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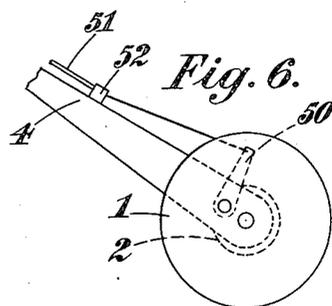
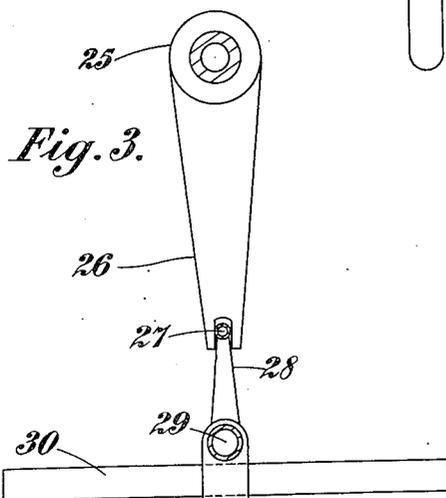
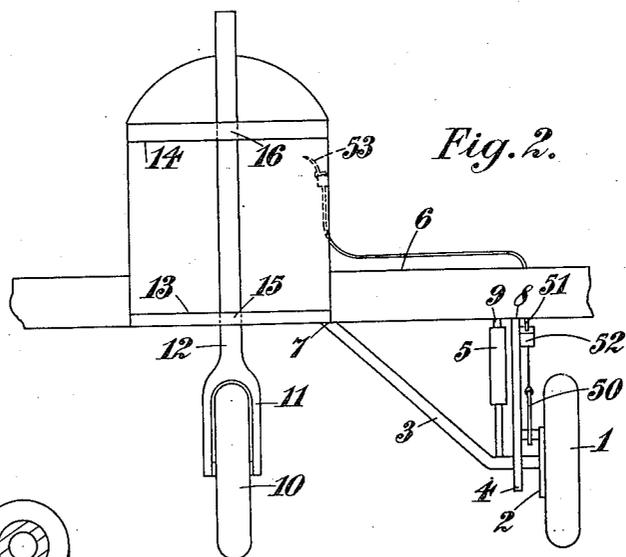
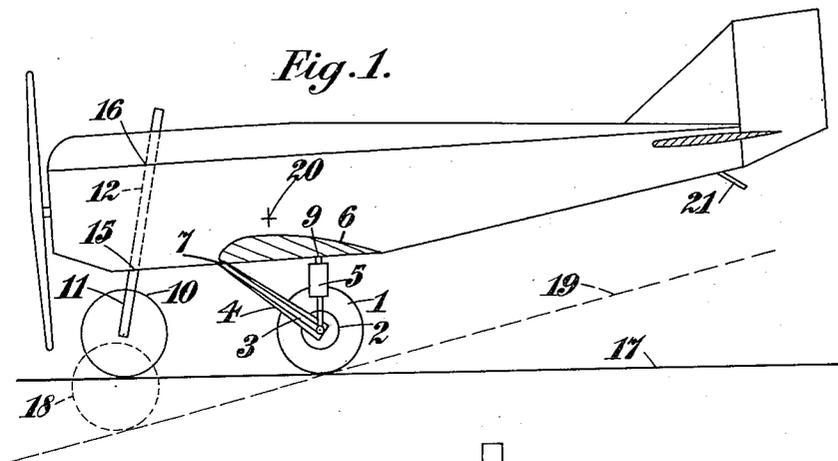
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UNDERCARRIAGE FOR AEROPLANES

Filed Oct. 14, 1927

2 Sheets-Sheet 1



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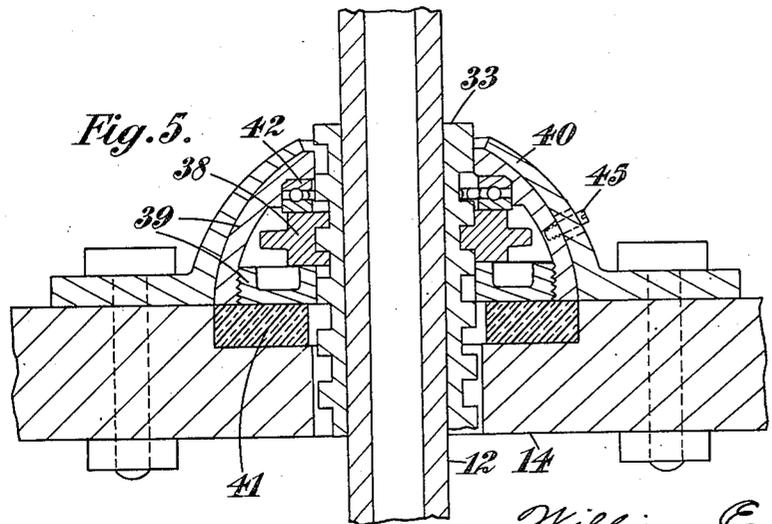
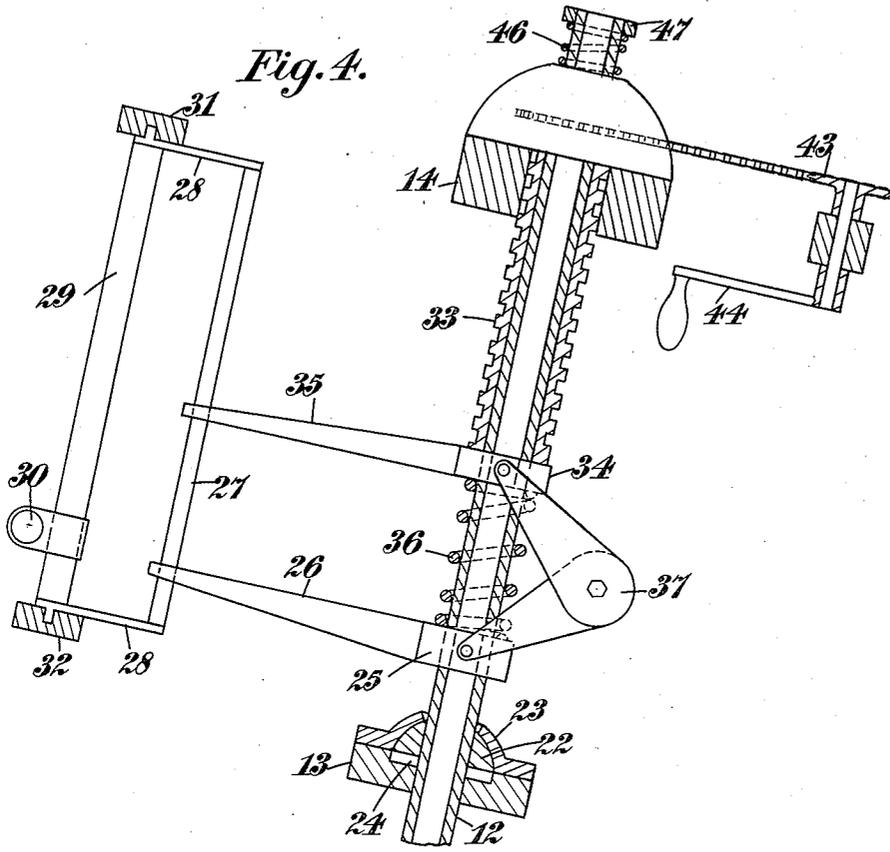
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UNDERCARRIAGE FOR AEROPLANES

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2 Sheets-Sheet 2



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# UNITED STATES PATENT OFFICE.

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## UNDERCARRIAGE FOR AEROPLANES.

Application filed October 14, 1927, Serial No. 226,241, and in Great Britain October 25, 1926.

This invention relates to undercarriages for aeroplanes in which the weight of the machine is supported while on the ground by two sets of wheels, one set ahead of the centre of gravity of the machine, and the other at the rear thereof.

It has heretofore been proposed to provide such an undercarriage with means for raising and lowering one of the sets of wheels during flight, and also with means for steering the machine but a large angle of attack of the main planes was relied on for stopping the machine when landing.

This invention has for its main object to enable a machine to take-off from wheels on the ground and with the main planes of the machine at a large angle of attack, and then while in the air to so alter the position of at least one of the sets of wheels that on touching the ground in landing the rear set shall touch first and thus automatically tip the machine forward on to the front set also, and thus reduce the angle of attack of the main planes, so that the weight is transferred from the planes to the wheels, thus enabling the machine to be brought to rest quickly by applying brakes to the wheels.

Another object of the invention is to render it possible to land an aeroplane on steerable wheels in a restricted space either at stalling speed or at a much higher speed if necessary, and yet come to rest quickly.

A further object of the invention is to lessen the risk of the machine provided with an undercarriage of the type described from leaving the ground again accidentally when landing, as compared with present day practice.

According to the invention, there is provided an undercarriage for aeroplanes comprising two sets of wheels, one ahead and the other at the rear of the centre of gravity of the machine, at least one of which sets of wheels is capable of steering the machine while on the ground, at least one of said sets of wheels is fitted with braking mechanism, and at least one of said sets is capable of being raised and lowered while in the air and capable of supporting the machine both while in the raised and lowered positions, for the purposes set forth above.

According to another feature of the invention, the set of wheels which can be raised and lowered while in the air can be mechanically fixed in its position of adjust-

ment so as to relieve the pilot of the weight of the machine during the entire taking-off operation.

According to a further feature of the invention, the set of wheels that can be raised and lowered when in the air is so operatively connected with the rudder control of the machine that the same set of wheels can be steered with the rudder in all positions of adjustment of the set of wheels.

The term "set of wheels" used in this specification and in the claims is to be understood as covering either one or more wheels. One set of wheels, for example the rear set, is preferably composed of at least two wheels having a wide track, and the other set, for example the front set, may have only one wheel, but if it has more than one wheel the track is preferably wide also. A set of wheels may consist of any number of wheels, but their axes should lie in one transverse vertical plane. Both sets of wheels may be adjustable in height. The angle of attack in the landing position may be negative. All the wheels in a set are preferably adjusted together, and all the wheels of a set preferably have the same degree of braking, applied together.

Brakes may be fitted to the front set as well as to the rear, but if so their power will be limited so as not to endanger overturn of the machine. All the brakes may be brought into action before landing and fixed in their operative position by the pilot.

The properties of steering, position adjustment and braking may be given to the front or rear sets in any combination.

The front set of wheels is preferably situated far enough ahead of the centre of gravity of the machine to avoid risk of overturning and to allow the rear set to carry a large part of the weight. The rear set is preferably situated only a short distance to the rear of the vertical plane passing through the centre of gravity of the machine in order to take a large part of the weight of the machine, but far enough back to prevent the machine from upsetting backwards.

All the wheels are preferably supported by any convenient type of shock-absorbing devices, preferably with energy-dissipating means associated therewith. The vertical movement permitted to the wheels by such devices is in addition to the vertical adjust-

ment of the wheels according to this invention.

The two sets of wheels are normally the only parts of the machine to touch the ground, but skids may be provided to protect the wing tips or tail in emergency. Such skids, if provided, however, should not contact with the ground and exercise a braking action on the machine when taking off.

The invention consists in the construction, arrangement and combination of parts described hereinafter and pointed out in the claims.

In order that the invention may be clearly understood reference will be made to the accompanying drawing wherein one embodiment is diagrammatically illustrated by way of example. In said drawing:—

Figure 1 is a diagrammatic side elevation, partly in section, showing an aeroplane provided with an undercarriage according to the invention, some parts, including one rear wheel, being omitted for the sake of clearness;

Figure 2 is a partial front elevation of the undercarriage;

Figure 3 is a diagrammatic plan view of the steering mechanism;

Figure 4 is a sectional side elevation of the front wheel mounting and steering mechanism;

Figure 5 is a vertical section showing details of the upper bearing of the front wheel tube, and

Figure 6 is a side elevation of the rear wheel and its braking mechanism shown in Figure 2.

Like reference characters designate like parts throughout the several views.

Referring to the drawing, the undercarriage illustrated comprises a front set of wheels consisting of only one wheel and it is given the properties of steering and position adjustment, while the rear set consists of two wheels to which brakes are fitted.

As shown in Figures 1 and 2, the rear wheels 1 having brakes 2 are carried on axles 3 and supported by radius members 4 to which the brakes are anchored, and by shock-absorbing members 5 of any convenient type. The members 3, 4 and 5 are pivoted to the main plane 6 at points 7, 8 and 9, respectively. The front wheel 10 is carried in a fork 11 on a tube 12 constituting a steering column which is supported by cross members 13, 14 of the frame at situations 15 and 16. The ground line corresponding to the landing position is shown at 17. The front wheel 10 is capable of being lowered, as described hereinafter, to the position indicated by broken lines 18 for taking-off, and the ground line is then at 19 as indicated by the broken line. The centre of gravity of the machine is at 20, and 21 indicates a

tail skid for preventing damage in emergency.

As shown in Figure 4, the tube 12 is located by a bush 22 in which it is free to rotate and slide endwise. This bush 22 is hemispherical and is held between a housing 23 fixed on the cross member 13, and a rubber pad 24, thus allowing the tube 12 to bend.

A collar 25 carrying a steering arm 26 is rigidly attached to the tube 12 above the housing 23, and the arm 26, as shown in Figure 3, is so pivotally connected with an upstanding tubular member 27 that it can swing about the same and also move endwise along it. The tube 27 is rigidly connected at its ends to arms 28 which are fast on the opposite ends of an upstanding tube 29 that carries a rudder bar 30, the tube 29 being journalled in upper and lower frame cross members 31 and 32 respectively. The rudder bar thus controls the front wheel for steering.

The upper part of the steering column or tube 12 is carried in a screwthreaded tube 33, on the lower end of which is fastened a collar 34 having an arm 35 pivotally and slidably connected with the tube 27. Between the collars 25 and 34 is a spring 36 which carries the load of the front wheel and is damped by a shock-absorber 37 pivoted to the collars 25 and 34.

As shown in Figure 5, the screwthreaded tube 33 is supported by a nut 38 in the form of a sprocket-wheel. This nut is arranged in a two-part bush 39 carried between a hemispherical housing 40 fixed to the cross member 14, and a rubber pad 41 on the latter. A ball-bearing is inserted between the top of the nut 38 and the bush 39 for reducing friction. The nut 38 has teeth on its outer periphery and can be rotated while in the air by a chain 48 (Figure 4) which passes through openings in the parts 39, 40 and round a wheel 43 which can be turned by a handle 44. A screw 45 locates the bush 39 in the housing 40 within small limits. A spring 46 is interposed between the upper end of the screwthreaded tube 33 and a collar 47 fast on the top of the steering column 12. By rotating the handle 44 the airman can raise or lower the front wheel 10 which is always capable of steering and supporting the machine. In any position of adjustment of the wheel 10 it is mechanically held against up and down movement, so that the airman has not to take the weight of the machine during any operation.

Any convenient braking mechanism may be employed. As shown in Figures 2 and 6, a lever 50 for actuating the expanding member of an expanding brake 2 is attached to one end of a Bowden wire 51 that is anchored at 52 and has its other end operable by a lever 53 within reach of the pilot.

It will be appreciated that the construction of aeroplane undercarriage described above enables the machine to take-off from wheels on the ground with the main planes at a large angle of attack, whereupon the pilot when in the air can so alter the position of the front wheel that on touching the ground, when landing either at or above stalling speed, the rear wheels touch first, when the machine will automatically tip forward and rest on the front wheel, the angle of attack of the main planes being thereby reduced so that the weight is transferred from the planes to the wheels, when the machine can be rapidly brought to rest in a restricted space either at stalling speed, or at a considerably higher speed by applying the brakes to the rear wheels. There is consequently very little risk of the machine leaving the ground again accidentally when landing after one or more wheels have made contact with the ground.

I claim:

1. An undercarriage for aeroplanes comprising in combination two sets of wheels (each set consisting of one or more wheels), one set ahead of and the other set at the rear of the vertical plane passing through the centre of gravity of the machine, which sets of wheels normally support the whole ground-borne weight of the machine in taking-off and in landing, mechanism to enable an occupant of the machine while in the air to alter the position of at least one of the said sets of wheels so that on landing the angle of attack of the main planes is less than it was when taking-off, mechanism to enable at least one of the said sets of wheels to be operated for steering the machine, and braking mechanism acting on at least one of the said sets of wheels, the front set of wheels being situated far enough ahead of said vertical plane through the centre of gravity of the machine to avoid risk of overturning and to allow the rear set of wheels to carry a large part of the ground-borne weight of the machine for the purpose described.

2. In an aeroplane, the combination with the frame, of two sets of wheels, one situated ahead and the other at the rear of the vertical plane passing through the centre of gravity of the machine, which sets are intended normally to support the whole ground-borne weight of the machine in taking-off and in landing, means operable by a person in the machine while in the air for raising and lowering one of said sets of wheels and mechanically holding the same in its position of adjustment so as, when on the ground, to be capable of supporting the machine while in the raised or lowered position independently of the operator, and so that on landing the angle of attack of the main planes is less than it was when taking-off, means for so operating at least one of

the said sets of wheels as to steer the machine when on the ground, and braking mechanism applied to at least one of the said sets of wheels and operable from the machine, for the purpose described.

3. In an aeroplane, the combination with the frame, of two sets of wheels, one set situated ahead and the other at the rear of the vertical plane passing through the centre of gravity of the machine, which sets are intended normally to support the whole ground-borne weight of the machine in taking-off and in landing, means operable by a person in the machine while in the air and arranged to raise and lower the front set of wheels so that on landing the angle of attack of the main planes shall be less than it was when taking-off, means for so operating at least one of the said sets of wheels as to steer the machine when on the ground, and braking mechanism applied to the rear set of wheels and operable from the machine, for the purpose described.

4. In an aeroplane, the combination with the frame, of two sets of wheels, one set situated ahead and the other at the rear of the vertical plane passing through the centre of gravity of the machine, which sets are intended normally to support the whole ground-borne weight of the machine in taking-off and in landing, a rudder bar mounted to rock about an upstanding axis, mechanism operable by a person in the machine for raising and lowering one set of wheels in relation to the main planes while in the air, so that on landing the angle of attack of the main planes is less than it was when taking-off, means operatively connecting the rudder bar with said mechanism in all positions of the set of wheels controlled by the latter, so that the movements of the rudder bar are imparted to the steered set of wheels in all positions of adjustment of the latter, and braking mechanism applied to at least one of the said sets of wheels and operable from the machine, for the purpose described.

5. In an aeroplane, the combination with the frame, of two sets of wheels, one set situated ahead and the other at the rear of the vertical plane passing through the centre of gravity of the machine, which sets are intended normally to support the whole ground-borne weight of the machine in taking-off and in landing, a rudder bar mounted in the frame to rock about an upstanding axis, mechanism operable by a person in the machine for raising and lowering the front set of wheels in relation to the main planes while in the air so that on landing the angle of attack of the main planes is less than when taking-off, which mechanism comprises an upstanding steering column that is mounted to rotate and move endwise in the frame and carries the front set of

wheels, means for moving the steering column endwise in the frame and holding it mechanically against endwise movement in its position of adjustment, an arm that  
5 has one end fast on the steering column and extends transversely of the length of the latter, and an upstanding member mounted to rock with the rudder bar about said up-  
standing axis and pivotally engaged by the other end of said arm, which latter is mov- 10  
able along the said upstanding member, and a brake that is applied to the rear set of wheels and is operable from the machine, for the purpose described.

In testimony whereof I affix my signature.  
WILLIAM EDRINGTON GRAY.