13**. Thus, the pulley has the tendency to wind on more rope while the drum **3** has a

tendency to wind on more film. Since the drum **2** and the rope pulley **11** are connected to each other by the gearing **7**, these tendencies can not cause rotary movements but only a tensioning of the map strip **1** and the rope **18**.

Movement of the rope pulleys and thus movement of the strip can only be caused by an outside moment of rotation. For this purpose, a D.C. motor **23** is provided which, via a gear **24**, drives a gear **25** fixed to shaft **9**. This motor is fed by two voltages V_X and V_P which are in series. The voltage V_X corresponds to the position coordinate in the direction of movement of the map and is supplied by a navigation calculator. The voltage V_P is a voltage provided from a potentiometer and which is tapped off between the center tap and the wiper arm **26** of a potentiometer **27**. A voltage source **28** feeds the potentiometer while the wiper arm **26** is operated by a toothed roller **29** which is in engagement with the edge perforations **30** of the map strip **1**. The dashed line **31** indicates a mechanical connection between the toothed roller **29** and the wiper arm **26**. The motor **23** is arranged to rotate in a direction so that it decreases its supply voltage continuously by means of the potentiometer **27**. When voltages V_X and V_P have the same value, the motor stops. In this manner, the coordinate voltage V_X controls the position of the map strip **1**.

The sensitive driving system provides that the present invention does not have any residual moment. Starting from the stopped position of the motor at which $V_X=V_P$, it is assumed that the vehicle or airplane whose position is to be indicated moves in the direction of the map strip **1**. The navigation calculator, as a result, increases its output voltage V_X. Thus, a voltage difference is provided at the motor **23** and this causes the motor to rotate shaft **9** in a direction which increases voltage V_P. The rope pulley **11** and the drum **2** may thereby rotate in counter-clockwise direction with the corresponding gear transmission ratio. This causes the angular radius **21** to increase. On the other side, the angular radius **22** decreases and to the same extent the effective lever on the rope pulley **12** decreases because the rope is wound on downwardly and the radius on which the rope is wound on pulley **12** decreases. The torsion spring **16** also rotates. However, this occurs without the ends thereof turning with respect to each other. The two opposite tensioning moments mentioned above and produced by this spring always remain equal independently of the change of the angular radii.

FIGURE 2 illustrates a schematic view of two rope pulleys **40** and **41** in the form of truncated cones. In use, they correspond exactly to the rope pulleys shown in FIGURE 1 although the details of the drive are not shown in FIGURE 2. The two rope pulleys **40** and **71** are fixedly connected with coaxially extending threaded lugs **42** and **43**, respectively. The threads of these lugs are shown as simple lines. Points **44** and **45** are shown in this figure to indicate that the rope pulley **40** can not move in axial direction. However, the rope pulley **41** is arranged on a shaft **46** which can be displaced in its bearings **47** and **48**. A connecting member **49** is provided which has two threaded openings into which the threaded lugs **42** and **43** are disposed.

The pitch of the thread on the lugs **42** and **43** and the pitch of the rope grooves **50** are the same. Therefore, the angle α which is formed between the rope segment **51** and a line projected at right angles to the axes of lugs **42** and **43** at the point where the rope intersects with the axis of lug **42**, remains constant independently of the position of the rope. It is therefore possible to adjust the angle α in such manner by adjusting the rope pulleys suitably before the rope is placed onto and fixed in the pulleys, that the rope will not rub on the edges of the grooves, since these edges might be sharp and in any event wearing would occur.

Assuming that the device is positioned as shown in FIGURE 2, the rope is mostly wound on the pulley **41** while the pulley **40** is nearly empty of rope. Assuming, now that the pulley **40** rotates twice in a direction to wind rope onto this pulley, this then corresponds to one rotation of pulley **41** in its unwinding direction since in the positions illustrated, the effective diameter of pulley **41** is twice that of pulley **40**. The connection member **49** thus moves by two pitches ($2h$) to the position indicated in dashed lines. At the same time, the pulley **41** threads itself by a movement equal to one pitch, out of the connection member and attains the position indicated by dashed lines **52**. However, during this time, the rope has moved on the pulleys in the direction of arrow **53** and the movement has been an amount equal to two pitches on the pulley **40** and one pitch on pulley **41**. This difference in axial travel is compensated for by the opposite axial movement of pulley **41** so that the rope angle α is also maintained in the new position **52** of the pulley **41**.

The rope angle α is thus maintained during the entire winding and unwinding process, even though the ratio resulting from the rotary speeds of the two rope pulleys changes constantly. In the two end positions in which the entire length of rope is wound on one of the two pulleys, the displaceable pulley **41** is in the position **52***a* shown in dashed lines. Starting from this position, it moves into the position **52***b* shown in dashed lines and then back to position **52***a* without changing the direction of winding. Position **52***b* corresponds to the middle position of the rope, that is, when the rope has an equal length wound on each pulley.

Since the pitch angle of the rope grooves is different at each point, contrary to what occurs in a cylindrical thread, the rope angle α will preferably be adjusted to a medium value between the largest and the smallest pitch angle and this compromise of pitch angle can be seen from the example shown in FIGURE 2.

The embodiment shown in FIGURES 3 through 5 above all provides a considerable saving in space. In this embodiment, the thread lugs are eliminated and a threaded type of connection is provided by means of a double cam which directly engages the rope grooves. This cam is shown in FIGURE 3 and includes two halves which are pivotally connected by a shaft **60**. One half of this cam can be displaced along two guide bars **61** and **62** and includes two longitudinal girders **63** and **64** connected to each other by a bridge, the end **65** of which can be seen. The two guide bars pass through the longitudinal girders.

A lever **66** is mounted on the shaft **60** and a tension spring **67** is connected to the other end of lever **66**. Therefore, the cam half **68** has a tendency to tilt upwardly toward the right as viewed in FIGURE 3 since this cam part is fixed to shaft **60** which is mounted for rotational movement in girders **63** and **64**. Cam portion **68** is provided with two ridges **69** which are elongated and have rounded upper ends and are designed to engage in the empty grooves of the rope pulley **70**. Corresponding ridges are provided on the bridge **65** although they are not visible in FIGURE 3. They are, however, indicated at **71** in FIGURES 4 and 5.

FIGURES 4 and 5 illustrate the double cam in a simplified manner and also illustrate the rope pulleys **70** and **72** as well as the rope **73** which is disposed about the pulleys. Pulley **72** can not be moved in axial direction whereas the pulley **70** can be displaced on its shaft (not shown) in the direction of double arrow **70'**. The guide bars **61** and **62** are fixedly mounted to be parallel to the opposing surfaces of the two cones. By having the ridges **71** displaced relative to the ridges **69** in the direction of the guide bars, these ridges can then engage into grooves of the two rope pulleys which are free of the rope, even though the rope runs over the double cam.

The functioning corresponds to the embodiment of FIGURE 2. If the pulley **70** moves axially, then the distance between the surface lines of the cones changes. However, this is compensated for because the ridges **69** are always spring-pressed into the grooves because of the spring **67** and thereby follow the movement of pulley **70**.

It will be understood that the above description of the present invention is susceptible to various modifications, changes, and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

What is claimed is:

1. A device for maintaining the tensile stress of a strip stretched between two drums, comprising, in combination:

two conical pulleys for positioning a rope and having spiral grooves in their conical surfaces;

a rope having its ends fixed to the conical pulleys and partly wound about the rope pulleys in the grooves;

two drums having a strip stretched between them and wound on the drums; and

gearing means for connecting the drum on which the strip is wound with the rope pulley from which the rope is unwound, and the drum from which the strip is unwound with the rope pulley on which the rope is wound, and including means for providing torsional biassing interposed between one of the drums and the pulley to which it is connected.

2. A device as defined in claim **1** wherein said pulleys are arranged with the smaller end of one opposite the larger end of the other.

3. A device as defined in claim **2** wherein said rope is wound on the pulleys so that they rotate in the same direction.

4. A device as defined in claim **1** wherein said rope and pulleys are arranged so that both pulleys rotate in the same direction and the tendency of the effective levers of the rope pulleys are opposite to each other.

5. A device as defined in claim **1** wherein one of said pulleys is mounted for axial displacement.

6. A device as defined in claim **5** wherein said pulleys have threaded lugs projecting therefrom, and a connected member disposed between the lugs and into which the lugs are threaded.

7. A device as defined in claim **5** comprising a cam having a first portion engaging the grooves of one pulley and a second portion engaging the grooves of the other pulley.

8. A device for maintaining the tensile stress of a strip stretched between two drums, comprising, in combination:

two conical pulleys for positioning a rope and having similar spiral grooves in their conical surfaces with the large end of one pulley opposite the small end of the other pulley;

a rope having its end fixed to the conical pulleys and partly wound about each of the rope pulleys in the grooves thereof;

two drums having a strip stretched between them and wound on the drum;

means for maintaining a similar angle of approach between the rope and those grooves which the rope is entering regardless of where on the pulley such grooves are disposed; and

gearing means for connecting the drum on which the strip is wound with the rope pulley from which the rope is unwound, and the drum from which the strip is unwound with the rope pulley on which the rope is wound, and including means for providing torsional biassing interposed between one of the drums and the pulley to which it is connected.

9. A device as defined in claim **8** wherein said means includes means for mounting one of said pulleys for axial movement, and means connected between said pulleys for causing said one pulley to move axially with respect to the other upon rotation of said pulleys.

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FRANK J. COHEN, *Primary Examiner.*

N. L. MINTZ, *Assistant Examiner.*