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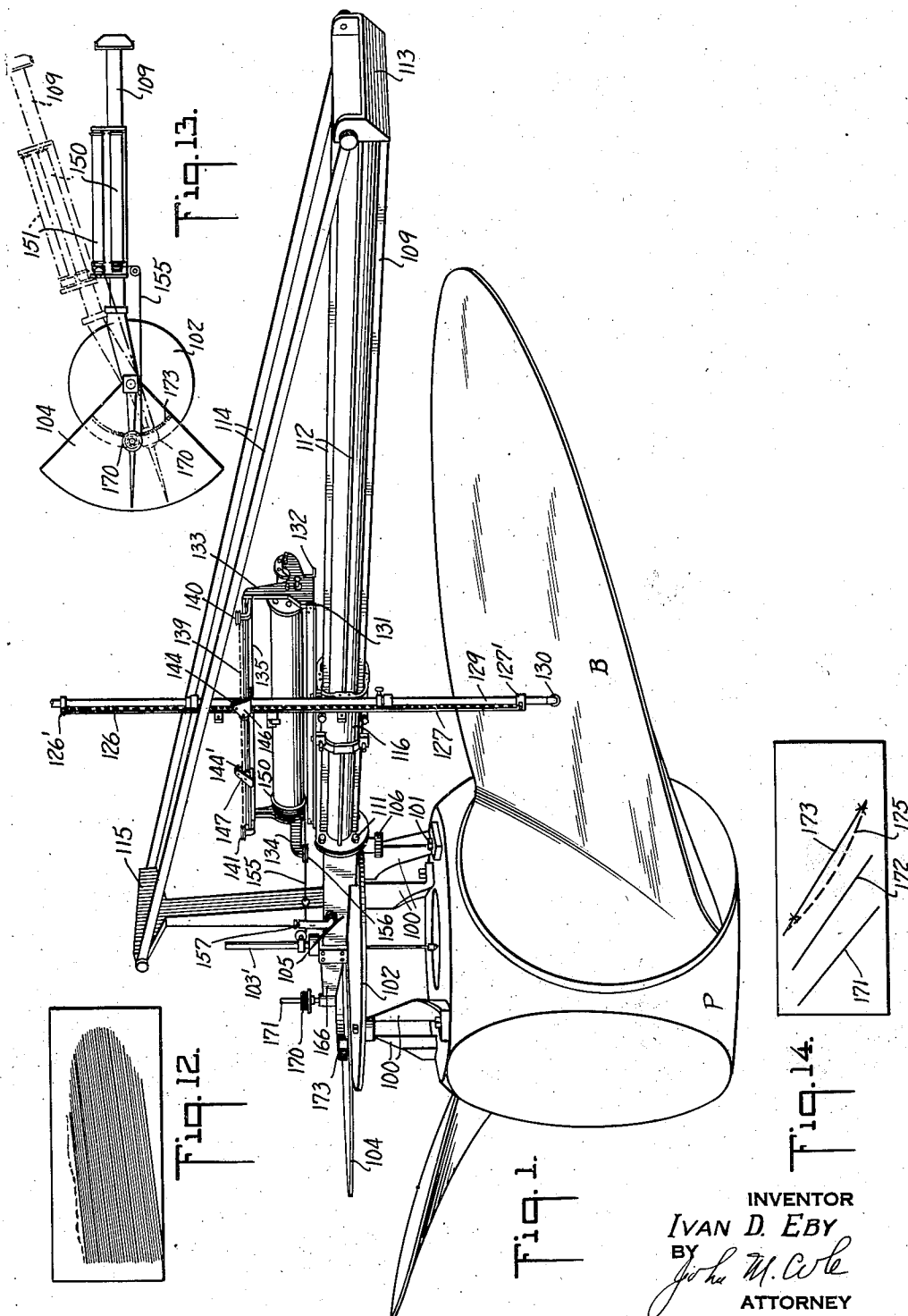
I. D. EBY

2,248,973

RECORDING PITCHOMETER

Filed Sept. 9, 1939

5 Sheets-Sheet 1



INVENTOR
IVAN D. EBY
BY *John M. Cole*
ATTORNEY

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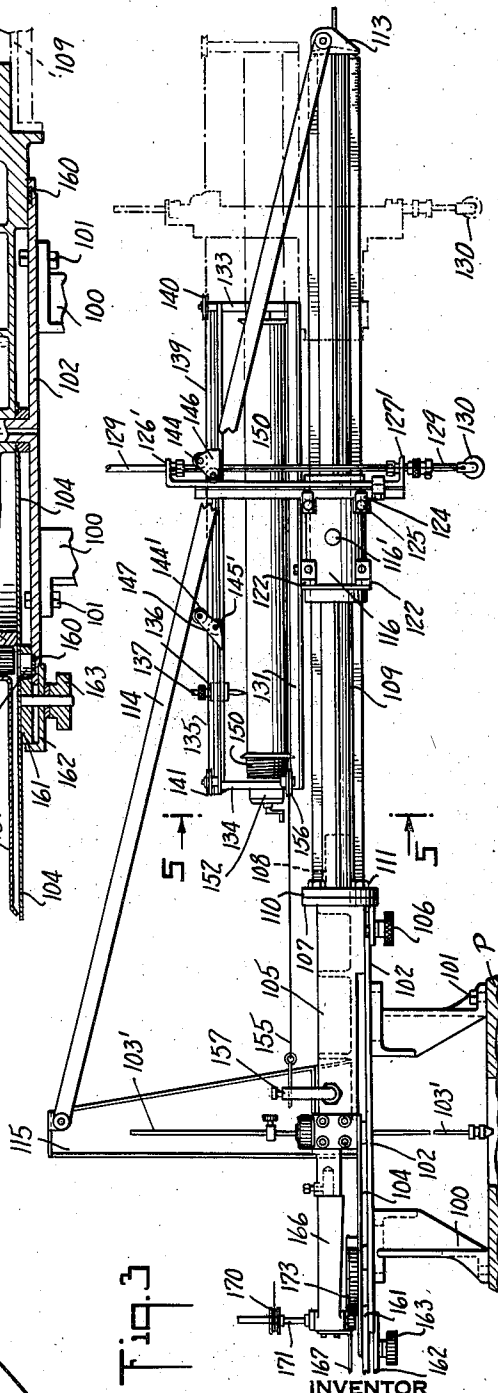
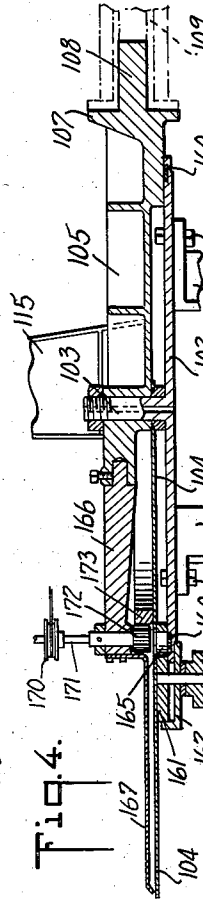
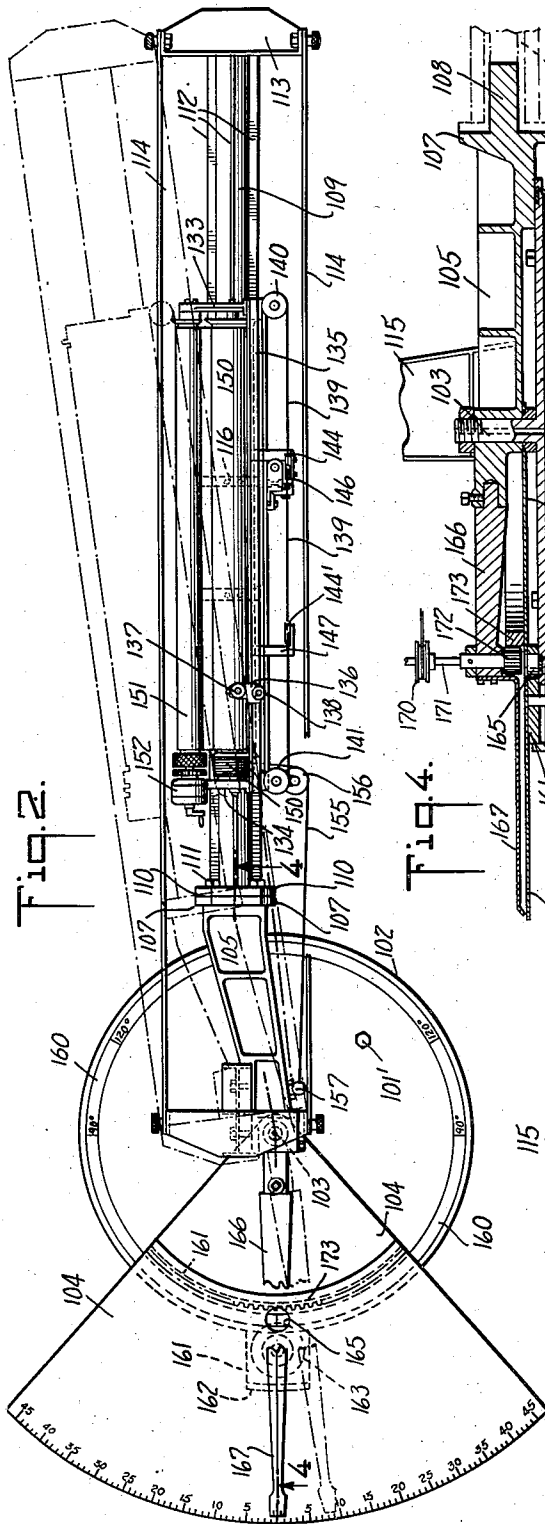
I. D. EBY

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5 Sheets-Sheet 2



INVENTOR
IVAN D. EBY
BY *John M. Cole*
ATTORNEY

July 15, 1941.

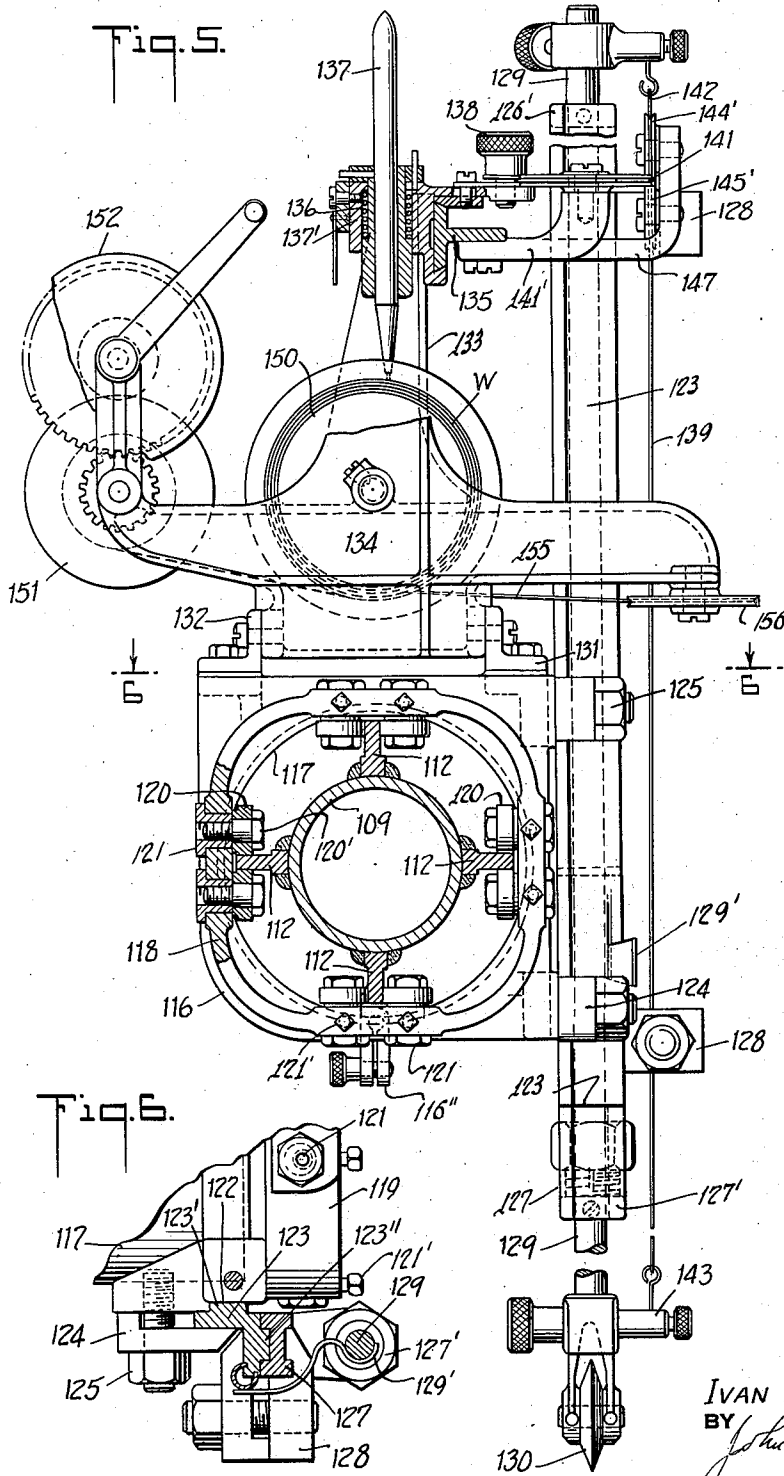
I. D. EBY

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RECORDING PITCHOMETER

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5 Sheets-Sheet 3



INVENTOR
IVAN D. EBY
BY *John M. Cole*
ATTORNEY

July 15, 1941.

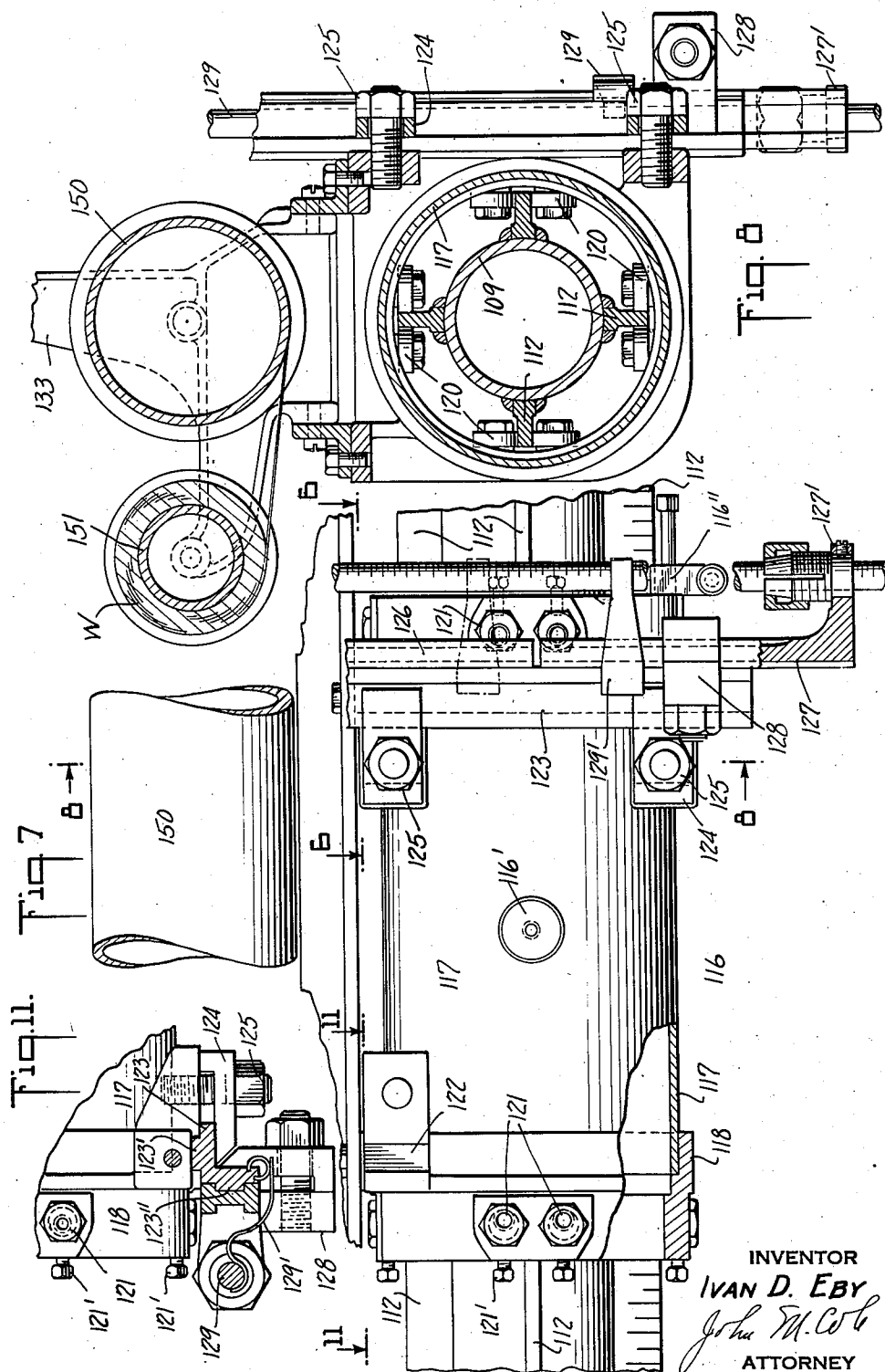
I. D. EBY

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RECORDING PITCHOMETER

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5 Sheets-Sheet 4



INVENTOR

IVAN D. EBY

John M. Costello
ATTORNEY

ATTORNEY

July 15, 1941.

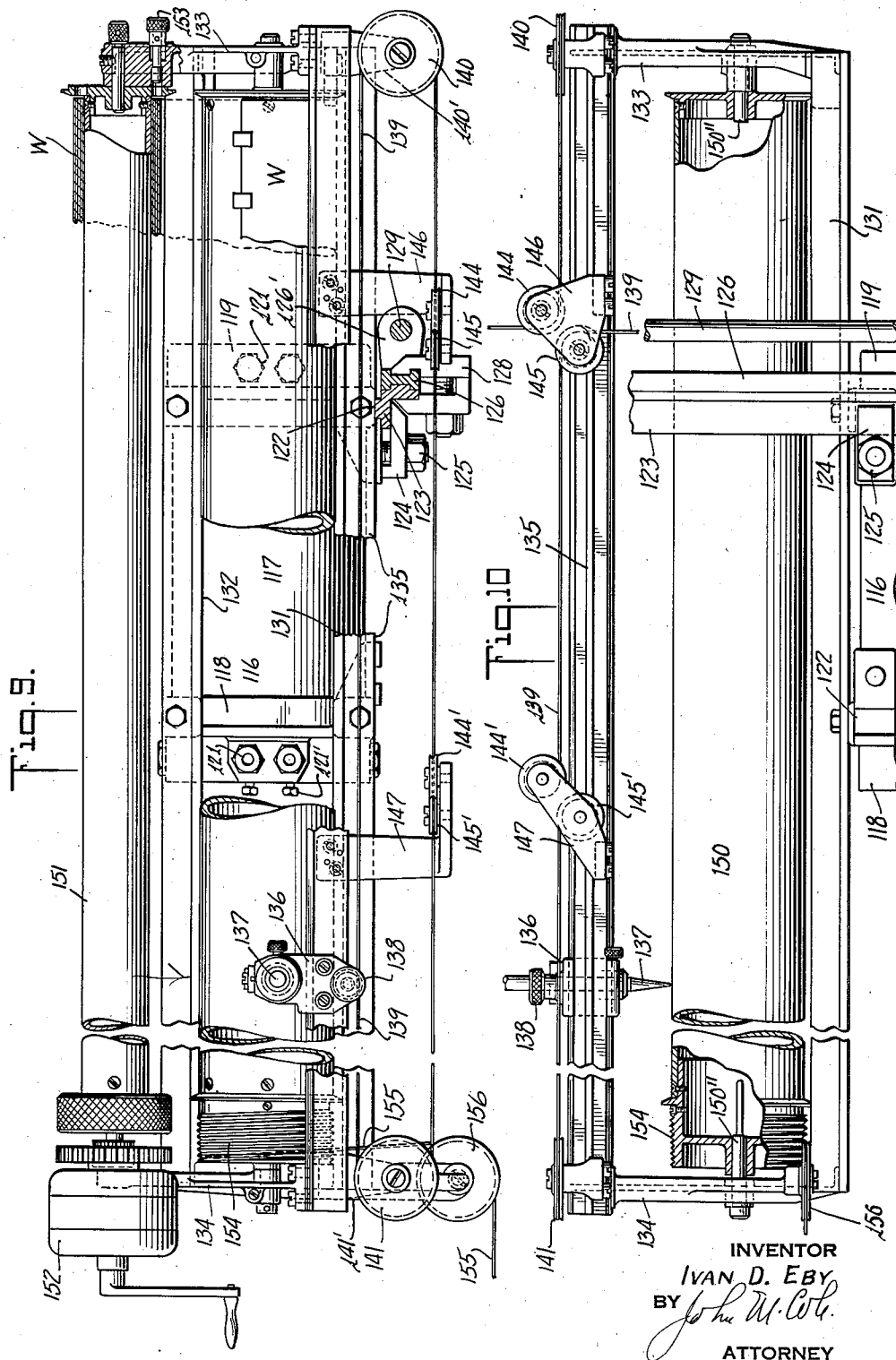
I. D. EBY

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RECORDING PITCHOMETER

Filed Sept. 9, 1939

5 Sheets-Sheet 5



UNITED STATES PATENT OFFICE

2,248,973

RECORDING PITCHOMETER

Ivan D. Eby, Staten Island, N. Y.

Application September 9, 1939, Serial No. 294,080

15 Claims. (Cl. 33—174)

The present invention relates to recording pitchometers, and is more particularly directed toward improvements in recording pitchometers of the type shown and described in my co-pending application Serial No. 849,518, filed October 23, 1934 (to be issued as Patent No. 2,172,368 on September 12, 1939).

The present invention contemplates recording pitchometers adapted to be constructed of heavy, extremely rigid parts capable of ready assembly and disassembly so that the devices may be disassembled for shipment and reassembled for use in different shipyards or plants.

The present invention contemplates a recording pitchometer wherein the cylinders on which the chart is made are supported on a radially shiftable carriage and mounted on horizontal axes, thereby reducing the overall vertical dimensions of the device and making it possible to construct a more rigid piece of apparatus.

The present invention also contemplates an arrangement whereby the normal vertical movement of the follower cooperative with the blade surface of the propeller is transmitted through cords to a horizontally movable marker or pencil adapted to cooperate with the wrapping on the horizontal cylinder.

A further object of the present invention is to provide recording pitchometers having means to compensate for the increased periphery of the wrappings on the cylinder whereby the linear speed of the pencil point is identical with the linear speed of the carriage along the arm.

A further object of the invention is to provide a recording pitchometer having means whereby the same recording mechanism may be employed to obtain either the profile of the propeller blade surface in radial planes or can be employed to obtain the profiles of the propeller surface at specified radii.

Other and further objects will appear as the description proceeds.

While the invention is more especially designed for use in connection with cast metal propellers for water craft, it may be used on the patterns for such propellers, on the blades of water pumps and water wheels, or on wood or metal air screws.

The accompanying drawings show, for purposes of illustrating the present invention, an embodiment in which the invention may take form, it being understood that the drawings are illustrative of the invention rather than limiting the same.

In the drawings:

Figure 1 is a perspective view of a recording pitchometer showing it mounted over the blade of a propeller;

Figure 2 is a top plan view of the recording pitchometer;

Figure 3 is a side elevational view of the same;

Figure 4 is a sectional view on the line 4—4 of Figure 2;

Figure 5 is a vertical sectional view taken on the line 5—5 of Figure 3 with parts in elevation and parts broken away;

Figure 6 is a fragmentary horizontal sectional view taken on the line 6—6 of Figures 5 and 7;

Figure 7 is an enlarged fragmentary elevational view taken in the same direction as Figure 3, parts being broken away and parts in section;

Figure 8 is a section taken on the line 8—8 of Figure 7;

Figure 9 is a top plan view of the chart making mechanism, parts being in section;

Figure 10 is a front elevational view of the same;

Figure 11 is a fragmentary sectional view taken on the line 11—11 of Figure 7 when certain parts of the mechanism are in a different position than shown in Figure 7;

Figure 12 is a diagrammatic illustration of a chart showing profiles of the propeller blade surface at radial planes;

Figure 13 is a diagrammatic top plan view illustrating the use of the recording pitchometer for making charts of the surface of the propeller blade at selected radii; and

Figure 14 illustrates a chart showing the profiles of the propeller blade taken at a plurality of radii.

A conventional propeller hub is indicated at P and the blades at B. The propeller is normally placed flat, as indicated in Figure 1, and the pitchometer is secured to the upper face of the propeller hub. The pitchometer is supported by four legs 100 bolted to the propeller by bolts indicated at 101. The upper ends of these legs are secured by bolts 101' to a disk or plate 102. This plate is welded to an upwardly extending hub 103, see Figure 4. This hub is drilled to receive a centering device 103' and rotatably receives a sector-shaped protractor 104 and a rotatable bracket 105. The bracket can be turned about the axis of the hub 103 and clamped in any selected position by means of a clamping device indicated at 106. The arm supporting bracket 105 is a heavy, rigid casting and provided with a flange 107 near the end, the end being in the form of a round extension indicated at 108.

A long tubular arm 109 has a flanged end, indicated at 110, and is secured to the flange of the bracket by bolts indicated at 111. This arm is reinforced by four longitudinally extending guides 112 welded to the tube and ground accurately to shape and size. The outer end of the arm 109 carries a yoke 113 to which are secured tie members 114, the other ends of these tie members being secured to an inner yoke 115, secured to the bracket 105, thereby forming a rigid structure with minimum deflection.

A carriage 116 is reciprocable along the arm 109. The carriage is here shown as being made out of a piece of tubing 117 which is provided with an inner carriage bracket 118 and an outer carriage bracket 119 of substantially larger diameter than the arm 109. The brackets 118 and 119 are the same, but of opposite hand, and are provided with pairs of rollers 120 mounted on studs 120' secured in eccentric bushings 121 locked in adjusted position by set-screws 121', as indicated in Figure 7. These rollers bear on opposite faces of the guides or fins 112 carried by the arm 109, and when the rollers eccentrics are adjusted the carriage axis can be brought to exactly the proper position to coincide with the axis of the arm and so that the carriage will be oriented at the proper angle relative to the arm. In this way all parts carried by the carriage may be accurately leveled and plumbed so that they are in accurate relation with the center line of the propeller. The carriage may be locked in any selected position by a jamb nut 116'.

The brackets 118 and 119 have vertically extending grooves 122 adapted to receive the tongue 123' on one face of a generally angle-shaped bar 123, as shown more clearly in Figures 6, 9 and 10. This bar is clamped to the bracket 118 (or to the bracket 119) by clamping members 124 and bolts 125. The other side of the angle member 123 has a tongue 123'' as indicated, to slidably receive the grooves in the long legs of L-shaped brackets 126 and 127. The brackets 126 and 127 are clamped to the bar 123 by clamps indicated at 128. They may be adjusted to the proper height according to the propeller being charted. The short legs 126' and 127' of bracket members 126 and 127 slidably support a vertical rod 129 carrying on its lower end a roller 130 adapted to cooperate with the upper surface of the propeller blade B. The rod 129 may be graduated in inches and a cooperable slidable pointer 129' carried by the angle member 123 may be employed in making measurements of rod movement.

Each of the brackets 118 and 119 has grooves 122 so that the rod 129 can be mounted either on the outer end of the carriage, as indicated in Figures 1-10, or can be mounted on the inner bracket, as indicated in Figure 11. The dimensions of the parts are such that the movement of the rod 129 from one position to the other changes the radius at which the roller contacts the blade by one foot. This makes it possible to bring the follower nearer the blade axis for propellers of smaller diameter. The lower guide 112 carries graduations as indicated in Figures 3 and 7 to cooperate with a pointer 116''.

The carriage brackets 118 and 119 carry longitudinally extending angles 131 and 132 which extend beyond the carriage brackets. These angle members support end brackets 133 and 134 extending upwardly above the radially extending arm 109 and rearwardly as indicated in the drawings. A longitudinally extending T-shaped

bar 135 is secured to the brackets 133 and 134, and this bar is provided with a longitudinally reciprocable carrier 136 for a pencil 137 and pencil carrier. The angles, brackets and bar 5 pencil carrier has suitable mechanism for releasably gripping a pencil and for pressing it against the paper wrapping W on the cylinder on which the record is to be made.

The pencil carrier has a clamping device 138 10 whereby it may be secured to a cord 139. This cord passes around pulleys 140 and 141 secured to brackets 140' carried by guide bar 135 and is connected to the top and bottom of the rod 129, as indicated at 142 and 143, Figure 5. When the 15 rod 129 is mounted on the right-hand or outer end of the carriage, the cord 139 passes around guide wheels, indicated at 144 and 145, so as to go to the ends of the rod 129. When the assembly is as indicated in Figure 11, the cord is passed 20 around similar guide wheels 144' and 145'. The guide wheels are carried on brackets indicated at 146 and 147.

From the foregoing it will be apparent that for any setting of the radial arm 109 over the 25 propeller blade there is a corresponding position of the pencil 137 along the guide 135 for each elevation of the roller 130 as determined by the surface of the propeller blade. It is therefore apparent that by moving the carriage along the 30 arm the follower 130 will be moved up and down according to the profile of the propeller blade in the radial plane under consideration, and the movement of the pencil 137 will correspond with the change in profile.

The brackets 133 and 134 rotatably carry a 35 cylinder 150 on suitable bearings 150' and 150'' as indicated. To the rear of the cylinder 150 the brackets 133 and 134 carry a paper storage cylinder 151. This cylinder is adapted to receive a 40 substantial quantity of paper and is connected to a suitable spring device, such as a phonograph motor indicated at 152, for maintaining tension on the paper. It is provided with a stop device 153 to prevent unwinding when the paper wrapping W is not secured to the cylinder 150. This 45 wrapping can be secured to the cylinder, as indicated at the right hand of Figure 9, by suitable stickers.

The inner end of the cylinder 150 is provided 50 with a drum 154 adapted to receive a cord 155. This cord is passed about a guide pulley 156 and when used to chart profiles in radial planes is secured to an anchorage 157 adjacent the propeller axis, so that when the arm 109 is turned 55 relative to the axis, there will be no motion given the cord so long as the carriage is stationary. When the carriage is moved along the arm from the foot of the propeller toward the top, the cord will be pulled off of the drum and this will cause 60 the drum and cylinder to rotate, drawing paper onto the cylinder 150 from the storage cylinder 151. On return movement of the carriage toward the root of the propeller the paper will be automatically rewound onto the storage cylinder 151.

Inasmuch as the periphery of the cylinder is 65 small as compared with the length of the propeller blade being charted, it is necessary to wrap several layers of paper around the drum. The 70 added layers of paper change the amount of paper wound on for each turn of the drum, and in order to compensate for this and insure that the linear speed of the paper at the pencil point is always identical with the linear speed of the 75 carriage along the arm, the drum 154 is provided

with spiral grooves to receive the cord, and these grooves are accurately cut on a cone of the proper taper to correspond with the thickness of the paper.

Plate or disk 102 carries a ring 160 which is marked at each 90° for four-bladed propellers and at each 120° for three-bladed propellers. This ring fits very tightly in the place in the groove which receives it, but can be adjusted when desired. The protractor 104 is provided with a bearing plate 161 adapted to bear on the periphery of the disk 102 and this plate carries a clamp member 162 adapted to be clamped against the ring by a nut 163. As shown in Figure 4, the protractor and bearing plate have a sight opening 165 at the same radius as the ring 160. The bracket 105 has an extension 166 which carries a pointer 167, this pointer being adapted to be moved past the graduations at the edge of the protractor 104.

After the machine has been set up on a propeller, so that it is accurately centered over the propeller axis and the carriage has been adjusted to proper position, the arm 109 is then brought to the center line of one of the propeller blades and clamped in this position. The zero on the protractor is then brought opposite the zero on the pointer, the protractor clamped into position and the ring 160 moved to bring one of its graduations opposite the center of the sight opening 165, a sighting wire, not shown, being usually employed to assist in making the adjustment. The arm clamp 106 is then released and the arm with pointer swung over the other blades and their center lines checked with the graduations on the ring 160. This will show how far the blades are displaced from the proper position and, if the displacement is not too much, the best compromise set up for the center lines of the blades. The ring and protractor are then re-set. The pitchometer is in readiness for making the charts for the profiles of the blades in radial planes. Such a chart is indicated diagrammatically in Figure 12. Here, the long, straight parallel lines indicate the desired profiles of the propeller blade in regularly spaced radial planes, and the dotted line indicates the line which would be drawn on the chart where the profile of the propeller blade departed substantially from the desired profile. The lines will have different slopes according to the propeller design and may converge or diverge, depending upon whether or not the propeller has other than uniform pitch.

Where it is desired to obtain the profiles of the blade at the desired radii, the recording pitchometer is slightly rearranged and, instead of moving the carriage lengthwise of the arm, the carriage is clamped to the arm at each radius and the arm swung about the propeller axis so that the roller 130, is turned from the position shown in Figure 1 so that it will traverse the surface of the propeller along the arc. This will move the recording pencil back and forth along the guide.

In order to move the paper under the pencil, cord 155 is disconnected from the anchorage 157 and, by means of an extension, is wrapped about a pulley 170 as is more clearly shown in Figure 13. This pulley is carried on a vertical shaft 171, mounted in the arm 166, and provided at the lower end with a pinion 172 which is in mesh with a rack 173, secured to the protractor 104. With this arrangement the moving of the arm 109 about the propeller axis will shift the pinion 172 along the gear 173 and cause the pinion to rotate at an angular speed, depending upon the

diameters of the rack and pinion. By selecting a pulley 170 of the proper diameter, it is possible to wind on an amount of cord which corresponds exactly with the length of the arc through which the rod 129 travels at the radius at which the carriage has been clamped. A series of pulleys 170 is provided so that by merely changing them one can obtain profiles of the propeller at selected radii from root to tip. This makes it possible to secure full size, accurate patterns of the propeller blade surface at selected points.

Figure 14 diagrammatically shows the type of chart to be obtained with the set-up shown in Figure 13. The heavy diagonal lines 171, 172 and 173 illustrate the contours of a blade surface at various radii, the steeper line 171 being nearer the root of the blade than the flatter lines to the right. For the working surface of the blade these lines will be straight or slightly curved according to the contour set up by the designer of the blade. The lines for the back face of the blade will be curved somewhat as indicated by the heavy dash line 175. The lines will be positioned along the chart according to the location given the pencil on the guide and the amount of paper which has been wrapped onto the cylinder before the particular line is drawn. The spacings of the lines lengthwise of the chart have no function other than to facilitate segregating the chart lines. If along any selected line marks are placed indicated at X and X at a known angular spacing, then the overall pitch between these two points may be accurately checked.

From the foregoing, it will be seen that one can readily make on the same machine charts of both types for the surfaces of the propeller blade. After each chart is made it is removed from the machine, placed on the drawing table, and gone over carefully so as to ascertain how true the surface is. While on the drawing board suitable marks can be placed on the chart to show where material must be ground off to provide the desired surface and, in the case of the cross sectional charts, these can be compared with the drawings specified by the designer.

After a chart has been gone over on the drawing board and lines drawn representing the true surface desired, the chart is replaced on the machine and is then used as a guide for grinding operations.

It is obvious that the invention may be embodied in many forms and constructions within the scope of the claims, and I wish it to be understood that the particular form shown is but one of the many forms. Various modifications and changes being possible, I do not otherwise limit myself in any way with respect thereto.

What is claimed is:

1. A pitchometer for preparing a chart to show the departures of the surface of a screw propeller blade or the like from an ideal blade surface whereby the pitch of the propeller may be recorded, comprising a radially extending swingable arm, means for rotatably supporting the arm coaxially of the propeller whereby the arm is adapted to be placed in various radial positions opposite the sloping surface of the propeller blade, a radially movable carriage on the arm, a carriage carried follower movable transversely thereof and held in contact with the blade surface being recorded whereby the position of the follower at any radius is a function of the radial position of the arm, a horizontal cylinder carried by the carriage, a self winding paper storage cylinder, a paper wrapping extending from the

storage cylinder and secured to the first cylinder, a follower actuated recording marker movable with the carriage and bearing on the paper wrapping, and means to turn the cylinders on their axes in response to movement of the carriage along the radial arm so as to move the paper wrappings under the marker.

2. A pitchometer such as claimed in claim 1, wherein the cylinder turning means includes a cord anchored adjacent the propeller axis and wound about a cylinder actuating drum.

3. A pitchometer for preparing a chart to show the departures of the surface of a screw propeller blade or the like from an ideal blade surface whereby the pitch of the propeller may be recorded, comprising a radially extending swingable arm, means for rotatably supporting the arm co-axially of the propeller whereby the arm is adapted to be placed in various radial positions opposite the sloping surface of the propeller blade, a radially movable carriage on the arm, a carriage carried follower movable transversely thereof and held in contact with the blade surface being recorded whereby the position of the follower at any radius is a function of the radial position of the arm, a cylinder carried by the carriage and having thereon a paper wrapping, a follower actuated recording marker movable with the carriage and bearing on the paper wrapping, and means to turn the cylinder on its axis in response to movement of the carriage along the radial arm so as to move the paper wrappings under the marker, said last mentioned means including a cord anchored adjacent the propeller axis and wound about a cylinder actuating drum of tapering diameter to compensate for the thickness of the wrapping on the cylinder.

4. A pitchometer for preparing a chart to show the departures of the surface of a screw propeller blade or the like from an ideal blade surface whereby the pitch of the propeller may be recorded, comprising a radially extending swingable arm, means for rotatably supporting the arm co-axially of the propeller whereby the arm is adapted to be placed in various radial positions opposite the sloping surface of the propeller blade, a radially movable carriage on the arm, a horizontal cylinder carried by the carriage, a self-winding paper storage cylinder, a paper wrapping extended from the storage cylinder and secured to the first cylinder, means to turn the first cylinder on its axis in response to movement of the carriage along the radial arm so as to wind and unwind the paper wrapping, a horizontally movable marker supported by the carriage, a vertically movable follower supported by the carriage and bearing on the blade surface, and a marker operating cord connected with the follower.

5. A pitchometer such as claimed in claim 4, having duplicate mounting means for the follower at different points lengthwise of the carriage and cord guides for the marker at corresponding points.

6. A pitchometer for preparing a chart to show the departures of the surface of a screw propeller blade from an ideal blade surface whereby the pitch of the propeller may be recorded, comprising a radially extending swingable arm having guides projecting radially of the arm, means for rotatably supporting the arm co-axially of the propeller whereby the arm is adapted to be placed in various radial positions opposite the sloping surface of the propeller blade, a car-

riage, means for mounting the carriage on the arm comprising rollers bearing against the guides, a carriage carried follower movable transversely thereof and held in contact with the blade surface being recorded whereby the position of the follower at any radius is a function of the radial position of the arm, a cylinder carried by the carriage and having thereon a paper wrapping, a follower actuated recording marker movable with the carriage and bearing on the paper wrapping, and means to turn the cylinder on its axis in response to movement of the carriage along the radial arm so as to move the paper wrappings under the marker.

7. A recording pitchometer having a horizontal arm swingable about the axis of a propeller or the like, a carriage movable along the arm, a follower slidably carried by the carriage for vertical movement, a carriage supported frame, a frame carried horizontally disposed cylinder about which paper is wrapped to provide a recording surface, a frame carried self-winding storage cylinder parallel with the first cylinder, a cord receiving drum drivingly connected with the wrapping receiving drum, a cord wrapped about the drum and adapted to actuate the drum to draw paper onto the cylinder, a horizontally movable marker carried by the frame and bearing on the wrapping on the first cylinder, and a marker operating cord connected to the follower whereby the position of the marker transversely of the wrapping varies according to the elevation of the propeller blade surface with which the follower is in contact.

8. A recording pitchometer such as claimed in claim 7, wherein the follower is secured to vertically adjustable guides whereby its position relative to the arm may be varied, and wherein the cord connection to the marker can be altered.

9. A recording pitchometer such as claimed in claim 7 having an anchorage adjacent the propeller axis for the cylinder operating cord so that the paper wrapping is wound onto and off from the receiving cylinder as the carriage is moved back and forth along the arm.

10. A recording pitchometer such as claimed in claim 7, wherein the drum is of varying diameter to compensate for the thickness of the paper wound on the cylinder.

11. A recording pitchometer such as claimed in claim 7, having means to lock the carriage against movement along the arm, a second drum to which the cylinder operating cord is connected and means for operating the second drum in response to swinging of the arm at a speed equal to the linear speed of the follower about the propeller axis.

12. A recording pitchometer such as claimed in claim 7, having means to lock the carriage against movement along the arm, a second drum to which the cylinder operating cord is connected and rack and pinion means for operating the second drum in response to swinging of the arm at a speed equal to the linear speed of the follower about the propeller axis.

13. A pitchometer for preparing charts showing the profiles of the surface of a propeller blade or the like in either a plurality of radial planes or at a plurality of radii, comprising a radially extending arm adapted to be swung about the propeller axis or to be locked in selected radial positions, a carriage movable along the arm and lockable in selected positions, a carriage supported follower movable parallel with the propeller axis and bearing on the propeller blade surface, a

marker operable by the follower, two carriage supported cylinders, one being a self-winding paper storage cylinder, the other being a receiving cylinder onto which paper may be wrapped to provide a recording surface cooperative with the marker, cord operated means to rotate the paper receiving cylinder to draw paper onto the same, and two alternatively usable cords actuating means, one acting in response to movement of the carriage along the arm when the arm is locked against swinging movement to move the paper at a linear speed equal to the linear speed of the carriage along the arm, the other acting in response to swinging movement of the arm when the carriage is locked at the selected radius to move the paper at a linear speed equal to the linear speed of the follower.

14. A pitchometer for preparing a chart to show the profiles of a propeller blade surface at selected radii comprising a radially extending swingable arm, means for rotatably supporting the arm co-axially of the propeller whereby the arm is adapted to be swung opposite the sloping surface of the propeller blade, a carriage, means

to lock the carriage on the arm, a carriage carried follower movable transversely thereof and held in contact with the blade surface being recorded whereby the position of the follower at any radius is a function of the radial position of the arm, a cylinder carried by the carriage and having thereon a paper wrapping, a cord receiving drum for actuating the cylinder, a cord, a follower actuated recording marker movable with the carriage and bearing on the paper wrapping, and means to turn the cylinder on its axis in response to the swinging of the arm so as to move the paper wrappings under the marker, said means including a lockable sector, a pinion swingable by the arm and in mesh with the sector, a drum operated by the pinion at a surface speed equal to the speed of the follower in the arc through which it moves, and about which the cord is wrapped.

15. A pitchometer such as claimed in claim 14, wherein the sector is carried on a plate swingable about the propeller axis and lockable in position.

IVAN D. EBY.