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[54] **TOY ORNITHOPTER WIND-DRIVING MECHANISM**

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[58] **Field of Search** .....46/74 R, 75

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[57] **ABSTRACT**

This invention provides a toy ornithopter which has an elongated body and two pairs of wings at the front with a driving mechanism including a cranked drive member arranged so that the wings move in pairs in out-of-phase relation with one pair moving up as the other pair moves down. The driving mechanism includes either articulated linkages connected to the wings or a specially shaped fitment on which the wings are mounted so arranged as to cause the wings to undergo the desired motion.

7 Claims, 13 Drawing Figures

FIG. 1.

FIG. 2.

FIG. 3.

FIG.4.

FIG.5.

FIG.6.

Fig.7.

Fig.8.

Fig.9.

Fig.10.

Fig.11.

Fig.12.

Fig.13.

TOY ORNITHOPTER WIND-DRIVING MECHANISM

This invention relates to a flying toy in the form of an ornithopter.

According to the present invention a toy ornithopter comprises an elongated body, at least two pairs of wings, a driving mechanism mounted on the body and including a shaft with a cranked drive member disposed in front of the body and movable in a circular path about the axis of the shaft and articulated linkages actuated by said drive member and connected to the wings so that the wings are moved responsive to the movement of said linkages in such manner that each pair of wings moves in out-of-phase relation with each other pair.

Each articulated linkage may consist of a single piece of plastics material having the link members thereof interconnected by integral hinges. Preferably the link members are formed with sockets or the like in which the wings are directly mounted.

If it be desired to locate the wings at positions displaced longitudinally of the body relatively to the linkages, the linkages may actuate longitudinally extending rods pivotally secured at one end to the body and connected at the other end to one or other link member of the linkages, the wings being mounted on the rods intermediate the ends of the latter.

If only two pairs of wings are to be provided as would most frequently be the case, it is preferred that the movements of the pairs of wings should be 90° out-of-phase.

The invention will be hereinafter more fully described with reference to the accompanying drawings in which:

FIG. 1 shows a perspective view of the toy ornithopter with the linkages thereof shown diagrammatically.

FIGS. 2 and 3 show a front view of the diagrammatic driving mechanism in two positions relatively angularly displaced by 180°.

FIG. 4 shows a front view of a preferred form of driving mechanism.

FIG. 5 shows a plan view of the mechanism of FIG. 4.

FIG. 6 shows a perspective view of another form of toy ornithopter with the wings displaced rearwardly from the driving mechanism.

FIG. 7 is a plan view of a modified form of ornithopter.

FIG. 8 is an end view of the ornithopter in the direction of the arrow A.

FIG. 9 is an enlarged section on the line B—B

FIG. 10 is an enlarged fragmentary view in the direction of the arrow A.

FIG. 11 is a side elevation

FIG. 12 is a fragmentary view in the direction of the arrow C in FIG. 10 and FIG. 13 is a fragmentary view in the direction of the arrow D in FIG. 10.

The toy ornithopter shown in FIG. 1 has a body which includes a hollow stem 1 provided at its front end with a face plate 2. A horizontal surface 3 secured to the stem 1 acts as a stabilizer in the manner of a tailplane. The surface may take any suitable form, but in the illustration it is a slightly concave (seen from above) ovoid plate of plastics material.

The stem 1 is rigid and its hollow interior accommodates a rubber band (not shown) which at the front end is attached to a shaft 24 having a cranked drive member 4. At the rear end of the stem 1, a notch 5 holds a bar 6 which can be withdrawn from the notch 5 for rotating the rubber band to twist the same.

A fin 7 projects downwards to allow the toy to be held.

The drive member 4 rotates in the face plate 2 and its axially extending end part 8 travels in a circular path about the axis.

The part 8 drives two link members 9, 10 which are respectively connected to L-shaped link members 11 and 12. The link members 9 and 11 and the link members 10 and 12 form a pair of articulated linkages which operate wings as hereinafter described.

The members 11, 12 are pivoted on a fixed pivot at 13 and 14, at the ends of the face plate 2 so that they lie one on each side of the center line of the body.

The toy, as shown, is provided with two pairs of wings, one pair 15 and 16 being disposed forwardly of the other pair 17 and 18, and the latter rear pair in the position of rest lying somewhat above the pair 15 and 16. These wings are connected respectively to one of the links 9, 10, 11, 12 for example wing 15 is connected to the link 12, wing 16 to the link 11, wing 17 to the link 10, and wing 18 to the link 9.

The wings may be of any suitable shape for instance to simulate the wings of a dragon-fly and may be formed with a curved leading edge of flexible light material such as cane with the air-reacting part consisting of a flexible membrane such as a plastics material. The wings are individually movable according to the movement of the link members 9, 10, 11, 12, and operate in pairs so that one pair 15 and 16 moves upwardly while the other pair 17 and 18 moves downwardly.

The mode of action of the drive mechanism and wings is illustrated by FIGS. 2 and 3. In FIG. 2 the drive member 4 is vertically downward and in FIG. 3 it has rotated through 180°.

The angular change in position of the link members 9–12 as a result of this rotation has caused a rotational change (as well as a small and immaterial translational change) in the wings 15 to 18 which thus undergo a flapping half-stroke.

When there are two pairs of wings as in the present embodiment, the wings are preferably operated 90° out of phase.

To ensure this, the relative dimensions of the various parts of the drive mechanism are such that each of the members 9 to 12 has a length in a straight line between its pivots which is equal to the total throw of the part 8 of the drive member 4, or to twice the eccentricity of the drive member 4.

Instead of the links being formed of metal each articulated linkage may be formed of a single piece of plastics material the links of which are connected by integral hinges. This construction is shown in FIGS. 4 and 5 wherein, as in the earlier Figures a crank drive 4 rotates about the axis 23 of a shaft 24, the forward end of which bears on a face plate 32 of plastics material such as polypropylene which at its two lateral extremities 33, 34 is formed as thin flexible regions acting as hinges for link members 29, 30. These links at their

other ends are formed as thin flexible regions **35**, **36** acting as integral hinges for further link members **37**, **38** respectively which at their other extremities are pivotally connected to the drive member **4**. The provision of integral hinges allows rotation with little or no friction.

The wings **15-18** are rigidly mounted at one end in sockets formed on the link members. For example, as shown, one pair of wings **15** and **16** are inserted in sockets in links **29** and **38** respectively while the other pair of wings **17** and **18** are inserted in links **37** and **30** respectively. Thus the wings partake in the movement of the links on which they are rigidly mounted and since the integral hinges are mutually parallel and are sufficiently flexible the link members execute all movements necessitated by the free rotation of the drive member **4**.

If desired the integral hinges may be replaced by conventional forms of hinges between the link members of plastics material of the linkages.

Where it is desired to locate the wings in positions longitudinally displaced from the front or nose of the toy, a modified construction is provided as shown in FIG. **6**. This comprises the linkage structures **9**, **10**, **11**, **12** as shown in FIG. **1** actuated by the drive member **4**.

Instead of the links carrying the wings, however, the links are rigidly connected to rods **19**, **20**, **21**, **22** which extend along the body and at their rear ends are pivotally anchored to the stem **1**. Each rod carries one of the wings **15–18** so that the latter are indirectly operated from the links. For example wing **16** is mounted on rod **20** fixed to link **11**, wing **18** is mounted on rod **22** fixed to link **9**, wing **15** is mounted on rod **19** fixed to link **10** and wing **17** is mounted on rod **21** fixed to link **12**. In this embodiment all the points of attachment of the rods to the links are located near the articulation points between the links.

An alternative embodiment of the invention has wings attached to and supported by rods as in FIG. **6**. The rods are capable of rotational movement only and each is driven by a respective lever arm pivotally linked to a connecting rod driven by a single crank shaft having two cranks, 90° out of phase with each other. The wings of each pair are driven from one of these cranks, the crankshaft being powered as before by a rubber band.

The use of rods for supporting the wings as shown in FIG. **6** enables the wings to be located close to the center of gravity of the toy and gives support against forward or backward shocks on the wings.

The toy may be made from any desired structural material having an adequate lightness.

If completely rigid wings are used there would have to be provision for pivoting about its axis of elongation.

If more than two pairs of wings are used (this is more readily done by driving by a crankshaft arrangement) the preferred degree by which the wings are out of phase will be $180°/n$ where n is the number of pairs of wings.

Referring to the embodiment shown in FIG. **6**, it is not essential that the rods are connected adjacent the position of articulation of the members **9**, **11**, **10**, **12** respectively.

The length of the rods **19–22** is chosen so that the radius of movement of the front ends of the rods is large compared with the degree of movement; thus the fact that its front end is constrained by the linkage to move in a plane becomes unimportant and bending of the linkage or strain at the pivot of the rods is minimized. Referring now to the modification illustrated in FIGS. **7** to **13** the ornithopter **101** has a body **102**, two pairs of wings **103*a***, **103*b*** and **104*a***, **104*b*** and a driving mechanism including a shaft connected at the front to a cranked driving member **105** and a rubber or like band **106** that may be twisted in known manner to turn the shaft and the driving member **105** when released. The ornithopter **101** also has a tail plane **107** connected to the body **102** by means of a link **108** and a shaped fitment **109** which connects the driving member to the wings **103*a***, **103*b*** and **104*a***, **104*b***.

The fitment **109** is shaped to receive the end of the shaft driving member **105** in a socket **118** at a central position and is also shaped with apertures at **110**, **111**, **112**, **113** to receive rods **114**, **115**, **116**, **117** to which the wings are attached. Preferably the fitment is moulded as a single substantially flat unit and is then bent around and the two ends suitably interconnected to form a symmetrical fitment which comprises the central socket **118** to receive the driving member **105** and two curved and shaped arms each extended sideways, then upwards and then inwards so that the two free ends may be interconnected and may also receive the driving member **105**. As described apertures are provided in the upwardly extending parts of the arms at **110**, **111**, **112** and **113** to receive the rods **114**, **115**, **116** and **117**, two at each side, in such a way that the rods extend outwardly at the correct angle.

The arms of the fitment are moulded or otherwise shaped in such a thickness that the rods can be firmly located in position in the apertures at **110**, **111**, **112**, **113**.

The body **102** of the ornithopter **101** consists of a transparent or translucent tube so that the driving mechanism is visible and the driving mechanism includes the rubber or like band **106** which at the front end is connected to the shaft which in turn is connected to the cranked drive members and at the rear is connected to a fixed transverse bar **119** or in another way to be hereinafter described. By making the body **102** transparent or translucent it is possible to inspect the driving band **106** which extends longitudinally within the tube as it is being wound up and to tell when the band **106** has been wound into one row and then into two rows of coils. In this way overwinding or underwinding is unlikely to occur.

In a modification, instead of attaching the driving band **106** at the rear to the transverse bar **119** I may fix the band **106** to a center piece of the tail plane **107** of the ornithopter **101** so that the tail plane **107** holds the driving band **106** in position and in turn the driving band **106** holds the tail plane **107** in position because as the band is wound up the band **106** pulls on the tail plane **107** and so holds it in place.

Another advantage of this construction is that the tail plane **107** may be set at a desired angle and the band **106** will then hold the tail plane **107** substantially at that angle in flight for the first part until the pressure or pull of the band **106** decreases and then the tail plane **107** may be arranged to pivot downwardly so that the ornithopter **101** comes down in a steady glide.

The wings **103***a*, **103***b*, **104***a*, **104***b* are made of any suitable light weight material, e.g., material sold by the Du Pont Company under the Trade Mark MYLAR. The leading **120** edge of each wing preferably comprises a rod of material consisting of glass fibers embedded in an epoxy resin which gives a tough, light and not too flexible leading edge, and the wing material, e.g., the Mylar is connected to the rod. In operation each wing twists and the angle of attack of each wing changes since as a wing goes up the pressure above the wing causes the trailing edge to be pressed down while as a wing comes down the pressure below the wing causes the trailing edge to be pressed up. The rods at the leading edge **120** of each wing are preferably of graduated thickness being relatively stiff at the wing root and relatively pliable at the wing tips so that the wings may twist as required.

In an alternative construction, which however is not so lifelike, the rods may be stiff all the way along and the wing material may be floppy which gives the same effect as having a twisting leading edge.

In some constructions it may be desirable to provide a trailing edge support in the form of a light rod projecting from the main rods **114**, **115**, **116** and **117** near the wing root but I prefer to avoid this and to strengthen the wings by providing a strengthening member **121** extending across the wings at or near the center. The strengthening members **121** may comprise a length of plastics material secured, e.g., adhesively to the wing surface.

In the embodiment of the invention as illustrated in the accompanying drawings the shape of the fitment **109** will be apparent especially from FIG. **10**. The front end of the shaft is secured in the aperture **118** at the bottom center of the fitment **109** and the driving member connected to the shaft projects from the end of the shaft. The driving member **105** viewed from the side as in FIG. **13** projects forwardly then upwardly and then forwardly again at **122** through the matched apertures in the meeting ends of the fitment **109** and finally upwards again at **123** and then forwards at **124** to form a handle by means of which the band **106** may be wound up.

In operation as the driving member **105** is rotated by the shaft the wings **103***a*, **103***b*, **104***a*, **104***b* are caused to move upwards and downwards in a realistic manner in such a way that the wings move in an out of phase relation with one another. As illustrated in FIG. **10** one pair of wings are secured more or less to the top of the fitment and the other pair of wings are secured intermediate the length of the sides of the fitment. As the driving member **105** is rotated clockwise the top center of the fitment moves down to the right until at the bottom center the two sides are overlapping and then the top center of the fitment moves up to the left back to the start. During this movement of the fitment all of the wings in turn are caused to undergo a flapping movement as the point of connection of the wing with the fitment is moved.

It may be mentioned that the 90° out of phase relationship between the pairs of wings not only gives the ornithopter **1** a very realistic and lifelike appearance simulting for example for example a dragonfly but it also attains thereby a greater efficiency in the utilization of the elastic energy from the driving band.

In a modification the ends of the arms of the fitment are provided with moulded clips which may be formed integrally and which fasten on to and may be removed from the cranked driving member without breaking. These clips and the use of a large washer on the driving member case assembly of the ornithopter during manufacture and facilitate the replacement of the rubber band during use.

What I claim is:

1. A toy ornithopter comprising an elongated body having a front end and a rear end with at least two pairs of wings extending transversely of the body and a tail plane at the rear end of the body, a driving shaft extending along the body and an elastic band driving means carried by the body for rotating the shaft, a driving member comprising a rotatable driving crank projecting forwardly from the shaft and thus moveable in a circular path about the longitudinal axis of the shaft upon rotation thereof, articulated linkages pivotally connected at one extremity to said driving crank and at their other extremity to spaced points adjacent the front end of said body, each of said wings being moved by a separate link of said articulated linkages, whereby movement of said crank through its circular path moves each pair of wings in a flapping motion which is 90° out of phase with the motion of the other wing pair.

2. A toy according to claim **1**, comprising a pair of articulated linkages in which each articulated linkage consists of a single piece of plastic material the links of which are interconnected by integral hinges.

3. A toy according to claim **1**, in which the link members of the articulated linkages are formed with sockets on which the wings are directly mounted.

4. A toy according to claim **1**, in which the link members of the articulated linkages are fixedly connected respectively to rods extending longitudinally of the body and having their ends remote from the linkages pivotally anchored to the body, the wings being mounted on the rods intermediate the ends of the latter.

5. A toy ornithopter according to claim **1**, wherein said body carries a fitment shaped to receive the end of the shaft in a socket at a central position and is also shaped with apertures to receive rods to which the wings are attached.

6. A toy ornithopter according to claim **5**, wherein the fitment is moulded as a single unit which is then bent to shape to form a central socket to receive the driving shaft, and to form said articulated linkages as two curved and shaped arms each extending sideways, then upwards and then inwards, the free ends being interconnected and pivotally attached to the driving crank.

7. A toy ornithopter according to claim **1**, wherein the body consists of a transparent or translucent tube and the driving means includes a rubber or like band extended longitudinally within the tube and connected at the front to the shaft.

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