

Oct. 15, 1935.

S. GRAY

2,017,534

FLYING MACHINE

Filed July 5, 1934

2 Sheets-Sheet 1

Fig. 1

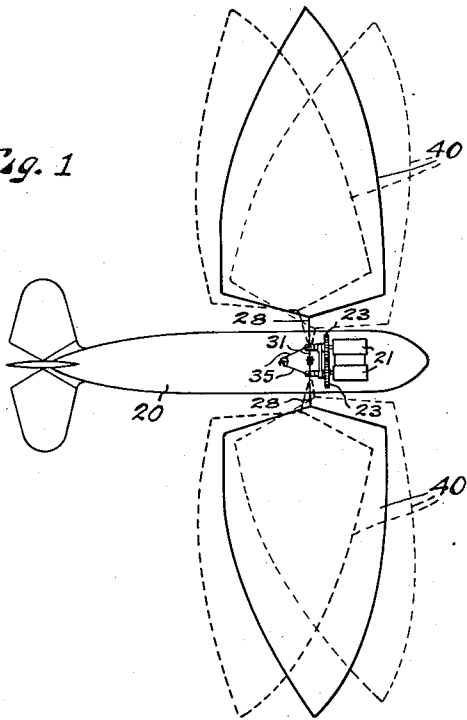


Fig. 2

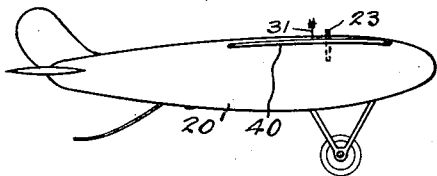


Fig. 7

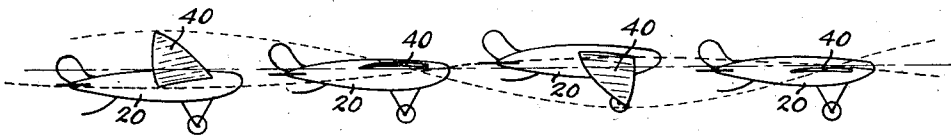


Fig. 9

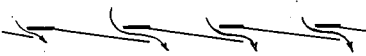


Fig. 10

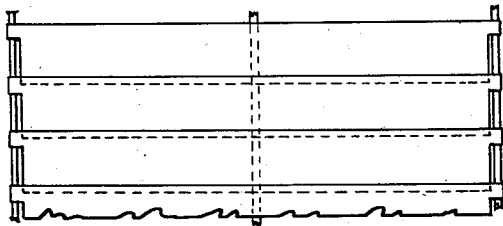
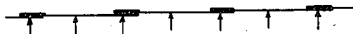


Fig. 8

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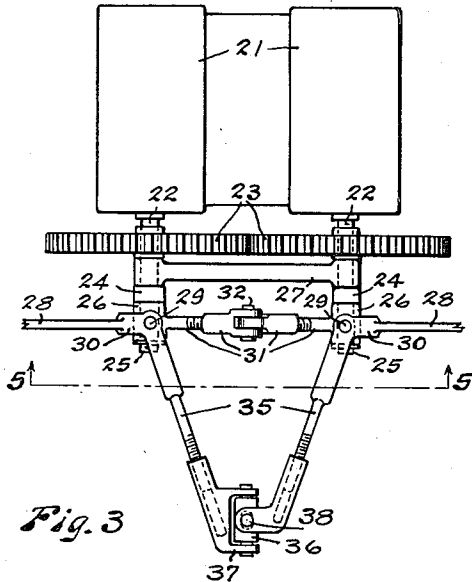


Fig. 3

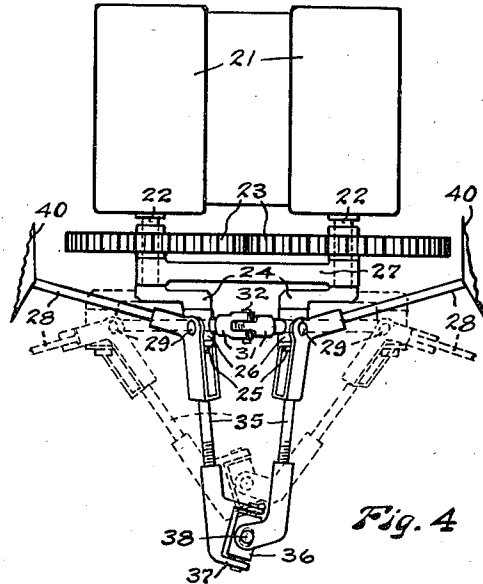


Fig. 4

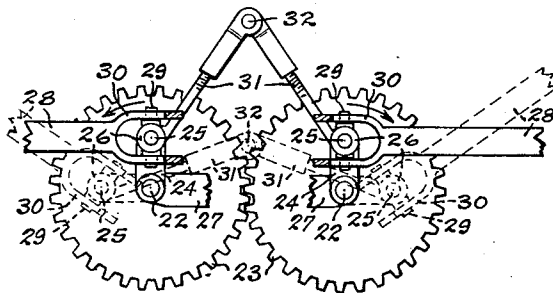


Fig. 5

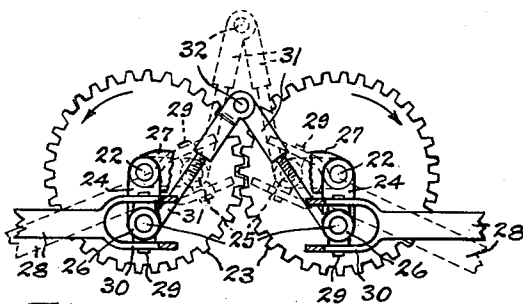


Fig. 6

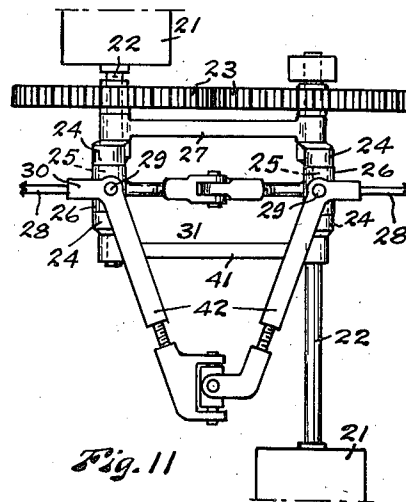


Fig. 7

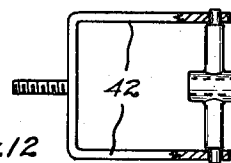


Fig. 8

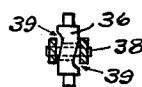


Fig. 9

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2,017,534

FLYING MACHINE

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Application July 5, 1934, Serial No. 733,818

6 Claims. (Cl. 244—20)

This invention relates to flying machines of the ornithopter type, and has for its leading object the provision of novel mechanism interposed between the usual power means and the pair of wings separately connected pivotally at opposite sides of the fuselage, whereby such mechanism when set in motion will impart to such wings not only the usual and desired uniform flapping or rapid reciprocation, but will, during such flapping or reciprocation and at exactly the correct time therein, rock or so turn each of the said wings that their forward positions will move in an arc downwardly and forwardly and thereby at each such stroke necessarily compel the desired forward movement of the machine.

Other objects of the invention are to obtain a constant force upward on the body of the plane and impart to it a greater stability laterally and longitudinally than that now possessed by the rigid type of airplane; to eliminate motor torque action and its accompanying dangers; to provide a construction that will eliminate the necessity of propelling the machine for a considerable distance along the ground preparatory to flight; to provide a construction of machine adapted to a more nearly vertical ascent and descent than is attainable in the operation of flying machines of the type now in general use; and to improve generally the construction and operations of machines of the ornithopter type.

These objects I attain by the parts and combination of parts shown in the drawings and hereinafter particularly pointed out and described. That which I believe to be new will be set forth in the claims.

In the drawings—

Fig. 1 is a plan view of an ornithopter constructed in accordance with my invention showing by full lines a mid position of the wings and by dotted lines the extreme forward and rear positions of the wings.

Fig. 2 is a side elevation of said ornithopter.

Fig. 3 is a detached plan view of the wing operating mechanism, showing certain crank members in vertical positions and showing the main wing supports broken away and the wings omitted.

Fig. 4 is a plan view similar to Fig. 3, showing by full lines the positions of the several parts when the crank pins are closest together and by dotted lines the position of the several parts when the crank pins are farthest apart.

Fig. 5 is a view partly in elevation and partly in section substantially on broken line 5—5 of Fig. 3 showing by full lines the position of the several parts when the cranks are substantially

vertical and in their uppermost positions and by dotted lines the positions of these parts when the cranks are substantially horizontal and farthest apart.

Fig. 6 is a view similar to Fig. 5 except that the positions of the parts when the cranks are in their lowermost vertical positions are shown by full lines and the positions of said parts when the cranks are substantially horizontal and closest together are shown by dotted lines.

Fig. 7 is a somewhat diagrammatic view illustrating one wing action which may be obtained by my device.

Fig. 8 is a fragmentary plan view of a wing constructed so that it has a valve action in the air.

Figs. 9 and 10 are somewhat diagrammatic fragmentary views illustrating the action of this wing on the up stroke and on the down stroke, respectively.

Fig. 11 is a fragmentary plan view of a wing operating means illustrating an alternative manner of motor installation.

Fig. 12 is a detached elevation, with parts in section, of a forked arm member employed in the construction shown in Fig. 11, and

Fig. 13 is a detail, partly in section, of the universal joint that connects the rear ends of the two arms that control those motions of the wings other than the flapping motion.

Referring to the several figures of the drawings in which like parts are indicated by the same reference characters,—20 indicates the body or fuselage of the machine and which, as a whole, may be of any usual or desired construction. In the forward portion of this body 20 are located two motors each indicated by 21 and preferably arranged in parallel relation and at a short distance from each other, as in Figs. 1, 3 and 4, but which may be otherwise arranged relatively to each other as shown in Fig. 11 and referred to hereinafter. The rotatable shaft of each motor is indicated by 22, and secured upon each shaft is a gear 23, the two gears being similar to each other in all respects and meshing one with the other. The projecting end of each shaft has formed therewith a crank 24 the end portion of which has secured thereto or formed therewith a pin 25 and on each pin is rotatably mounted a sleeve 26. The motors, of course, are to be mounted upon a suitable base or block as usual, and each of the said shafts will be journaled in a frame member, such, for example, as the cross-bar indicated at 27.

Connected with each sleeve 26 is a bar 28 that at 55

its outer end is connected in any suitable manner with and supports one of the two laterally-extending wings that by their several movements cause the machine to rise and to proceed as desired, as hereinafter explained. The connection of each bar 28 with its sleeve 26 is, in the construction illustrated, by means of two oppositely-located studs 29 on the sleeve that project and fit loosely in openings in the sides of a channel-shaped portion 30 of the bar 28.

The two sleeves 26, 26, are connected together by a pair of links 31, the connection of each link with its sleeve being preferably an integral one, as indicated in the drawings, and the two links being pivotally connected together at their adjacent ends, as indicated at 32. In the assembly of the apparatus the parts are to be so positioned that the two cranks must always be in the same relative positions at all times, that is, when one link is in either of its vertical or its horizontal positions or in any intermediate position the other link will be positioned in exactly the same manner. This is made clear by the full line and broken line showings in Figs. 3, 4 and 5. Inasmuch as the sleeves 26 on the crank-pins 25 are loosely mounted on such pins and the wing-supporting bars 28 are fast at their inner ends to the two sleeves, respectively, it is necessary that not only the degree of independent rocking or partial rotation of the sleeves on their respective crank-pins be controlled but that such limitation or control of that movement be absolutely uniform as to the two sleeves and thereby attain exactly similar rocking or up and down motions of the two wing-carrying bars 28, and thereby securing, of course, a perfect synchronization in the flapping of the wings. It is for accomplishing this result that the links 31 are provided, and not only must such links be of equal length but their combined length should be somewhat greater than the distance between the two crank-pins when both of the cranks extend horizontally and towards the respective wings. So making the links obviates any possibility of a dead center position or of passing such a dead center, either of which might be attended with grave consequences.

It is desirable that provision be made for varying the extent of the up and down stroke of the wings of the machine and I accomplish that by making each of the links 31 in two pieces and providing one of such parts with a socket into which the other member of the link is screw threaded, as clearly shown in the drawings. By the lengthwise adjustment thus provided the amount of independent turning of each sleeve on its crank-pin can be changed as desired, which will, of course, affect the extent of swing of the wing-supporting bars and the wings attached, respectively, to the outer ends of such bars. Other length-regulating means, such for example, as turnbuckles might well be substituted for the means shown.

In order to have the wings act in a manner to propel the machine in a forward direction through the air they must be given a movement in addition to the flapping movement already described. Such forward propulsion motion involves a constant and rapid change in the position of the wings from a practically horizontal position when the crank 24 is in its highest position in the construction illustrated, to an inclined position and vice versa the moving of the wings in an inclined position and through an arc trending

downwardly and forwardly will serve, as will be understood, to effect the desired propulsion.

To obtain the required simultaneous turning motion of the two wings, in order to obtain this propulsive effect, I provide two arms 35, 35, that extend diagonally rearward from the sleeves 26, 26, to which they are respectively pivotally connected, and at their rear ends are movably connected together through the medium of a universal joint such as shown in Fig. 13 and more particularly referred to hereinafter. These arms, like the links 31, 31, are shown as being each formed of two parts screw-threaded together, such construction being for the purpose of changing their effective length in order to obtain variations in the inclinations that they effect in the wing movements. As clearly shown in the drawings each diagonal arm 35 is integral with one of the wing-supporting bars 28, said two members thus constituting an elbow lever, and the channel-shaped intermediate section 30 that was referred to in connection with the bar 28 is continued past the studs 29 so as to form a part of the arm 35. Providing each of the elbow levers with such a channel-shaped section permits of its pivotal attachment to the two oppositely-located studs 29, on the sleeve and enables it to rock freely on such studs without contacting or interfering with the rapidly rotating crank pin.

The universal joint that has been referred to as connecting the rear ends of the diagonal arms 35 together comprises a horizontally-disposed roller 36 pivotally mounted in a yoke 37 formed in the rear end of one of said arms and to which roller the turned forked end of the other of said arms is connected by a pivot pin 38. The distinguishing features of this joint construction resides in providing an opening through the roller of materially greater longitudinal diameter than the pivot pin 38 that passes through it whereby the pin may wobble freely and also by so cutting away the roller as to form at each side of said hole a curved recess 39 that will allow the projection thereof of the fork ends of the other arm 35 as the two arms are given a limited longitudinal turning movement due to the rotation of the two cranks 24, 24, and the described partial rotations of the sleeves 26, 26, that are mounted thereon respectively, and to one of which sleeves each of the diagonal arms is pivotally connected. Fig. 4 well illustrates, both by the full lines and the broken lines, the character of the longitudinal turning of these arms 35 that is compelled by the movements referred to.

The two wings that have been referred to herein are each indicated by 40. As shown such wings are of the well known type comprising a plurality of overlapping valves or flaps which open on the up stroke and close on the down stroke as illustrated in the diagrammatic views shown in Figs. 9 and 10, and, while I prefer that type of wing, it is to be understood that my invention can be advantageously employed in the manipulation of wings of other construction.

In Fig. 11, is represented a different arrangement of the motors wherein only one of them is located as in the construction already described while the other one is located in the rear of the gear that it drives and at a considerable distance from such gear. So locating the other motor necessitates making the forward portion of each of the diagonally-arranged bars that forms a part of one of the elbow levers in the shape of an open framework, so that in its vibrating movement it will not contact the shaft of such rear

motor or any portion of the supporting frame such as the additional frame cross-bar that is indicated by 41. In Fig. 12 is shown a portion of such a frame-like construction, the same being indicated generally by the numeral 42. As the other features are substantially the same in all respects as in the other figures the same numerals to designate the parts have been employed.

It is believed that in connection with the description of the construction and relative arrangement of the parts of the mechanism sufficient has been said to render it unnecessary to give more than the following brief statement of the operation of the machine as a whole.

The driving of the motors, causes, through the two similar intermeshed gears 23, a rapid and exactly equal rotation of the shafts 22 and their cranks 24. The sheeves 26 loosely mounted on the crank-pins and carried around with such pins are given a succession of quick independent partial rotations back and forth on such pins during each complete rotation of the cranks. These movements of the sleeves are compelled by the links 31, which as stated, are each fast at its outer end to a sleeve. This rapid back and forth rocking of each sleeve on its crank-pin necessarily imparts a vertical swinging motion to the wing-supporting bar 28 that is pivoted to and projects laterally from the sleeve. It is through this motion that the up and down flapping of the wing carried by the said bar is effected.

The attainment of the necessary forward motion of the machine is through the action of the diagonal arms 35 on the wing-supporting bars 28. As pointed out hereinbefore each of the bars 28 is so joined to one of the arms 35 as to constitute an elbow lever, and hence any movement of one member is necessarily transmitted to the other. Now as the two cranks 24 rotate, the diagonal arms that have pivotal connection with the sleeves on the crank-pins are caused to swing laterally and in a circle and hence give a corresponding motion to the bars 28 and the wings carried by those bars respectively. This compound lateral and circular motion is permitted by reason of the universal joint construction connecting the rear ends of the arms 35 together, and at each complete rotation of the cranks the wing-supporting bars, and, of course, the wings themselves, move rearward and upward and downward and forward, the extreme tip of each wing thereby being made to describe a curved path, as indicated by the broken lines in Fig. 7. This rapid and constant changing of the position of the wings ensures them being presented at all times in positions to best effect the desired forward movement and with the least possible tendency to so move through the air in a manner that would act to destroy or neutralize the forward motion.

What I claim as new and desire to secure by Letters Patent is as follows:

1. In a machine of the class described, the combination with a fuselage, of two parallel synchronously-driven rotary shafts mounted thereon, a crank on each shaft, a pin on each crank, a sleeve rotatably mounted on each pin, a wing pivotally connected with each sleeve, and means for restraining independent complete rotation of the sleeves and compelling them to rock or partially rotate back and forth a plurality of times during each complete rotation of the cranks to cause an up and down movement of the wings.

2. In a machine of the class described, the combination with a fuselage of two parallel syn-

chronously-driven rotary shafts mounted thereon, a crank on each shaft, a pin projecting from each crank, a sleeve loosely mounted on each pin, a wing-supporting bar pivotally connected to each sleeve, and movable means connecting said two sleeves together for causing a limited rocking or partial rotation back and forth of said sleeves during the rotation of the cranks whereby the two wing-supporting bars and the wings carried thereby are moved up and down.

3. In a machine of the class described, the combination with a fuselage of two parallel synchronously-driven rotary shafts mounted thereon, a crank on each shaft, a pin projecting from each crank, a sleeve loosely mounted on each pin, a wing-supporting bar pivotally connected to each sleeve, a pair of links fixedly secured respectively to said sleeves and extending toward each other and pivotally connected together, said links acting to compel a rocking or partial rotation back and forth of said sleeves during the rotation of the cranks whereby the two wing-supporting bars and the wings carried thereby are moved up and down.

4. In a machine of the class described, the combination with a fuselage of two parallel synchronously-driven rotary shafts mounted thereon, a crank on each shaft, a pin projecting from each crank, a sleeve loosely mounted on each pin, a wing-supporting bar pivotally connected to each sleeve, a pair of links fixedly secured respectively to said sleeves and extending toward each other and pivotally connected together, said links acting to compel a rocking or partial rotation back and forth of said sleeves during the rotation of the cranks whereby the two wing-supporting bars and the wings carried thereby are moved up and down, said links having a combined length greater than the distance between the cranks when the cranks are farthest apart.

5. In a machine of the class described, the combination with a fuselage, of two parallel synchronously-driven rotary shafts mounted thereon, a crank on each shaft, a pin on each crank, a sleeve rotatably mounted on each pin, a wing pivotally connected with each sleeve, means for restraining independent complete rotation of the sleeves and compelling them to rock or partially rotate back and forth during each complete rotation of the cranks to cause an up and down movement of the wings, and other means connected with said sleeves and partaking of their rocking motion for imparting to the wings a backward and forward movement.

6. In a machine of the class described, the combination with a fuselage of two parallel synchronously-driven rotary shafts mounted thereon, a crank on each shaft, a pin projecting from each crank, a sleeve loosely mounted on each pin, a wing-supporting bar pivotally connected to each sleeve, movable means connecting said two sleeves with each other for causing a limited rocking or partial rotation back and forth of said sleeves during the rotation of the cranks whereby the two wing-supporting bars and the wings carried thereby are moved up and down, two arms rigidly united to the two wing-carrying bars, respectively, and loosely connected together at their opposite ends to permit each arm to have a limited longitudinal twisting motion whereby as the wing-carrying bars are moved up and down to impart a flapping motion to the wings they will also be moved forward and back to impart a propulsive movement also to the wings.

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