

Nov. 22, 1927.

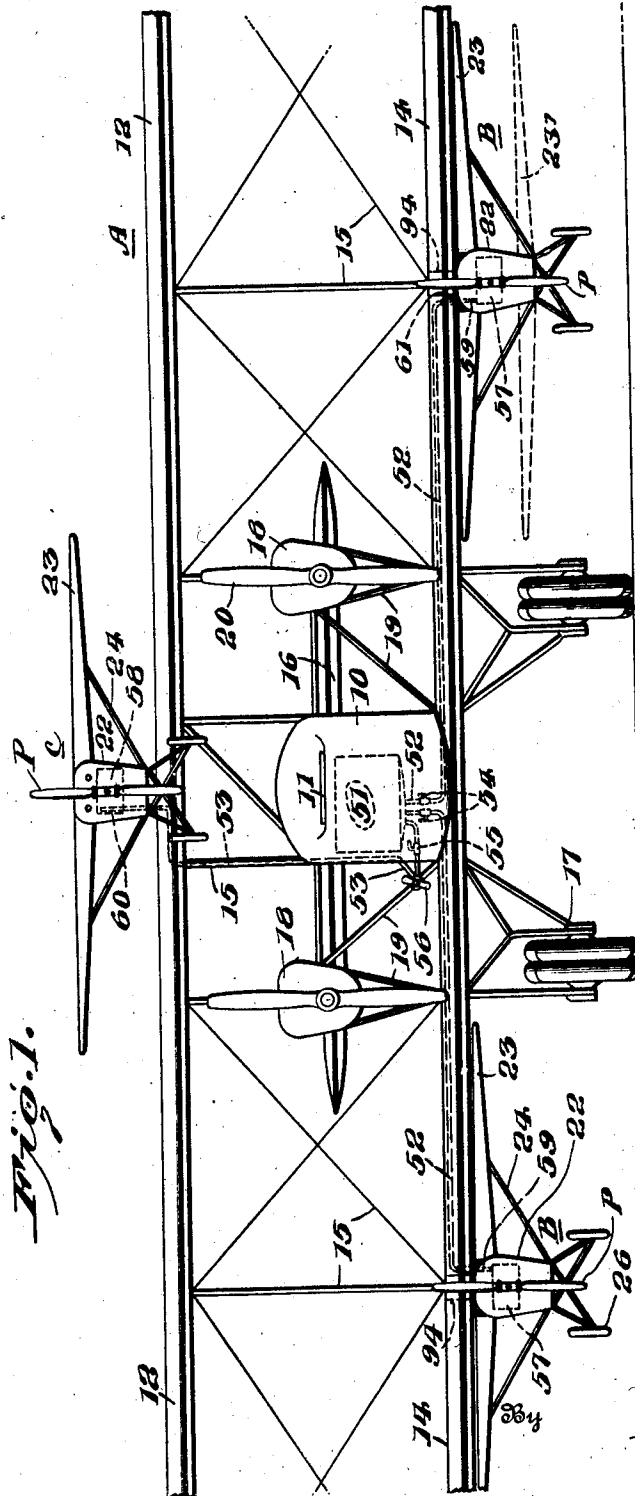
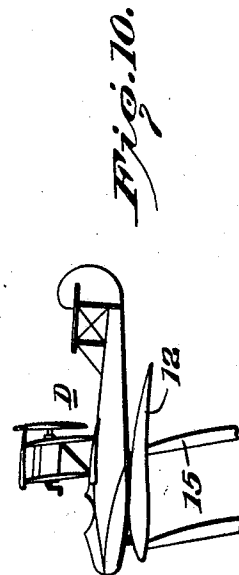
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1,650,346

AIRPLANE

Filed June 25, 1923

6 Sheets-Sheet 1



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AIRPLANE

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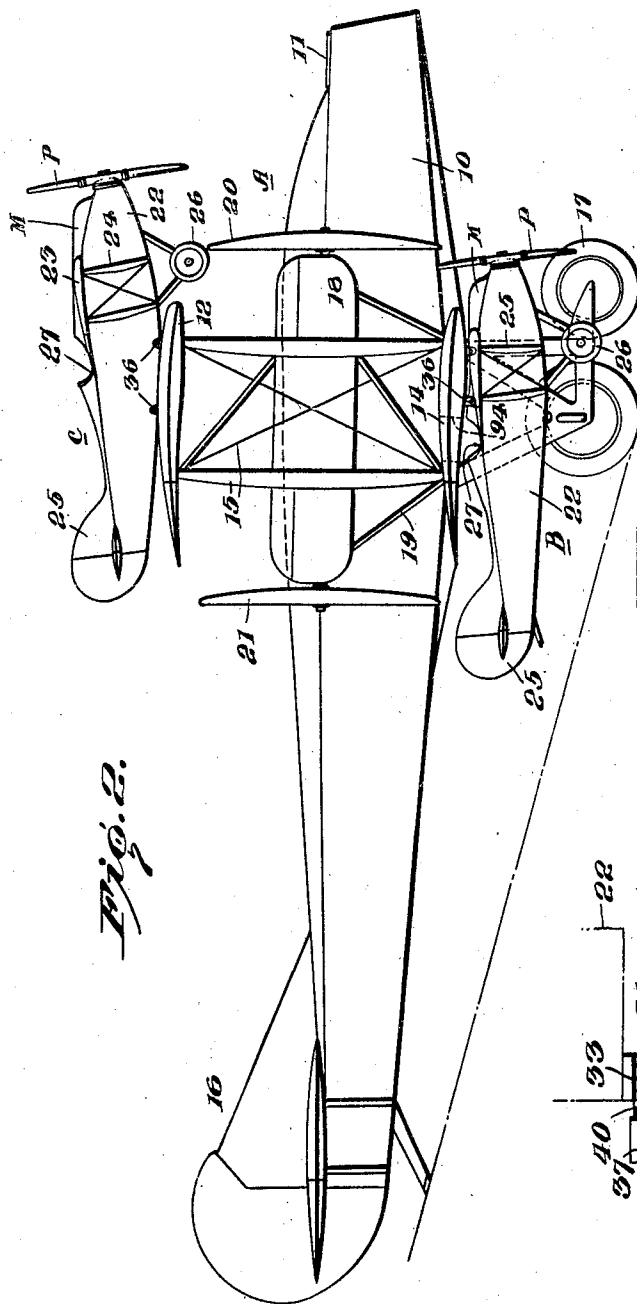


Fig. 2.

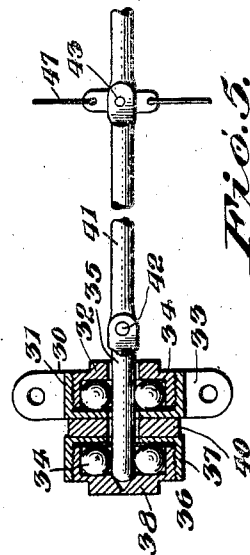


Fig. 3.

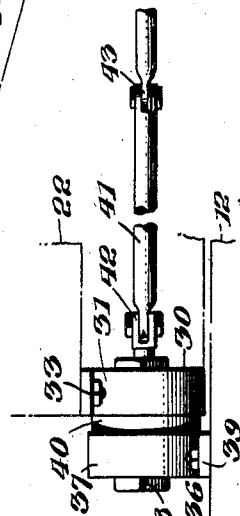


Fig. 4.

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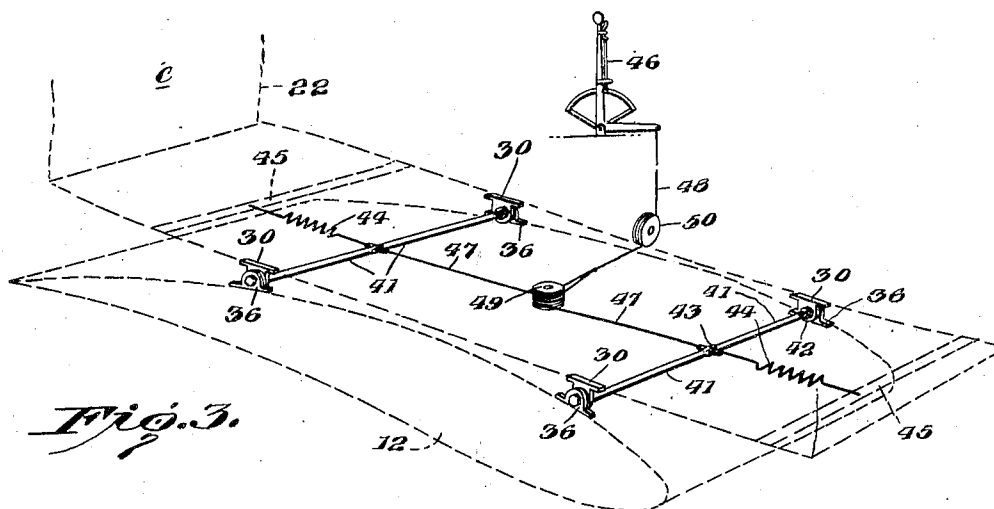


Fig. 3.

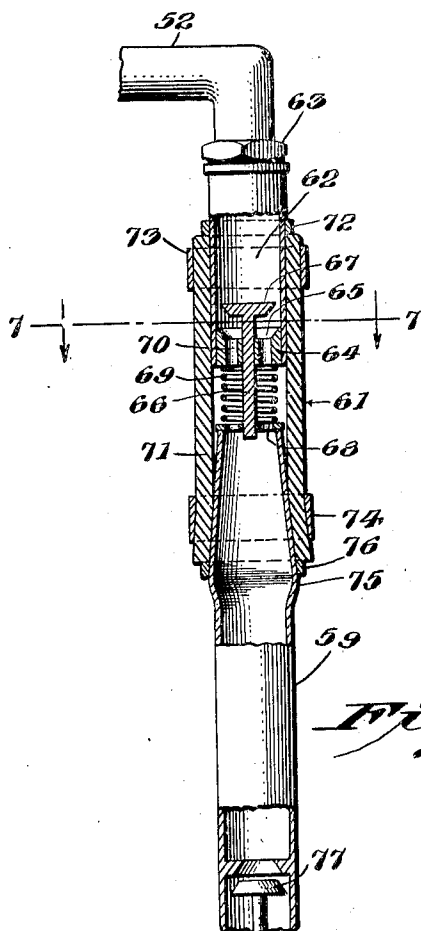


Fig. 6.

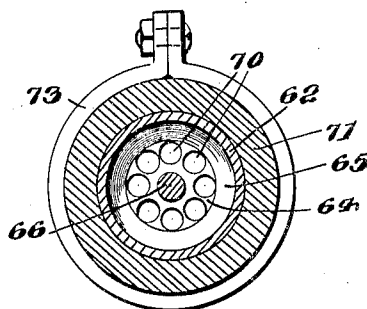


Fig. 7.

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By

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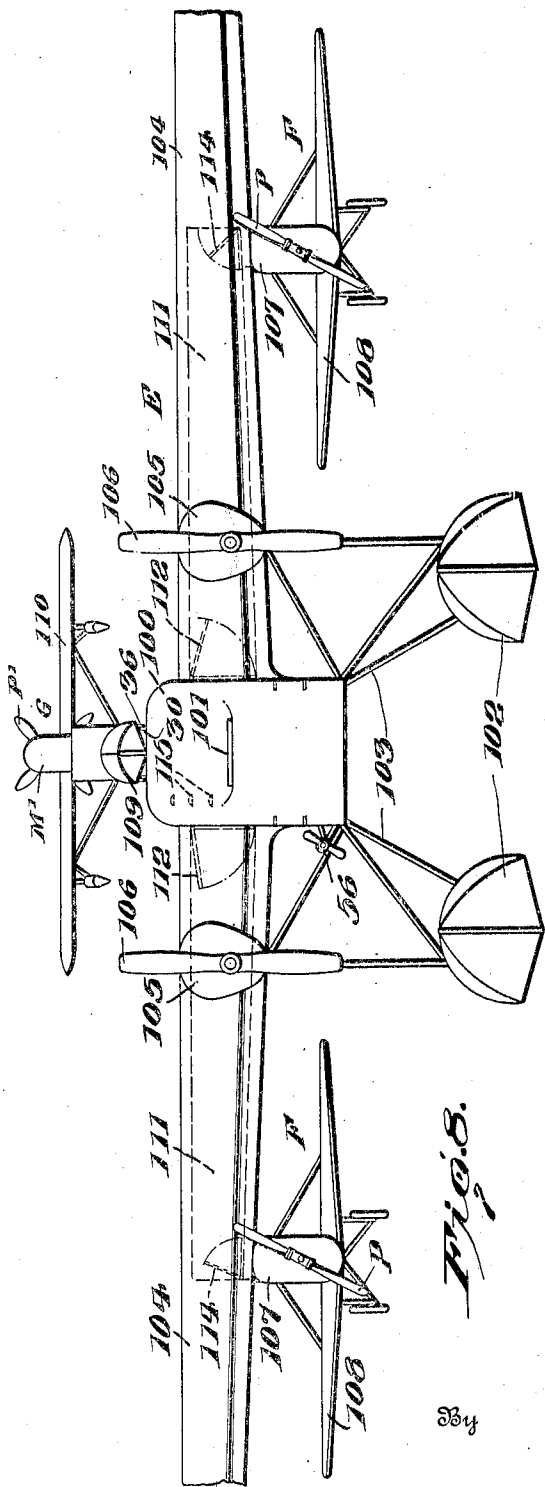


Fig. 8.

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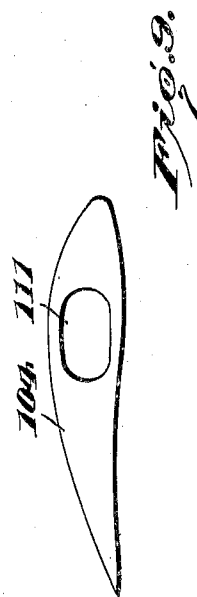


Fig. 9.

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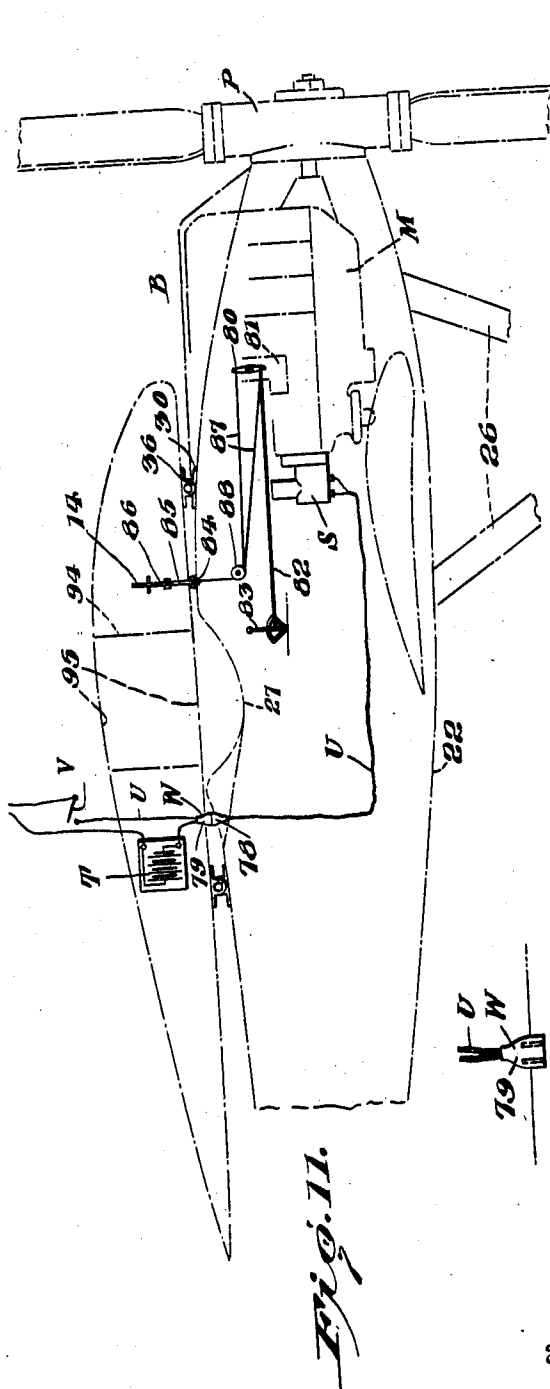
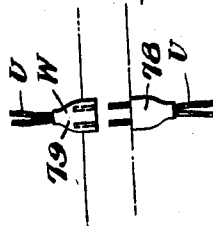
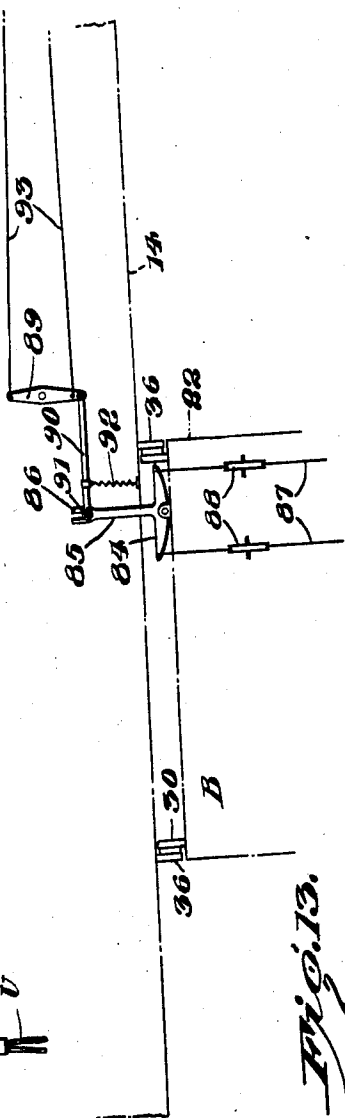
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AIRPLANE

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6 Sheets-Sheet 5



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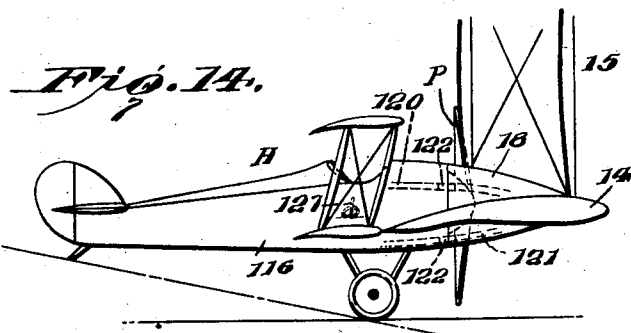
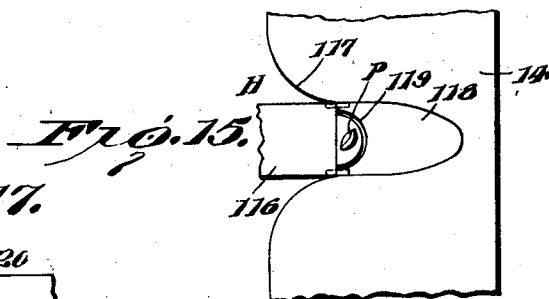
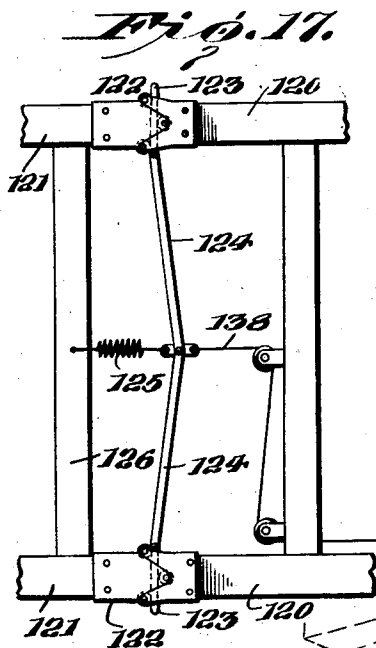
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6 Sheets-Sheet 6



UNITED STATES PATENT OFFICE.

RANDOLPH F. HALL, OF ITHACA, NEW YORK, ASSIGNOR OF ONE-THIRD TO THEODORE P. HALL, OF WALLINGFORD, CONNECTICUT, AND ONE-SIXTH TO PAUL WILSON, OF ITHACA, NEW YORK.

AIRPLANE.

Application filed June 25, 1923. Serial No. 647,524.

This invention relates to certain improvements in airplanes; and the nature and objects of the invention will be readily recognized and understood by those skilled in the arts involved in the light of the following explanation and detailed description of the accompanying drawings illustrating what I at present consider to be the preferred embodiments or mechanical expressions of my invention from among various other forms, arrangements, combinations and constructions of which the invention is capable within the spirit and scope thereof.

The present invention is mainly directed to the provision of aircraft as airplane carriers or "mother ships" for transporting powered auxiliary airplanes thereon; and to the design of the auxiliary airplanes and the mounting thereof on the carrier or mother ship. The invention is characterized in the preferred adaptations thereof by a relatively large aircraft of the heavier-than-air type forming the carrier or mother ship, and a plurality of powered auxiliary airplanes detachably mounted and supported on the mother ship as units thereof and capable of release individually or as a group, from the mother ship during flight for independent operations.

One of the basic objects of the invention is to so design the powered auxiliary airplanes and mount the same on the mother ship as elements thereof, that the supporting and control surfaces of the auxiliary airplanes will be in aerodynamical relation and cooperation with the supporting and control surfaces of the carrier or mother ship, with the result that the balance, control and performance generally of the mother ship is not materially impaired or interfered with and the structure and arrangement presented by the carrier or mother ship and the auxiliary airplanes mounted thereon is properly balanced and aerodynamically efficient.

Another fundamental object of the invention is to mount and arrange the powered auxiliary airplanes on the carrier or mother ship, so that they provide additional power units for the mother ship, which are controllable from a central or localized point on the mother ship, such as the control cockpit thereof, or may be each individually controlled from the respective auxiliary airplanes.

A further object of the invention is to arrange for the conservation of the necessarily limited individual fuel supplies of the auxiliary airplanes for use in independent operations thereof when released from the mother ship, by providing a separate fuel system having a source of fuel supply on the carrier or mother ship for supplying fuel to the auxiliary airplanes during operation thereof on the mother ship as power units; and to further provide for automatically disconnecting the separate fuel system and rendering the same inoperative upon release of the auxiliary airplanes from the mother ship.

A further object of the invention is to provide for detachably mounting and supporting the powered auxiliary airplanes on the mother ship with a minimum of exposed resistance creating structure, so that the auxiliary airplanes can be individually released from the respective control cockpits thereof or other desired points thereon; or so that the auxiliary airplanes can be released from a localized point on the carrier or mother ship.

A further object of the invention is the provision of mechanism for detachably mounting and supporting an auxiliary airplane on a carrier or mother ship in position for flight therefrom, and for maintaining the auxiliary airplane in proper mounted position against the forces acting thereon during flight of the mother ship, and which mechanism is operable to instantly release the auxiliary airplane from the carrier or mother ship for flight.

A further object of the invention is to so mount the auxiliary airplanes on the carrier or mother ship and to so design and arrange the latter, that the auxiliary airplanes are readily accessible from the mother ship to permit of pilots or passengers entering the auxiliary airplanes from the mother ship and returning from the auxiliary airplanes to the carrier or mother ship.

With the foregoing and certain other objects and results in view, which other objects and results will be readily apparent to those familiar with the aeronautical art from the following description and explanation, the invention consists in certain novel features in construction and in combination and arrangements of elements as will be more

fully and particularly pointed out and referred to hereinafter.

Referring to the accompanying drawings:

Fig. 1, is a front elevation of a heavier-than-air carrier or mother ship of the biplane type having powered auxiliary airplanes detachably suspended from the lower wing at opposite sides of the chassis, and a powered auxiliary airplane detachably mounted on the upper wing along the fore and aft axis of the mother ship; the fuel supply from the mother ship to the auxiliary airplanes being shown in dotted lines.

Fig. 2, is a view in side elevation of the mother ship and auxiliary airplanes mounted thereon, as shown in Fig. 1.

Fig. 3, is a purely diagrammatical view in perspective of the mechanism for detachably mounting and supporting an auxiliary airplane on the wing of the carrier or mother ship, a portion of the auxiliary airplane and a portion of the wing of the mother ship being shown in relative mounted position in dotted outline.

Fig. 4, is a detail view in elevation of one of the detachable fittings of the mechanism for releasably mounting the auxiliary airplane on the mother ship as shown in Fig. 3, a portion of the operating mechanism being shown.

Fig. 5, is a section through the fitting as shown in Fig. 4.

Fig. 6, is a view in section of the automatic coupling for the fuel supply lines from the mother ship to the auxiliary airplanes, as shown in dotted lines in Fig. 1.

Fig. 7 is a transverse section taken on the line 7-7 of Fig. 6.

Fig. 8, is a view in front elevation of a heavier-than-air carrier or mother ship of the thick internally braced monoplane seaplane type, having powered auxiliary airplanes of the low wing monoplane type suspended from the wing of the mother ship, and an auxiliary high wing monoplane of the seaplane type mounted along the fore and aft axis of the mother ship above the body thereof; the passages in the thick wing of the monoplane from the fuselage to the cockpits of the suspended auxiliary airplanes being shown in dotted lines.

Fig. 9, is a diagrammatic view of the transverse section through the thick wing of the mother ship of Fig. 8, and showing the form and arrangement of the internal passage therethrough.

Fig. 10 is a side elevation of an auxiliary airplane of the flying boat type detachably mounted on the upper wing of the biplane mother ship of Fig. 1, a portion only of the biplane wing truss of the mother ship being shown.

Fig. 11, is a diagrammatic view of a portion of the mechanism for controlling the power plant of an auxiliary airplane from

the mother ship and of the self-starter and controlling circuit for starting the power plant from the mother ship; a portion of a wing of the mother ship and of the auxiliary airplane suspended therefrom being shown in dotted outline.

Fig. 12, is a detail view of the detachable coupling in the self-starter controlling circuit between the mother ship and auxiliary airplane of Fig. 11.

Fig. 13, is a detail view, more or less diagrammatical, of the detachable operating connections of the auxiliary airplane power plant controlling mechanism shown in Fig. 11.

Fig. 14, is a view in side elevation of a modified design and mounting of auxiliary airplane on and extending from the trailing portion of a wing of the mother ship, a portion only of the mother ship wing truss being shown.

Fig. 15, is a detail fragmentary view in top plan of the design, arrangement and mounting of the auxiliary airplane and wing of the mother ship, as shown in Fig. 14.

Fig. 16, is a more or less diagrammatical view of an auxiliary glider detachably mounted on and extending from the trailing portion of a wing of the thick internally braced type, the mounting being similar to that shown in Figs. 14 and 15.

Fig. 17, is a more or less diagrammatical view of one possible form of mechanism for detachably mounting and supporting the modified forms of auxiliary airplanes of Figs. 14, 15 and 16 to the wing of a carrier or mother ship.

Fig. 18, is a diagrammatical view in perspective of the mechanism for detachably mounting and supporting an auxiliary airplane on the wing of a mother ship, as shown in Fig. 3, with the mechanism arranged for operation from the mother ship to detach and release the auxiliary airplane therefrom.

In the preferred embodiments and adaptations of the broad principles and characteristics of the invention, as illustrated in the accompanying drawings and described hereinafter, the airplane carrier or mother ship for transporting the auxiliary airplanes is formed by an aircraft of the heavier-than-air-type. However, attention is here directed to the fact that various features of the invention are equally adapted to use with and application to an airplane carrier or mother ship formed by an aircraft of the lighter-than-air type, as will be readily recognized by those familiar with this art and hence it is not desired or intended by the illustrated examples to limit all features of the invention to use with and on a carrier or mother ship of the heavier-than-air type.

One aeronautical and mechanical expression embodying and presenting the broad principles and features of the invention is

illustrated in Figs. 1 and 2 of the accompanying drawings. In this form of the invention the carrier or mother ship is formed by a relatively large multi-motored airplane A of the biplane type including the main body or fuselage 10 having the control cockpit 11 in the forward portion thereof, the upper and lower wings 12 and 14 with the interwing bracing 15 providing a biplane wing truss, the tail unit or empennage 16, and undercarriage or chassis 17, all assembled and relatively arranged in the usual manner to present a biplane of more or less conventional general design familiar to those skilled in the art. Power or motor nacelles 18 are mounted between the upper and lower wings 12 and 14 at opposite sides of the fuselage 10 by means of suitable struts or trussing 19, and each is provided with a tractor propeller 20 and a pusher propeller 21, respectively, driven by any suitable power plants or motors (not shown) within the power nacelles 18, in the usual or any other desired manner.

According to the broad principles of the invention, powered auxiliary aircraft are detachably mounted on the carrier or mother ship for transportation thereby and release therefrom during flight, and the auxiliary aircraft are designed and mounted on the mother ship in proper balance and aerodynamical relation therewith, and to form additional power units therefor, so as to secure in the combined craft an aerodynamically efficient structure. In carrying out these principles of the invention with the type of carrier or mother ship presented by the relatively large biplane A of Figs. 1 and 2, powered auxiliary airplanes are utilized. In the specific example disclosed in Figs. 1 and 2, a pair of auxiliary airplanes B are detachably suspended from the lower wing 14 of the mother ship A, and a similar auxiliary airplane C is detachably mounted and supported on the upper wing 12 thereof. The auxiliary airplanes B and C, in the present instance are of the tractor monoplane type having a high wing, and each includes a fuselage 22 with the control cockpit 27 therein, monoplane supporting surface or wing 23 of the high type extending across the upper portion of the fuselage with the supporting trusses or struts 24, empennage 25, chassis 26, and tractor propeller P of the variable pitch type driven by any desired power plant or motor M. The disclosure of the variable pitch propeller P on the auxiliary airplanes B and C is purely diagrammatical to indicate any of the types of variable pitch propellers in general use and familiar to those skilled in the aeronautical art, and it is not deemed necessary to make a disclosure of the usual actuating means operable from the control cockpit for controlling propellers of this type, it being understood

that such types of propellers include suitable control means therefor.

The auxiliary airplanes B are detachably suspended from the lower wing 14 of the mother ship A, on opposite sides of the chassis 17 and equidistant from the longitudinal or fore and aft axis of the mother ship, and the auxiliary airplane C is detachably mounted and supported on and above the upper wing 14 along the longitudinal axis of the mother ship A. In this manner the lateral balance of the mother ship around the longitudinal axis is maintained, as the loads imposed by the auxiliary airplanes B and C are normally equally distributed with respect to the fore and aft or longitudinal axis of the carrier or mother ship.

In mounted position of the auxiliary airplanes B suspended from the lower wing 14 of the mother ship A the wings 23 of the auxiliary airplanes are located beneath and covered by the mother ship wing 14 and the cockpits 27 lie below and are covered by the after or trailing edge portion of the wing 14. The fuselages 22 of the auxiliary airplanes B extend forwardly and rearwardly a distance beyond the leading and trailing edges, respectively, of the wing 14 of the mother ship A, with the tractor propellers P located forwardly of the wing 14 and having operating clearance therewith and with the adjacent structure of the mother ship A. The empennages 25 on the fuselages 22 are positioned to the rear of and spaced from the wing 14 and adjacent structure of the mother ship A, and the chassis 26 of the auxiliary airplanes B terminate in planes above the plane of contact of the mother ship chassis 17, so that the auxiliary airplanes B will have sufficient clearance when the mother ship is on the ground with the auxiliary airplanes B in mounted position thereon. The foregoing relative mounted position of the airplanes B on the mother ship A is clearly shown in Fig. 2 of the drawings.

The auxiliary airplane C in position mounted on the upper wing 12 of the mother ship A along the fore and aft axis thereof, is supported on or from the wing 12 at points on the fuselage 22 to the rear or aft of the chassis 26, so that the propeller P and chassis 26 are positioned forwardly of the leading edge of the wing 12, with the monoplane wing 23 of the auxiliary airplane C located a distance above and extending forwardly from or staggered with respect to the mother ship wing 12, as disclosed in Fig. 2. Due to the use of the high type monoplane wing 23 on the auxiliary airplane C, in mounted position on the upper wing 12 of the mother ship as above described, a maximum space is obtained between the wing 12 of the mother ship and the wing 23 of the airplane C mounted thereon, with the result that minimum interference therebetween is secured

and the efficiency of the combined wing structure in flight is materially increased. This feature in the design of the auxiliary airplanes is embodied in the preferred types thereof intended for mounting below a wing of the mother ship, by forming and providing the same with monoplane wings, of the low or underslung type, such as the low type monoplane wing 23' shown in dotted outline on one of the auxiliary airplanes B of Fig. 1, and as shown in the lower auxiliary airplanes of Fig. 8 described hereinafter.

The auxiliary airplanes are detachably mounted and supported on the carrier or mother ship in proper position to be released therefrom for independent flight during flight of the mother ship, and one form and embodiment of mechanism for this purpose is disclosed herewith by way of example in Figs. 3, 4, and 5 of the accompanying drawings. The mechanism provides in this instance a four point suspension or support between the auxiliary airplanes and the mother ship, formed by spaced pairs of fittings secured to the auxiliary airplane and detachably coupled or connected to similar spaced pairs of fittings secured to the mother ship. The release fittings 30 which are secured to the auxiliary airplanes comprise a cup or socket member 31 having a closed side formed with a central bore therethrough and the opposite side thereof open and adapted to be closed by a removable retaining cap 32 provided with a central bore therethrough which is alined with the bore in the opposite closed side wall of the cup or socket member 31 when the cap 32 is in position thereon, as shown in detail in Fig. 5 of the drawings. The socket member 31 is fixed in edgewise (vertical position) on and extending from a suitable base plate 33, in the present instance integral therewith for attaching the fitting 30 in position. A series of antifriction members such as the balls 34 are loosely mounted and confined within the fitting 30, and a locking and release pin 35 is mounted extending transversely through the fitting 30 in the alined bores thereof with the balls 34 positioned therearound. The pin 35 is longitudinally movable in the fitting 30 and bears on and against the balls 34 positioned therearound which form antifriction bearings therefor. (See Fig. 5.)

In the specific example illustrated, four of the fittings 30 with the pins 35 mounted therein, are fixed to and secured on each of the auxiliary airplanes in the relative position indicated in Fig. 3 of the drawings, that is, in spaced pairs with the fittings 30 of each pair at opposite sides of the airplane in horizontal alinement. The arrangement more or less diagrammatically illustrated in Fig. 3 discloses the manner of mounting and the position of the fittings 30 on the lower or under side of the fuselage 22 of the auxil-

iary airplane C which is detachably mounted on the upper wing 12 of the mother ship A. In mounting and suspending the auxiliary airplanes below the wing of a mother ship, the fittings 30 are fixed on the upper side of the fuselage in the same relative positions shown in Fig. 3 of the drawings. This position of the fittings 30 is illustrated in the mounting and suspending of the auxiliary airplanes B on and from the lower wing 14 of the mother ship A, in which case the fittings 30 are mounted in the relative arrangement shown in Fig. 3 of the drawings, at the upper side of the fuselage 22 forward of the cockpit 27 thereof and extending above the plane of the wing 23 mounted on the fuselage at this portion thereof (see Figs. 1 and 2).

A second series of fittings 36 similar to the fittings 30 are mounted on the mother ship in position to cooperate with the fittings 30 on the auxiliary airplanes and adapted to be detachably coupled or locked therewith by the pins 34. The fittings 36 each comprise the cup or socket member 37 having a closed side wall formed with a bore therethrough, and the opposite side open and normally closed by a removable retaining cap 38. A series of antifriction members or balls 34 are loosely mounted and confined in the cup or socket member 37 by the retaining cap 38, and the fitting 36 is fixed on a base plate 39 for attaching the fitting in mounted position. The mounting and relative position of the fittings 36 on the mother ship for cooperation with the fittings 30 and pins 34 on an auxiliary airplane is illustrated in Fig. 3, in which the fittings 36 are fixed in spaced pairs on the upper wing 12 of the mother ship A, in position so that the spaced pairs of fittings 30 on the auxiliary airplane C fit therebetween and are located adjacent thereto, respectively, with the pin receiving bores of the fittings 30 alined with the bores of the fittings 36, respectively, as disclosed in detail in Figs. 3 and 5 of the drawings. With the auxiliary airplane C in position mounted on the upper wing 12 and the fittings 30 alined with the respective fittings 36, as above described, the pins 35 of the fittings 30 extend outwardly therefrom into and are received by the fittings 36 and bear on and against the balls 34 thereof which form antifriction bearings therefor (see Fig. 5). Thus, the pins 35 connect and lock the fittings 30 and 36 together and secure the auxiliary airplane C in mounted position supported on and from the wing 12 of the mother ship A, and by withdrawing the pins 35 inwardly from engagement with the fittings 36 the fittings 30 are disconnected therefrom and the auxiliary airplane C is detached from the mother ship for release. Any suitable spacing washers and shock ab-

sorbing elements 40 can be interposed between the adjacent washers 30 and 36, respectively, and fixed to and carried by one of the fittings, as will be clear from Fig. 5.

5 In the detachable mounting of the auxiliary airplanes B suspended from the lower wing 14 of the mother ship A, the fittings 36 are positioned and arranged on the under side of the wing 14 to cooperate with the fittings 30 and locking pins 35 on the upper side of the fuselage 22 of the auxiliary airplanes B, respectively, in a manner similar to that described in detail with respect to the fittings 36 for the auxiliary airplane C on the upper wing 12 of the mother ship A. The position and relative arrangement of the fitting 30 and 36 with the auxiliary airplanes B in position supported on and suspended from the lower wing 14 of the mother ship A is indicated particularly in Figs. 1, 2, 11 and 12 of the drawings.

Suitable means is provided operable from the desired points on the mother ship or from the individual auxiliary airplanes, for locking the fittings 30 and 36 together in auxiliary airplane mounted position and for unlocking these fittings to release the auxiliary airplanes from mounted position on the mother ship. In the preferred adaptation of such means, each auxiliary airplane is provided with individual mechanism operable from the respective control cockpit thereof or other point thereon, for actuating the pins 35 of the fittings 30 to disconnect and unlock the latter from the fittings 36 on the mother ship and permit release of the auxiliary airplane. In Fig. 3 of the drawings one possible mechanical expression of such mechanism is illustrated. Levers or rods 41 are each pivotally connected at one end thereof to the inwardly extending ends, respectively, of the opposite pins 35 of each pair of opposite fittings 30 at 42, and these levers 41 are pivotally coupled at 43 and extend between and connecting the opposite pins 35 of each pair of fittings 30, respectively. In normal position with the opposite pins 35 extending into and locking the adjacent fittings 30 and 36, respectively, the rods 41 coupled therewith are in substantial longitudinal alinement, and are maintained normally in this position by tension means comprising a spring or the like 44 connected between the pivotal coupling 43 of the rods and an adjacent fixed structural element, respectively, of the auxiliary airplane, such as the fuselage compression members 45 indicated in Fig. 3.

The opposite pins 35 of each pair of fittings 30, respectively, can thus be withdrawn inwardly from engagement with the mother ship fittings 36 by pulling on the rods 41 at the point of pivotal coupling 43 against the tension of the spring 44, to fold the rods and draw the opposite pins 35, respectively,

inwardly from the fittings, as will be clear by reference to Fig. 3. An operating lever 46 is, in the present example mounted at an accessible point in the control cockpit of the auxiliary airplane C, in any well known or desired manner, and is operatively coupled or connected with the pairs of operating rods 41 by the cables 47, respectively, connected with the rods at the pivotal points 43, and the cable 48 attached to cables 47 and extending therefrom to the operating lever 46. The cables 47 extend over and around a double block or pulley 49 to permit of their necessary movement in opposite directions during operation, and the cable 48 runs over and on any suitable pulley 50 from cables 47 to the operating lever 46. With the foregoing mechanism, by moving the operating lever 46 in the control cockpit of the auxiliary airplane in the proper direction, the connecting cables 48 and 47 draw the pairs of operating rods 41 inwardly against the tension of the springs 44, respectively, and the pairs of opposite locking pins 35 are withdrawn from engagement with the mother ship fittings 36 to detach and disconnect the fittings 30 therefrom and release the auxiliary airplane. With the auxiliary airplane in attached mounted position on the mother ship the pins 35 of the fittings 30 are maintained in engagement with the fittings 36 to lock the fittings together and secure the auxiliary airplane to the mother ship, by the action of the tension means such as the coil springs 44 connected with the operating rods 41.

The release operating mechanism above described and illustrated in Fig. 3 is likewise employed with the detachable mounting fittings 30 and 36 of the auxiliary airplanes suspended from the lower wing 14 of the mother ship A. In the latter case the mechanism is located with the fittings 30 on the upper side of a fuselage 22 and wing 23 thereof, instead of on the under side of the fuselage, as in the case of the auxiliary airplane C as described in the example of Fig. 3. The application, mounting and arrangement of the release operating mechanism to and on the auxiliary airplanes, such as B, suspended from the mother ship will be clear and understood from the detailed description of this mechanism as applied to the auxiliary airplane C.

Under conditions where it is found desirable or expedient, the detachable fittings and release mechanism therefor, for mounting and supporting the auxiliary airplanes on a mother ship, can be so arranged that the auxiliary airplanes can be released from a localized point, such as the control cockpit, of the mother ship instead of operable from each auxiliary airplane, as hereinbefore explained with reference to Fig. 3 of the drawings. An adaptation of the fittings 30 and

36 for operation from the mother ship, is illustrated diagrammatically in Fig. 18 of the drawings, as applied to the mounting of the auxiliary airplane C on the upper wing 12 of the mother ship for release from the cockpit 11 thereof, and consists essentially in reversing the fittings 30 with the pins 35 and the operating mechanism therefor, with the fittings 36, so that fittings 30 are fixed on the mother ship and fittings 36 on the auxiliary airplane. This is accomplished in the specific example illustrated by attaching and mounting the fittings 30 with their pins 35 and operating mechanism therefor on the upper surface or side of the mother ship A, and attaching the fittings 36 on the under side of fuselage 22 of auxiliary airplane C arranged for co-operation and coupling with fittings 30 in the manner hereinbefore described and explained in detail. The operating lever 46 is mounted on the mother ship A, for example in the control cockpit 11, and the cable 48 from the cables 47 is extended in any well known manner over suitable mountings (not shown) to the control lever. The operation of the fittings arranged in this manner is the same as described with reference to Fig. 3, and the auxiliary airplane can be released from mounted position on the wing 12, from the control cockpit of the mother ship A. The foregoing arrangement is carried out on the auxiliary airplanes suspended from the wing of the mother ship such as the auxiliary airplanes B, in the same manner, with the operating lever of the release mechanism mounted in the control cockpit of the mother ship. Thus, the auxiliary airplanes so mounted can be simultaneously released from the mother ship A as a group, or can be selectively individually released from a localized control point on the mother ship A. In place of a separate operating lever for the release mechanism for each auxiliary airplane, it is clearly apparent that a single lever can be employed, or various other arrangements for controlling and operating the release mechanisms for the auxiliary airplanes utilized, without going beyond the spirit and scope of this feature of the invention.

While a specific type and arrangement of means and release operating mechanism therefor, for detachably mounting and supporting the auxiliary airplanes on the carrier or mother ship is illustrated and described herewith, it is not intended by this disclosure to limit the broad features of the invention, which consist in detachably mounting auxiliary airplanes on and for transportation by a mother ship as aerodynamical elements of the resulting combined structure and in position for release and flight from the mother ship during flight of the latter, to use of and with the

illustrated means and mechanism, as any other suitable or desired means for obtaining the results of these features of the invention may be utilized. However, the illustrated means and mechanism of the invention provides a structure and arrangement in which the essential requirements of simplicity with positive operation and a minimum increase in head resistance are present, and permits of efficiently carrying out and securing the objects and results of the above mentioned broad features of the invention.

The auxiliary airplanes have a smaller fuel capacity and considerably less operating range than that of the carrier or mother ship on which mounted, and as the invention provides for mounting the auxiliary airplanes on the mother ship to form additional power units therefor, it follows that in flight of the combined craft with the power plants of the auxiliary airplanes in operation, the fuel supplies of the auxiliary airplanes will be reduced or may become exhausted, with a corresponding decrease in the range of an auxiliary airplane when release from the mother ship for independent flight. The invention provides for maintaining the fuel supplies of the auxiliary airplanes at a maximum so that upon release of an auxiliary airplane for independent flight from the mother ship, it will be capable of its normal maximum range notwithstanding the extent of operation of the power plant thereof while mounted on the mother ship previous to its release.

In the adaptation illustrated in the drawings as an example of the above feature of the invention, a separate fuel supply system to the auxiliary airplanes in mounted position on the mother ship is provided, and which system draws fuel from a source of fuel supply located on the carrier or mother ship. This separate fuel supply system for the auxiliary airplanes as mounted on the mother ship A is illustrated more or less diagrammatically in dotted lines in Fig. 1 of the accompanying drawings, and includes the main supply tank or tanks 51 which may be the supply tanks for the motors of the mother ship or may be separate tanks, mounted in the present instance in the fuselage 10 of the mother ship A, with the fuel supply lines 52 extending therefrom through the lower wing 14 to and extending outwardly from the lower wing at points above the auxiliary airplanes B, respectively; and the fuel supply line 53 extending from the tank 51 upwardly through the wing 12 at a point below the auxiliary airplane C. The fuel supply line 52 may extend upwardly from the fuselage 10 through one of the center section struts 15 thereof, as indicated in Fig. 1, to prevent damage to the fuel line, although the invention is not limited to any particular arrangement and

mounting of the fuel lines from the source of supply 51 on the mother ship to the respective auxiliary airplanes. Suitable shutoff cocks 54 are mounted in the fuel supply lines 52, respectively, and a similar shutoff cock 55 is mounted in the fuel supply line 53, these fuel supply line shutoff cocks all being located within the fuselage and preferably accessible from the control cockpit 11 thereof.

Fuel is fed by gravity from the tank 51 in the mother ship, through the fuel lines 52 on opening the cocks 54, to the auxiliary airplanes B, respectively, which are positioned below the tank 51. However, it is necessary to provide some means for forcing or elevating fuel to the upper auxiliary airplane C which is located above the fuel supply tank 51, and in the present instance any suitable or desired pump 56 of the propeller or windwheel operated type, is mounted at the lower portion of the fuel line 53 which extends outwardly to the exterior of the fuselage 10. Thus, in flight of the mother ship the pump 56 is operated to force fuel from the tank 51 upwardly through the fuel line 53 to the auxiliary airplane C. It is to be understood, of course, that other types of fuel supply systems can be utilized than the gravity and pump or force feed types illustrated, and it is not intended to limit the invention to the illustrated examples.

The auxiliary airplanes are provided with any desired types of fuel supply systems for the power plants or motors thereof and it is not deemed necessary to make a detailed disclosure or explanation of any of such systems, as they are well known and understood by those skilled in this art. The fuel supply system of each auxiliary airplane includes the usual fuel supply tank, in the auxiliary airplanes B the fuel supply tanks 57 are mounted within the fuselages 22 thereof, respectively, and in the airplane C the fuel supply tank 58 is similarly mounted in the fuselage thereof, all in the usual or any other desired manner, as clearly illustrated in Fig. 1 of the drawings, in which the tanks 57 and 58 are more or less diagrammatically shown in dotted outline on the auxiliary airplanes B and C, respectively. The supply tanks 57 of the auxiliary airplanes B are each provided with a fuel intake pipe 59 extending upwardly therefrom through the fuselage and terminating on the exterior thereof; and the supply tank 58 of the auxiliary airplane is provided with an intake pipe 60 extending downwardly therethrough from the upper portion of the tank and outwardly through and terminating at the exterior of the under side of the fuselage 22. The intake pipes 59 of the auxiliary airplanes B are so arranged thereon that when the auxiliary airplanes are in position mounted suspended

from the lower wing 14 of the mother ship, the ends of the fuel supply lines 52 are directly above and in alinement therewith, respectively; and the intake pipe 60 of the auxiliary airplane C is so arranged thereon that in mounted position of the airplane on wing 12, the end of supply line 53 is directly below and in alinement therewith, as will be clear by reference to Fig. 1 of the drawings.

Means are provided for detachably connecting the fuel supply lines from the mother ship to the auxiliary airplanes in mounted position, with the respective supply tank intake pipes of the auxiliary airplanes, and for automatically closing or shutting off the fuel supply lines on the mother ship upon release of the auxiliary airplanes. This means in the example illustrated is in the form of a coupling mounted on the ends of the fuel lines for detachably receiving and connecting the auxiliary airplane tank intake pipes with the respective fuel lines, and includes an automatic shutoff valve for the fuel lines. This detachable coupling and automatic shutoff valve form a unit 61 which is illustrated in detail in Figs. 6 and 7 of the drawings as applied to one of the fuel supply lines 52 to the auxiliary airplanes B, but it will be clear from the following description that the mounting and operation thereof on the fuel line 53 to the auxiliary airplane C is the same as in the application of the detachable coupling as described with reference to a fuel line 52 and airplane B.

The detachable coupling and automatic shutoff valve unit 61, comprises a relatively short tubular housing or casing 62 which is removably secured or coupled at one end thereof by any suitable or desired fitting 63, to the end of a fuel supply line from the mother ship to an auxiliary airplane. In the detailed disclosure of Fig. 6, one of the units 61 is illustrated in mounted position on and attached to the end of one of the supply lines 52 depending from the under side of the lower wing 14 on the exterior thereof for coupling to an intake pipe 59 of one of the auxiliary airplanes B. A plug member 64 is sweated or otherwise suitably fixed in the outer free end of the casing 62 and is formed with a valve seat 65 on the inner end thereof. A central bore is provided extending longitudinally through the valve seat forming plug 64, and a valve stem 66 is mounted for longitudinal movement therein. A series of bores or ducts 70 forming fuel passages are provided longitudinally through the plug 64 around the central bore therein, and between said central bore and the valve seat 65, as particularly shown in Fig. 7 of the drawings. The valve stem 66 extends a distance inwardly and outwardly beyond the plug member 64 and is provided at its inner end within the casing 62 with a valve 67 adapted to seat upon the valve seat

65 and close the fuel passages through the plug formed by the bores or ducts 70. The outer free end of the valve stem 66 is provided with a cross head or bar 68 extending transversely thereof, and a coiled expansion spring 69 is interposed between the plug 64 and the cross head 68, which spring normally forces the stem 66 outwardly and maintains the valve 67 in seated position on the valve seat 65 closing the fuel passages through the plug 64 from the casing 62, formed by the bores or ducts 70.

A length of tubing 71, in the present instance of flexible type such as hose, is fitted over the housing or casing 62 and abuts a positioning collar 72 sweated or otherwise fixed on the casing 62 adjacent the inner end thereof. The tubing 71 is tightly secured in position on the casing 62 by a clamping band 73 fixed therearound adjacent the inner end thereof, and extends a distance outwardly from and in continuation of the casing 62. The outer extended end of the tubing 71 is provided with a clamping band 74 fixed thereon and therearound, for a purpose appearing and explained herein-after.

The intake pipes 59 of the tanks 57 of auxiliary airplanes B, and the intake pipe 60 of tank 58 of auxiliary airplane C, respectively are suitably formed and positioned to fit into the outer free ends of the tubing 71 of the detachable coupling units 61 on the fuel supply lines, when the respective auxiliary airplanes are in mounted position on the mother ship, and thus form a coupling and connection therebetween. In the detailed disclosure of Fig. 6 one of the intake pipes 59 of the auxiliary airplanes B is illustrated in operative coupled relation with a detachable coupling and automatic shutoff valve unit 61 attached to a fuel supply line 52, and this disclosure is likewise illustrative of the formation and operation of the intake pipe 60 of auxiliary airplane C and the detachable coupling and shutoff valve unit 61 attached on the fuel supply line 53. The intake pipe 59 extends upwardly from the tank 57 in its respective auxiliary airplane B and is positioned to align with the depending end of a fuel supply line 52 and operatively connected with and fit into a detachable coupling unit 61 thereon, when the respective auxiliary airplane is mounted on the mother ship. The intake pipe 59 illustrated in Fig. 6, is formed with an annular enlargement 75 therearound spaced a distance inwardly from the outer free end thereof, and a suitable positioning collar 76 is sweated or otherwise fixed on and around the pipe 59 substantially at the enlargement 75 thereof. The end portion or length of pipe 59 from the annular enlargement 75 is gradually reduced in diameter or tapered to form a reduced

end portion adapted to freely enter and fit into the tubing 71 of a detachable coupling unit 61. Any suitable or desired check valve 77 is mounted in the intake pipe 59, and is normally open to permit free passage of fuel therethrough, but is adapted to close and prevent escape of fuel from the tank with which the intake pipe is connected when the auxiliary airplane assumes an abnormal or other position tending to cause fuel to flow outwardly through the intake pipe 59, as will be clear to those familiar with this art, by reference to Fig. 6 of the drawings.

In operation and use of the detachable coupling and automatic valve unit 61, as illustrated in Fig. 6, when the auxiliary airplane B is mounted in position on and suspended from the under side of the wing 14 of the mother ship, the fuel intake pipe 59 for the tank 57, is aligned with, and the reduced end portion thereof extends upwardly into, the tubing 71 of the detachable coupling unit 61 depending from the wing on and connected with a fuel line 52. The reduced end of the intake pipe 59 engages the cross bar 68 on the valve stem 66 and forces the stem inwardly against the tension of spring 69 with the resultant unseating and inward movement of the valve 67 from the valve seat 65 to open the fuel passages 70 and place the fuel line 52 in communication with the intake pipe 59. In mounted coupled position, the reduced end length of the intake pipe 59 extends into the tube 71 of unit 61 with the reduced end thereof engaging the valve stem cross bar 68 and maintaining valve 67 in open unseated position against the tension of spring 69. The reduced end portion of intake pipe 59 extends into the tube 71 the required distance to maintain valve 67 unseated, with the outer end of the tube forced onto the enlarged portion of pipe 59 abutting the positioning collar 76, and held tightly on and against pipe 59 by the clamping band 74 to obtain a substantially leak proof joint between the intake pipe and the detachable coupling unit 61. With the intake pipe 59 and fuel supply line 52 coupled as above explained, fuel can freely flow from tank 51 on the mother ship to tank 57 on the auxiliary plane B in mounted position thereon, and the supply of fuel in the auxiliary airplane tank maintained at a substantial maximum. Upon release of the auxiliary airplane B from mounted position suspended from a wing of the mother ship, the intake pipe 59 for the tank 57 of the auxiliary airplane, as illustrated in Fig. 6 of the drawings, is withdrawn outwardly from position in the tube 71 of coupling unit 61 on the fuel supply line 52 of the mother ship. The withdrawal of intake pipe 59 releases the cross bar 68 and valve stem 66, so that the expansion spring 69 forces the valve stem out-

wardly and seats the valve 67 on valve seat 65 to close the fuel passages 70 and shut off flow of fuel from the fuel supply line 52. The action of the coupling and automatic valve unit 61 between the fuel supply line 53 on the mother ship and the intake pipe 60 of the auxiliary airplane C mounted on the upper wing 12 of the mother ship A is similar to that described with respect to the mounting of auxiliary airplanes such as B, and will be readily understood from the foregoing description in connection with Figs. 1, 6 and 7 of the accompanying drawings. The operation of the detachable fuel supply line coupling and shutoff valves units 61 between the mother ship and the auxiliary airplanes is entirely automatic, as the mounting of the auxiliary airplanes to the mother ship forces the auxiliary airplane intake pipes into the coupling units and opens the shutoff valves thereof to permit flow of fuel to the tanks of the respective auxiliary airplanes; and the release of the auxiliary airplanes uncouples or disconnects the fuel lines and causes the shutoff valves of the units 61 to immediately close and prevent flow of fuel from the severed supply lines.

If desired, in those fuel supply lines on the mother ship including a force feed, such as fuel lines 53 with pump 56 for the auxiliary airplane C, any suitable overflow system (not shown) from the tank 58 of the auxiliary airplane can be provided, to care for excessive or unnecessary supply of fuel which may be forced into the auxiliary airplane tank 58 by the pump 56. The operation and use of such an overflow as well as the installations and arrangements thereof will be clear and understood by anyone skilled in this art, and it is not deemed necessary to make a specific disclosure or detailed explanation thereof.

The invention further contemplates and provides for the control of the auxiliary airplane power plants or motors M from the control cockpits of each respective auxiliary airplane in which mounted, or from a central or localized point, such as the control cockpit 11 of the mother ship A, so that when desired and particularly during operation of the auxiliary airplanes as power units of the mother ship, the speed and power thereof can be controlled by the pilot of the mother ship from a localized point thereon to facilitate piloting and control of the combined craft. One possible mechanical expression of means for securing this result is more or less diagrammatically illustrated in Figs. 11, 12 and 13 of the drawings.

In addition to the reversible or variable pitch propellers P, hereinbefore referred to, with which the auxiliary airplanes are preferably provided to permit of varying the pitch of the propellers to meet various oper-

ating conditions encountered, as will be readily recognized, the auxiliary airplane motors M are each provided with a selfstarter which is operable from the mother ship, and by which the pilot of the mother ship can start the auxiliary airplane power plants as desired. In Fig. 11, by way of an example applicable to all the auxiliary airplanes, a self-starter S of any suitable or desired type is more or less diagrammatically illustrated as operatively coupled to the motor M of an auxiliary airplane B in mounted position suspended from the lower wing 14 of the mother ship A. A storage battery T or any other suitable source of electrical energy is mounted on the mother ship, in the present instance in the wing 14 thereof although not so limited, and is suitably electrically connected with the self-starter S by the usual circuit U, which includes a control switch V mounted on the mother ship A and preferably accessible from the control cockpit 11 thereof. The switch V, battery T, control circuit U are purely diagrammatically illustrated and it will be understood that any desired arrangement thereof to secure the results of this feature of the invention may be utilized. A detachable coupling or electrical connection W is provided in the self-starter circuit U between the auxiliary airplane B and the wing 14 of the mother ship. In the present instance this detachable electrical coupling W is formed by a plug member 78 mounted on the upper side of the fuselage 22 of auxiliary airplane B aft of and adjacent the control cockpit 27 thereof, and a socket member 79 mounted on the under side of wing 14 in position to be alined with and receive the plug member 78 and electrically couple the portion of the starter circuit U on the auxiliary airplane with the portion thereof on the mother ship, when the auxiliary airplane is in mounted position. In this manner the self-starter circuit U is uncoupled upon release of the auxiliary airplane from the mother ship and electrically coupled when mounted thereon, through the detachable coupling W formed by the plug member 78 which is slidably received in and by the socket member 79. Thus, the motors of the auxiliary airplanes can be started when desired from the mother ship by operating the control switches V of the self-starter circuits U, as will be apparent from the foregoing description in connection with Figs. 11 and 12 of the drawings.

Mechanism is provided for controlling the speed and power of the motors of the auxiliary airplanes from the control cockpit or other localized point on the mother ship, and is mounted and arranged to operate in connection with the usual motor throttle controls from the control cockpits of the auxiliary airplanes, respectively. An ar-

rangement of this motor control mechanism is diagrammatically illustrated in Figs. 11 and 13 of the accompanying drawings. The fuselage 22 and motor M of an auxiliary airplane B are diagrammatically illustrated in Fig. 11 in mounted position of the auxiliary airplane B on the wing 14 of the mother ship A, and the usual throttle control for the motor M is shown as comprising a suitable rocker arm 80 mounted on the throttle valve of the motor carbureter 81, with an operating rod 82 of the push and pull type extending from the rocker arm 80 to the manual control lever 83 mounted accessible from the control cockpit 27, for operation in the usual manner to control the speed and power of the motor M. A rocker member 84 is pivotally mounted on the upper side of the fuselage 22 of auxiliary airplane, in a substantially horizontal plane transversely thereof, and is provided with a vertically disposed lever 85 extending upwardly therefrom intermediate the ends thereof, as clearly shown in Fig. 13 of the drawings. The lever 85 is formed with and terminates in a bifurcated or forked upper free end portion 86. The ends of the pivotally mounted rocker member 84 are connected with the ends of the rocker arm 80, by cables 87 passing over and around the parallel pulleys 88, respectively, mounted in any suitable manner in the fuselage 22 below the ends of the rocker member 84. Thus, by actuating the lever 85 to rock the member 84, the rocker arm 80 is operated through cables 87 to open and close the throttle valve of the carbureter 81 of motor M.

A rocker arm 89 is pivotally mounted in a vertically disposed position within the wing 14 of the mother ship A, and a rod 90 is connected to the lower end of arm 89 and extends outwardly therefrom in a substantially horizontal position longitudinally of and within the wing 14. The rod 90 terminates in the wing 14 at a point directly above and aligned with the end of the lever 85 when the auxiliary airplane B is in mounted position on and suspended from the wing 14. The outer free end of rod 90 is provided with a transverse pin 91, and a spring 92, or other tension device is connected between the wing 14 and rod 90 to normally draw or pull the latter downwardly. When the auxiliary airplane B is in mounted position on the mother ship, the lever 85 extends upwardly into the wing 14, through a suitable opening formed in the lower side or skin thereof, and the bifurcated or forked end 86 of the lever 85 receives the pin 91 of rod 90, which pin is maintained and held in position in engagement with the lever 85 by the action of the spring 92. Operating cables 93 are connected to the opposite ends, respectively, of the rocker arm 89 and extend through the wing 14 to any suitable

operating lever (not shown) preferably mounted in and accessible from the cockpit 11 of the mother ship A, by means of which the rocker arm 89 can be actuated.

With the auxiliary airplane B, of Figs. 11 and 12, in mounted position on the mother ship, the speed of the motor can be controlled from the mother ship by operating the cables 93 to rock arm 89, which actuates lever 85 on the auxiliary airplane through the forked end 86 of lever 85 connected through pin 91 with the rod 90. The actuation of lever 85 rocks the member 84 and through cables 87 opens and closes the throttle valve of carbureter 81 on motor M by means of the rocker arm 80. Further, the motor M can be also controlled if desired from the cockpit 27 of the auxiliary airplane, by the control lever 83, as will be clear from Fig. 11 of the drawings. When the auxiliary airplane B of Fig. 11 is detached and released from the mother ship, the lever 85 on the auxiliary airplane is withdrawn downwardly from engagement with the rod 90 and pin 91, thus disconnecting the motor control mechanism from the mother ship to the auxiliary airplane.

The foregoing arrangement and installation of the remote control mechanism for the motors M of auxiliary airplanes B is readily adaptable to installation in connection with an auxiliary airplane mounted on the mother ship in the manner of auxiliary airplane C, as well as for installation with auxiliary airplanes mounted in various other positions on a mother ship, and the mechanical expression of such remote motor control mechanism and the application thereof to one of the auxiliary airplanes B is merely by way of example for purposes of explanation and illustration of the broad principles, operation and results thereof. Further, the remote control mechanism is adapted to use with any means for varying or controlling performance of the motors M, such as fuel mixture, ignition or cooling system, as for example the remote control of radiator shutters, and this feature of the invention includes remote control of any of the factors upon which the motor performance depends.

Provision is made in the design of a mother ship for passage of occupants therefrom to auxiliary airplanes mounted thereon. With the type of mother ship A and the design of the auxiliary airplanes B and C and the mounting thereof on the mother ship, access is had to an auxiliary airplane C mounted and supported on the upper wing 12 above the fuselage 10, by climbing from fuselage 10 onto wing 12 from which point the cockpit 27 of the auxiliary airplane is readily accessible. If desired suitable foot and hand holds (not shown) can be provided on the wing structure of the mother ship to

assist in mounting to the upper wing 12, as will be readily understood. However, in the case of the auxiliary airplanes B suspended from and located below the lower wing 12, it is necessary to design the wing 12 to form passages therein through which access can be had to the cockpits 27 of the airplanes B, with the latter in mounted position. In the example illustrated the lower wing 12 is provided with openings 94 transversely therethrough forming passages directly above and alined with the cockpits 27, respectively, of auxiliary airplanes B when the latter are in mounted position suspended from the wing 12, as shown in Figs. 2 and 11 of the accompanying drawings. Thus, passage between the fuselage 10 of the mother ship and the cockpits 27 of auxiliary airplanes B, is had along lower wing 12, on which a suitable protecting walk or runway (not shown) can be provided if desired, and through the passages formed in the wing 12 by the openings 94. Closures or doors 95 diagrammatically indicated closing an opening 94 of wing 12 in Fig. 11, are provided to prevent material reduction of the wing efficiency, and these doors 95 are normally maintained closed but of a readily opened type, such as a sliding door or closure. It will be understood from the foregoing, that if desired a passage can be formed through the upper wing 12 for access to an auxiliary airplane mounted thereon, such as the auxiliary airplane C, in a manner similar to that described with reference to auxiliary airplanes B and the wing passages 94 therefor.

The auxiliary airplanes B and C are mounted on the mother ship A in position to form aerodynamical units of the combined structure, and likewise in position for release and flight from the mother ship, as will be clear from the foregoing detailed description and explanation of this form and embodiment exemplifying the broad principles and features of the invention. In mounted position, the auxiliary airplanes form a balanced structure with the mother ship, and the supporting surfaces of the auxiliary airplanes function as additional supporting surfaces of the mother ship to assist in lifting the added weight of the auxiliary airplanes. The performance of the structure formed by the combined craft will in general be less than the performance of the auxiliary airplanes when detached, so that by setting the supporting surfaces of the auxiliary airplanes at a greater angle of incidence than the angle of the mother ship supporting surface, assistance in compensating for the added weight of the auxiliary airplanes in and increasing the performance of the combined craft may be secured. The control surfaces of the auxiliary airplanes in mounted position on the mother

ship may be utilized to assist in the control of the combined craft, but the action and results obtained will be determined by the relative positions and mounting of the particular auxiliary airplanes on a mother ship, as will be clear to those skilled in the aeronautical art. Further, as hereinbefore referred to, the auxiliary airplanes are mounted on the mother ship in position so the power plants or motors M thereof can be operated to function as additional power units for the combined structure, thus permitting an increase or greater range of performance and flexibility in operation.

In operation and use of the invention, the auxiliary airplanes are mounted in position on the mother ship in any suitable manner, for example, the upper auxiliary airplane C can be raised and set in position on the upper wing 12 by means of a derrick or the like; and the lower auxiliary airplanes B can be jacked or otherwise lifted into position beneath the lower wing 14. The auxiliary airplanes are then detachably connected to and locked in mounted position on the mother ship by the detachable coupling and release means including the fittings 30 and 36, and locking pins 35 with the operating mechanism therefor, as hereinbefore described and explained. In taking off for flight with the combined craft the power plants or motors M of the auxiliary airplanes can be started before taking off, or can be started at any time during flight from the control cockpit of the mother ship by means of the self-starters S and controlling circuits thereof, as determined by flight conditions and the performance desired from the combined craft.

When the motors M of the auxiliary airplanes are operated in flight as additional power units for the combined craft and it is desired to conserve the auxiliary airplane fuel supplies so as to secure maximum range for the auxiliary airplanes upon release from the mother ship for independent flight, the fuel supply lines 52 and 53 from the tank 51 on the mother ship to the auxiliary airplane supply tanks, respectively, are opened by the cocks 54 and 55. The detachable fuel line couplings and automatic cutoff valve units 61 connecting fuel lines 52 and 53 with the intake pipes 59 and 60, respectively, of the auxiliary airplane tanks, are automatically maintained open with the auxiliary airplanes in mounted position, so that, fuel is supplied to the auxiliary tanks from the supply 51 on the mother ship. In this manner as fuel is consumed by operation of motors M as additional power units of the combined craft, the supply in the auxiliary airplane tanks 57 and 58 is maintained at a maximum from tank 51 and fuel supply lines 52 and 53 on the mother ship. The motors M are controllable from the mother ship during oper-

ation thereon to meet the requirements of flight and performance conditions, through the medium of the remote motor control mechanism hereinbefore described and shown in Figs. 11 and 13 of the drawings, or the motors M can be controlled from the cockpits 27 of the individual auxiliary airplanes, respectively, by the control levers 83 therein. (See Fig. 11.) In order to further meet varying flight conditions and requirements, the variable pitch propellers P of the auxiliary airplanes can be utilized, and particularly to compensate for the different operating conditions encountered by the auxiliary airplanes when operated independently of the mother ship after release therefrom.

During flight of the combined craft, the auxiliary airplanes B and C can be released therefrom for independent flight by operating the control levers 46 of the respective auxiliary airplanes to be released, to unlock the detachable fittings 30 and 36 thereof and detach the auxiliary airplanes from the mother ship. Due to the mounted position of the auxiliary airplanes, upon detachment from the mother ship they are immediately placed in independent flight, the release preferably being made with the mother ship in a glide or dive so that in effect the auxiliary airplanes are projected into controllable flight. Upon release of the auxiliary airplanes the detachable fuel line couplings 61 between the mother ship and the auxiliary airplanes disconnect or sever the fuel lines and automatically function to shutoff and close the severed lines on the mother ship. The remote motor control mechanisms, as well as the self-starter circuits are likewise automatically disconnected instantly upon release of the auxiliary airplanes, as explained in detail in the foregoing description. The auxiliary airplanes are individually releasable from the respective control cockpits thereof as illustrated by Fig. 3 of the drawings, or are releasable from the mother ship by the use of the detachable coupling and release mechanism arranged as shown in and described with reference to Fig. 18 of the drawings.

The invention contemplates the use of auxiliary aircraft of the water type, such as seaplanes, hydroplanes and flying boats, as well as of the land type exemplified by the auxiliary airplanes B and C, hereinbefore described, and further provides for mounting both land and water types upon a mother ship. In Fig. 10 of the accompanying drawings an auxiliary aircraft D of the flying boat type is more or less diagrammatically illustrated as detachably mounted and supported on the upper wing 12 of the mother ship A of Figs. 1 and 2. The auxiliary aircraft D is mounted in a manner similar to the auxiliary airplane C by means of the described detachable mounting and

release mechanism, and is of particular utility in the event of the mother ship A being forced to land in a body of water such as a river or the sea. Experience has shown that an airplane generally sinks slowly after landing on water, and hence by mounting the flying boat D on the upper wing of the mother ship, an efficient means of escape from the mother ship is provided in such an emergency, as the flying boat D could be released and would float clear of the mother ship and flight could then be resumed with the flying boat D.

Another type and design of mother ship and auxiliary aircraft mounted thereon embodying the invention, is illustrated in Figs. 8 and 9 of the drawings. In this instance the mother ship E is formed by a seaplane of the thick wing monoplane type, and includes a main central body or fuselage 100 having the control cockpit 101 in the forward portion thereof; pontoons 102 supported from the fuselage 100 by a system of braces or struts 103; thick section internally braced monoplane wing or supporting surface 104 extending from opposite upper sides of the fuselage 100; multiple power units or motors 105 mounted in the wing 104 at opposite sides of the fuselage 100 and driving tractor propellers 106; and any suitable tail assembly or empennage (not shown). The general design and arrangement of the mother ship E will be readily understood by those skilled in this art from the foregoing brief description in connection with the disclosures of Fig. 8 of the drawings. Auxiliary airplanes F are detachably mounted and suspended from the wing 104 at opposite sides of the fuselage 100 equidistant therefrom, respectively, and an auxiliary craft of the flying boat or seaplane type G is detachably mounted and supported on the upper side of the fuselage 100 along the fore and aft or longitudinal center thereof. The relative position and mounting of the auxiliary airplanes F and G is similar to that of auxiliary airplanes B and C on the mother ship A.

The auxiliary airplanes F are of the low or underslung monoplane type having a fuselage 107 and the monoplane wing 108. A variable pitch tractor propeller P is provided on each airplane F and is driven by any suitable power plant (not shown) mounted within the fuselage 107 thereof. The remaining general design substantially conforms to that of the auxiliary airplanes B, hereinbefore described. The auxiliary flying boat or seaplane G is of the high wing monoplane type and includes the body or hull 109; high or parasol type monoplane wing 110; and motor M' driving a pusher propeller P'. The auxiliary aircraft F and G are detachably mounted for release in a manner similar to that described with refer-

ence to the auxiliary airplanes B and C on the mother ship A, and the detachable coupling and release means of the type hereinbefore described in detail, including detachable fittings 30 and 36, locking pins 35 and operating mechanism therefor, can be utilized for detachably mounting the auxiliary craft F and G on the mother ship E for release therefrom during flight. The separate or independent fuel supply system on the mother ship for maintaining the auxiliary airplane fuel supplies at a maximum, described in detail with reference to the mother ship A in Fig. 1 of the drawings, and including the detachable fuel line coupling and automatic shutoff valve units 61, is provided on the mother ship E for supplying fuel to the power plants of the auxiliary airplanes F and G. Further, the remote motor control mechanism of Figs. 11 and 13, may be applied to the mother ship E and auxiliary airplanes F and G, and the arrangement and operation thereof will be similar to that described with reference to the mother ship A.

In the type of mother ship E access to and from the fuselage 101 and the lower auxiliary airplanes F beneath the wing 104, is provided for by passages 111 formed within the wing 104 and extending longitudinally thereof, from opposite sides of the fuselage 100 to and terminating within the wing directly above the fuselages 107 of auxiliary airplanes F, respectively, when the latter are in mounted position suspended from the wing. Closures or doors 112 are provided in the sides of fuselage 100 for normally closing or shutting off the passages 111 from the interior of the fuselage. The outer ends of the passages 111 terminate in openings through the lower surface or skin of the wing 104, which are aligned with the cockpits (not shown) of the auxiliary airplanes F, respectively. Inwardly operating doors or closures 114 are provided for normally closing the openings, respectively, through the lower skin of wing 104. Access to the auxiliary flying boat G can be had from cockpit 101 of the mother ship fuselage 100 by passing over the upper side thereof, or access can be had from the interior of the fuselage 100 by climbing up suitable hand and foot holds 115 therein and climbing onto the upper side of the fuselage through any suitable opening (not shown) formed therein.

The types and designs of auxiliary aircraft hereinbefore described and explained have been mounted on the mother ship supporting surfaces either thereabove or suspended therebelow, but the invention contemplates mounting auxiliary aircraft in other positions on and with respect to the mother ship, and several modified designs of auxiliary aircraft and the mounting thereof on a

mother ship are diagrammatically illustrated in Figs. 14, 15 and 16 of the accompanying drawings.

In Fig. 15 of the drawings a modified design of auxiliary airplane and mounting thereof on the mother ship A is shown, in which an auxiliary airplane H is detachably mounted on the wing 14 of mother ship A, and extends rearwardly from the trailing edge thereof. In the example shown the auxiliary airplane H is of the biplane type having a fuselage 116 terminating in a blunt or flat nose at which a tractor propeller P is mounted. The wing 14 of the mother ship is formed with a cutaway portion 117 in the trailing edge portion thereof, shaped to receive the nose of the fuselage 116 of auxiliary airplane H, and a streamline built-up portion 118 is formed on the wing 14 forwardly of the cutaway portion 117 of the wing and terminates at the rear end thereof in a concave face forming a recess 119 to receive the propeller P and streamline hub or cap thereof. The built-up portion 118 on the wing 14 is adapted to aline with and form a forward streamline continuation of the fuselage 116 when the auxiliary airplane H is in mounted position on the wing 14, as will be clear by reference to Fig. 14 of the drawings.

Any suitable or desired mechanism for detachably mounting auxiliary airplane H on and extending rearwardly from the cutaway portion 117 of wing 14 is provided, and one possible mechanical expression of such mechanism is diagrammatically shown in part by Fig. 17 of the drawings. The auxiliary airplane H fuselage 116 is provided, for example, with the usual pairs of upper and lower longérons 120, and the built-up portion 118 on wing 14 is likewise provided with pairs of upper and lower longitudinal members 121 adapted to abut at the rear ends and aline with the forward ends of the fuselage longérons 120, respectively. Detachable coupling units 122 are mounted between and connecting the abutting aligned ends of fuselage longérons 120 and the ends of the longitudinal members 121 of the built-up wing portion 118. Each coupling unit 122 is provided with a locking pin 123 and the opposite pairs of locking pins, respectively, are connected by the pivoted rods 124 extending therebetween, and maintained in normal locking position by means of a tension member or spring 125 connected to a member 126 of the built-up wing portion 118. An operating lever 127 is mounted in the auxiliary airplane H and is connected with the pivoted rods 124 by means of a suitable system of operating cables 128, diagrammatically illustrated in the drawings. Thus, by actuating lever 127, the locking pins 123 of each opposite pair of coupling units 122, respectively,

can be withdrawn therefrom to detach the same and release the auxiliary airplane H from the wing 14 of the mother ship.

A further modified type and design of auxiliary aircraft I is diagrammatically illustrated in Fig. 16 of the drawings, as detachably mounted on and supported extending rearwardly from the trailing edge of a thick wing, such as the wing 104 of mother ship E, disclosed in Fig. 8 of the drawings. The auxiliary aircraft I is of the glider type and is detachably mounted to the wing 104 in a cutaway portion formed in the trailing edge portion thereof, in a manner similar to that described with reference to the auxiliary airplane H of Figs. 14 and 15. The thick section, internally braced type of wing 104 provides the forward continuation of the fuselage of the glider I without the necessity of forming a built-up portion on the wing, as in Figs. 14 and 15. Access to the glider I is had from the fuselage of the mother ship through the longitudinal wing passage 111, hereinbefore described, and a transverse passage 129 alined with and opening into the nose of the glider fuselage, as will be clear by reference to Fig. 16 of the drawings. The detachable mechanism including coupling units 122 and operating lever 127 mounted in the glider I, are utilized for detachably coupling the glider in mounted position on the wing 104, for release therefrom in flight of the mother ship. The arrangement and operation of this mechanism will be clear from the description thereof, with reference to the auxiliary airplane H, and Fig. 17 of the drawings.

From the foregoing examples it is seen that the broad principles and features of the invention are capable of various other aeronautical and mechanical expressions, and that the invention is not limited to any particular type or design of mother ship or of auxiliary aircraft mounted thereon. Further, any desired number and mounting arrangement of auxiliary aircraft on and with respect to a mother ship may be utilized, and the illustrated arrangements are disclosed merely for purposes of explaining the various features and principles of the invention.

Attention is directed to the fact that in the use and operation of the invention the auxiliary airplanes can be returned to the mother ship in flight after release therefrom, by employing any of the known methods of securing contact between aircraft in flight, as by trailing a lead from one which lead is engaged by the other craft and then drawing the lead to bring the attached or engage craft into mounted position on and with respect to the other craft.

The various uses and results of the invention as hereinbefore described and explained

will be apparent from the foregoing detailed description and explanation of the accompanying drawings. Among some of the various uses may be mentioned the following. In commercial work the auxiliary airplanes can be employed for local descents on non-stop or through flights of the mother ship, and the mother ship can be used for the transportation and delivery of aircraft shipments. In military work, a mother ship can be employed for bombing or the like operations, and the auxiliary airplanes released to act as protection for the mother ship in case of attack.

The term "aircraft" is employed in the appended claims in the broad, generic sense to include any and all types and designs, both heavier-than-air and lighter-than-air; and the term "airplane" as used in the claims includes all types and designs of heavier-than-air craft, both land and water, as well as gliders and semi-gliders.

It is evident that various modifications, variations, changes, and substitutions might be resorted to without departing from the spirit and scope of the invention, and hence I do not wish to limit the invention to the exact disclosures hereof.

Desiring to protect my invention in the broadest manner legally possible, what I claim is:

1. The combination with an airplane including a supporting surface, of an auxiliary airplane detachably suspended from the wing thereof in aerodynamic relation therewith, said auxiliary airplane in position thereon for release and flight therefrom.

2. The combination with an airplane, of an auxiliary airplane of the low monoplane wing type detachably suspended below a supporting surface of the airplane with the wing of the auxiliary airplane in aerodynamic relation with said supporting surface.

3. The combination with an airplane, of auxiliary airplanes detachably mounted on and suspended below a wing of said airplane on opposite sides of and equidistant from the longitudinal axis of the airplane to form a balanced aerodynamical structure therewith.

4. In combination, a powered aircraft forming a mother ship, and a powered auxiliary aircraft detachably mounted on the mother ship to form an additional power unit therefor controllable from the mother ship.

5. In combination, a powered aircraft forming a mother ship, a powered auxiliary airplane detachably mounted on the mother ship to form an additional power unit therefor, and means operable from the mother ship for controlling the auxiliary airplane power plant.

6. In combination, a powered aircraft, a powered auxiliary airplane detachably

mounted on the mother ship to form an additional power unit therefor, and means operable from the mother ship or from the auxiliary airplane, respectively, for controlling the power plant of the auxiliary airplane.

7. In combination, a powered aircraft, a powered auxiliary airplane detachably mounted on the mother ship to form an additional power unit therefor, control connections from the auxiliary airplane power plant to and operable from the mother ship, and means detachably coupling said control connections.

8. In combination, a powered aircraft, forming a mother ship, a powered auxiliary airplane detachably mounted thereon to form an additional power unit therefor, a self-starter mounted on the auxiliary airplane power plant, and means for operating and controlling said self-starter, mounted on and operable from the mother ship.

9. In combination, an airplane forming a mother ship, an auxiliary airplane detachably mounted on a wing of the mother ship, and a passage formed in the wing of the mother ship for access to the auxiliary airplane.

10. In combination, an airplane forming a mother ship, an auxiliary airplane detachably mounted on a wing of the mother ship, a passage formed in the wing of the mother ship for access to the auxiliary airplane, and means normally closing the passage in the wing.

11. In combination, an airplane forming a mother ship, an auxiliary airplane detachably mounted on a wing of the mother ship in position with a cockpit of the auxiliary airplane in proximity to the wing, and a passage formed in the wing of the mother ship and opening in alinement with the auxiliary airplane cockpit for access thereto.

12. In combination, an airplane forming a mother ship and including a fuselage and a thick section type wing, an auxiliary airplane detachably mounted on said wing, and a passage formed in the wing extending longitudinally therethrough from the mother ship fuselage and opening in proximity to the auxiliary airplane for passage of occupants from the mother ship to the auxiliary airplane.

13. In combination, an airplane including a fuselage and a thick section type wing forming a mother ship, an auxiliary airplane including a cockpit, detachably suspended from the mother ship wing, and a passage formed in the mother ship wing from the fuselage thereof to and opening in alinement with the auxiliary airplane cockpit.

14. In combination with an airplane, an auxiliary airplane mounted thereon, and means for detachably mounting the auxil-

iary airplane on the airplane, the said means providing a four-point support for the auxiliary airplane.

15. In combination, an airplane forming a mother ship, an auxiliary airplane mounted thereon and supported and attached thereto at four points.

16. In combination, an airplane forming a mother ship, and an auxiliary airplane detachably mounted thereon, the mother ship provided with spaced pairs of alined fittings, the auxiliary airplane provided with spaced pairs of alined fittings for detachable engagement with the mother ship fittings, locking pins for coupling the engaged fittings of the mother ship and auxiliary airplane, respectively, pivoted actuating rods for said locking pins normally maintaining the pins in coupling position, and means for operating said rods to withdraw said pins from coupling position for disengagement of said fittings and release of the auxiliary airplane.

17. In combination, an airplane forming a mother ship, and an auxiliary airplane mounted on a wing of the mother ship with the chassis of the auxiliary airplane extending in front of the mother ship wing.

18. In combination, an airplane forming a mother ship, and an auxiliary airplane mounted above a wing of the mother ship with the chassis of the auxiliary airplane extending in front of the mother ship wing.

19. In combination, an airplane forming a mother ship, and an auxiliary airplane mounted on the upper surface of a wing of the mother ship with the auxiliary airplane chassis extending in front of and below the leading edge of the mother ship wing.

20. In combination, an airplane forming a mother ship, a powered auxiliary airplane detachably mounted on the mother ship to form an additional power unit therefor, and said auxiliary airplane provided with a variable pitch propeller.

21. In combination, an airplane forming a mother ship, a powered auxiliary airplane detachably mounted on a wing of the mother ship in aerodynamic relation therewith, and said auxiliary airplane provided with a variable pitch propeller and forming an additional power unit for the mother ship.

22. The combination with an airplane forming a mother ship, of a powered auxiliary airplane mounted on the mother ship and detachable therefrom during flight for independent flight of the auxiliary airplane, and the said powered auxiliary airplane provided with a variable pitch propeller to meet the varying flight conditions encountered.

23. In combination, an airplane forming

a mother ship, and an auxiliary airplane mounted on the mother ship with a wing thereof in alinement and substantial continuation of a wing of the mother ship. 15

- 5 24. In combination, an airplane forming a mother ship, and an auxiliary airplane detachably mounted on the mother ship with a wing of the auxiliary airplane forming a rearward continuation of a wing of the
10 mother ship.

25. In combination, an airplane forming a mother ship, and an auxiliary airplane detachably mounted on and extending rearwardly from a wing of the mother ship with

a wing of the auxiliary airplane forming a rearward continuation of the mother ship wing to increase the area thereof.

26. In combination, an airplane forming a mother ship, and an auxiliary airplane detachably mounted at the trailing edge portion of a wing of the mother ship and extending rearwardly therefrom, a wing of the auxiliary airplane forming a rearward continuation of the mother ship wing. 20

Signed at Ithaca, New York, this 9th day 25 of June, 1923.

RANDOLPH F. HALL.