Oct. 20, 1964 L. L. GAUBIS 3,153,454

PITCH CHANGING MECHANISM

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FIG. 1

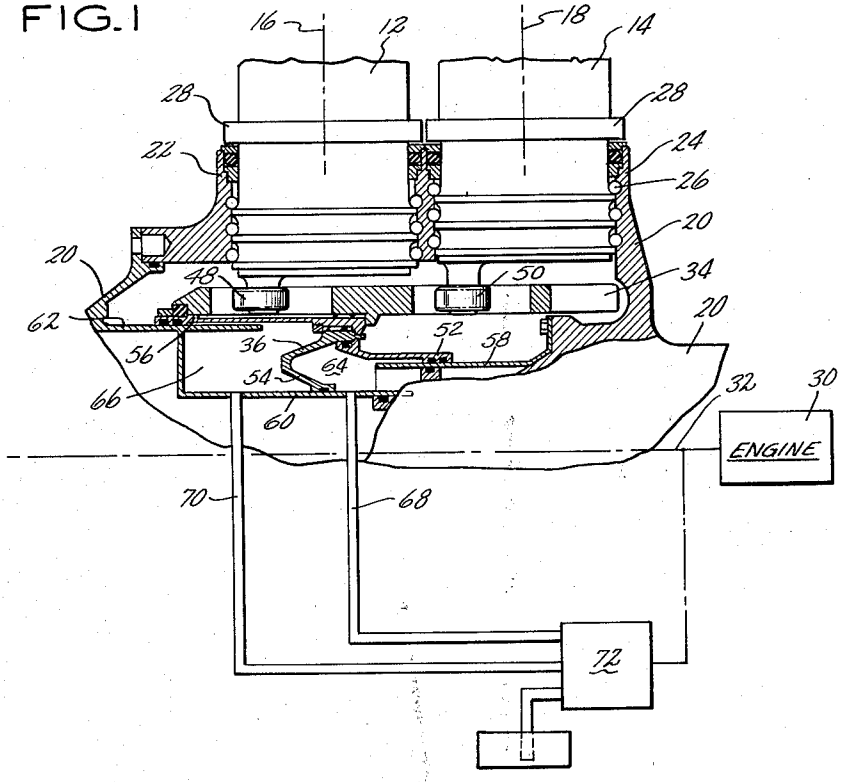
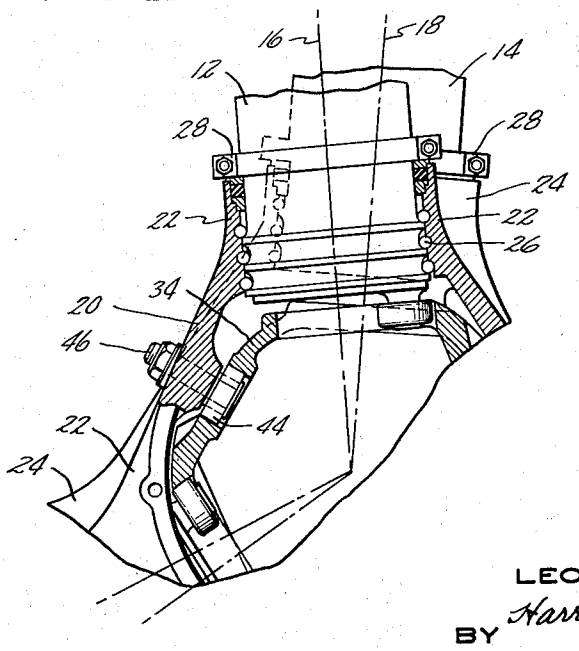


FIG. 2



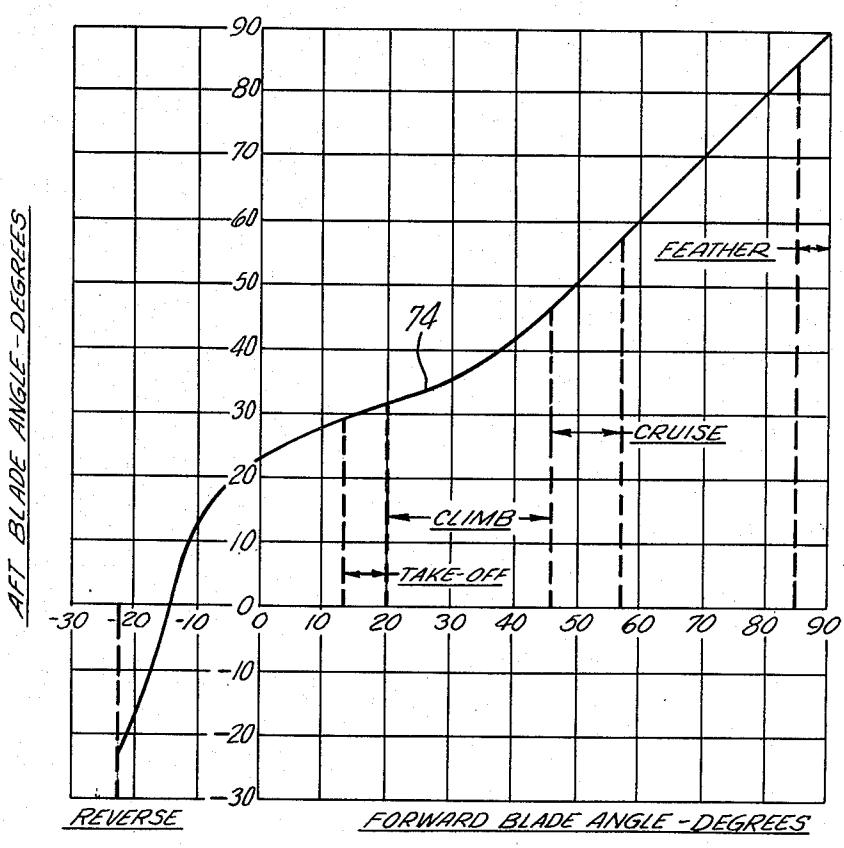
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FIG. 3



VARIATION OF AFT BLADE ANGLE WITH FORWARD BLADE ANGLE

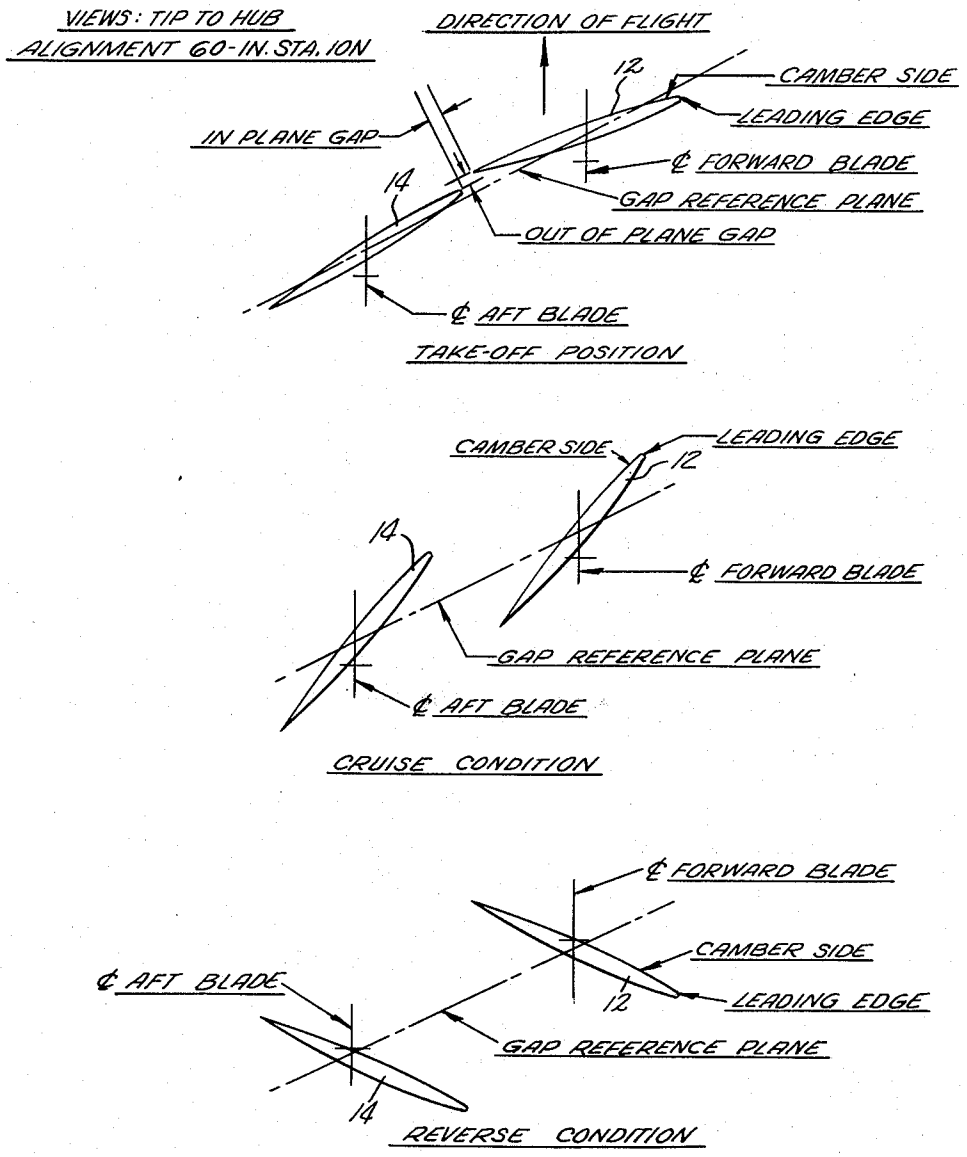
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FIG. 4



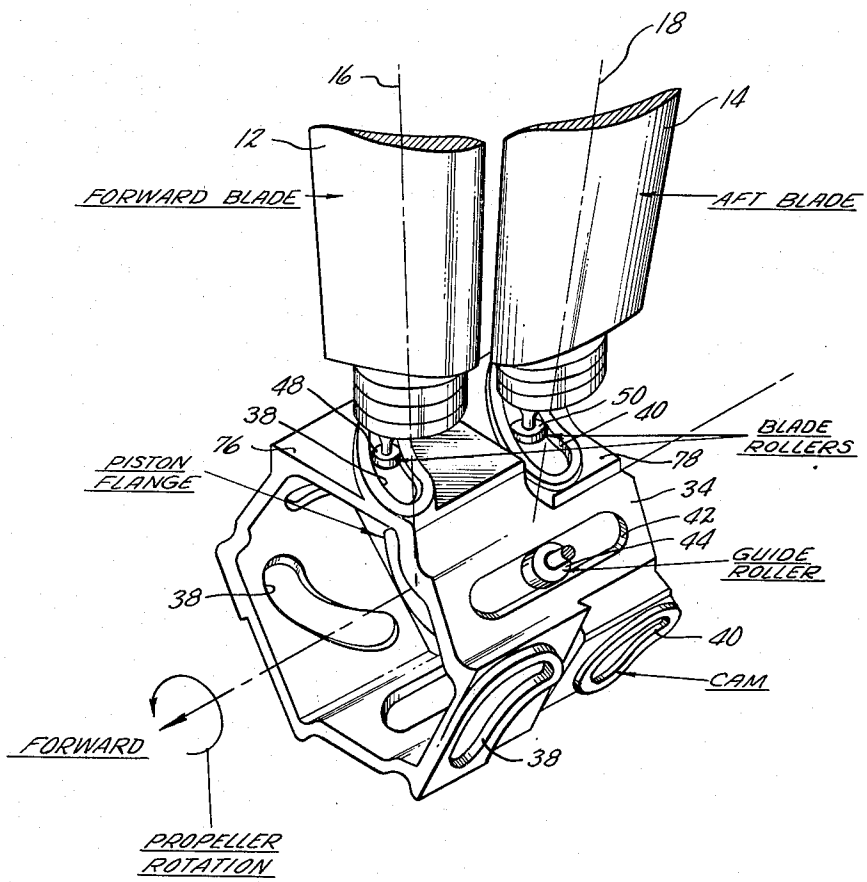
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FIG. 5



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3,153,454

PITCH CHANGING MECHANISM

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Filed Apr. 29, 1963, Ser. No. 276,488
10 Claims. (Cl. 170—135.24)

This invention relates to propellers and their pitch changing mechanism and particularly to pitch changing mechanism for variable camber propellers.

It is an object of this invention to provide mechanism for simultaneously changing the pitch of both sets of blades of a variable camber propeller and varying the effective camber of the propeller.

A further object is the provision of a simple effective mechanism for changing the pitch of the front and rear sets of blades of a propeller in accordance with different pitch change schedules.

Other objects and advantages will be apparent from the following specification and the attached drawings in which:

FIG. 1 is a longitudinal sectional view of the propeller and pitch changing mechanism;

FIG. 2 is a partial end view, partly in section of FIG. 1;

FIG. 3 is a graph showing the relative blade angles of the front and rear propeller blades;

FIG. 4 shows the relative blade positions under selected conditions; and

FIG. 5 is a perspective view, with parts removed, of the pitch change sleeve and the blade connections.

In the operation of propellers of the type shown in Rosen Patent 2,982,361 issued May 2, 1961, it has been found desirable to simultaneously change the pitch of the blades of both the front and rear banks of blades but during at least a portion of the pitch changing regime to change the pitch of the two sets at different rates or in accordance with different pitch changing schedules. As shown in FIGS. 3 and 4 it is desirable to have the two sets of blades at substantially the same angle or pitch in reverse and in feather positions and also in certain flight conditions such as cruise. In certain other flight conditions such as take off and climb it is desirable to have the rear or aft set of blades at a higher angle or pitch than the forward set of blades to obtain a preferred aerodynamic condition which may be referred to as high effective camber of the propeller.

In the particular embodiment chosen to illustrate this invention the two sets or banks of blades comprise the forward or front set of blades 12 and the rear or aft blades 14 all mounted for pitch changing movements around pitch changing axes 16 and 18 respectively in a hub 20. Each blade is held against outward movement in its respective blade arm 22 or 24 by means of ball bearings or other suitable means well known in the art. A ring 28, described and claimed in my joint application with Frederick A. Young for "Clamp Ring" Serial No. 276,489 filed on April 29, 1963, is clamped to each blade and prevents inward movement of the blade with respect to the hub during periods of rest. As explained more fully in the Rosen patent referred to above the pitch changing axes 16 and 18 are fixed with respect to each other and with respect to the hub and are circumferentially indexed with respect to each other at a predetermined acute angle so as to provide the desired cooperation between the front and rear sets of blades to give an effective low camber propeller with certain relations of the blade and an effective high camber propeller with certain other relations of the blades. The hub 20 which may be an integral structure containing the blade arm 22 and 24

for all of the blades is driven in the usual manner by an engine 30 driving a shaft 32 secured to the hub 20.

A sleeve 34 is mounted on and secured to a piston 36 for axial movement inside of the hub 20. As seen in FIG. 5 the sleeve 34 has a generally polygonal cross section having twice as many sides as there are blades in a single set of blades such as six sides when the forward set of blades has three blades to make up the set. As seen in FIG. 5 which shows a sleeve 34 for use with sets or banks of blades having three blades in each bank, three of the sides of the polygon are utilized for cam tracks 38 for the front or forward set of blades and cam tracks 40 for the aft or rearward set of blades. The remaining three sides are utilized for guide slots 42 for limiting rotation of the sleeve with respect to the hub. In the embodiment shown, the guide slot 42 is a straight slot receiving a roller 44 secured in any suitable manner such as by bolt 46 to the hub 20 between adjacent arms 22 of the front set, or 24 of the rear set, circumferentially around the hub approximately midway between said arms. In this embodiment the slot 42 and the guide roll 44 will prevent relative rotation of the sleeve 34 and the hub 20 while permitting axial movement of the sleeve 34 with respect to the hub.

Secured to and depending from blade 12 is a guide roll or cam follower 48 which is received in the respective cam slot 38 of the sleeve 34. A similar roll or cam follower 50 is secured to and depends from each blade 14 of the rear set of blades and is received in its respective cam slot 40 in the sleeve 34. Axial movement of the sleeve 34 will cause pitch changing movements of the blades 12 and 14 simultaneously in the same direction and by suitably shaping the slots 38 and 40 may impart pitch changing movements to the blades in accordance with predetermined different schedules for the front and rear sets of blades.

As shown in FIG. 1 piston 36 is secured to and inside of the sleeve 34 and has extensions 52, 54 and 56 including sealing means riding on hub etxensions 58, 60 and 62 respectively to form hydraulic chambers 64 and 66 into which hydraulic fluid may be introduced selectively to impart axial movement to the sleeve 34. Hydraulic fluid may be introduced into these chambers 64 and 66 by means well known in the art such as drilled holes in the hub or tubes passing through the propeller shaft, but for the sake of simplicity it is shown schematically as being introduced into chamber 64 through line 68 and into chamber 66 through line 70 which lines may be connected with and controlled by a governor 72 in a manner well known in the art or may be manually controlled to select the propeller pitch in a well known manner. The governor is driven in the usual manner in timed relation with the propeller. Because of the reduced centrifugal twisting moments of the tandem blade construction over that required for the equal power absorption of the single blade type of propeller and because of the reduced friction moments, the force required for changing the blade pitch is sufficiently low so that with pressure now commonly used in controllable pitch propellers it is possible to make the pitch changing pistons small enough so that it can be fitted inside of the pitch changing sleeve 34 and inside of the propeller hub making a more efficient and compact structure than where the piston must be placed outside of the propeller hub in order to obtain sufficient area. Furthermore by using a single sleeve containing individual cam slots for each blade and with different characteristics for the cam slots of the forward blade from the cam slots of the aft blade a very simple construction providing a single pitch changing device adjusting two sets of blades to different predetermined schedules is provided.

As shown in FIGS. 3 and 4 it is desirable in the take off range of the propeller to have the rear or aft blade

angle or pitch greater than that of the forward blade angle so as to provide the high effective camber for take off conditions as more fully explained in the Rosen patent referred to above. Also as shown in FIG. 3 it is desirable to have the blades change in a relation indicated by the line 74 of the graph. It will be noted that in changing from reverse pitch to the feather position the blades are always increasing pitch together although from reverse pitch to cruise they may be increasing pitch at different rates. From cruise to feather the blades have approximately the same pitch and also at the reverse position they have approximately the same pitch. If one of the blades were to decrease pitch while the other increased pitch the resulting power absorption might be such that governing difficulties might ensue. In FIG. 3 it will be noted that the blades are at substantially the same blade angle or pitch in the reverse pitch position. When increasing the pitch to position the blades for take off the pitch of the rear blade group is increased much more rapidly than the pitch of the forward blade group until the forward blade is brought to approximately zero pitch or with its chord substantially parallel to the plane of rotation. From then until the cruise position the pitch of the rear set of blades is increased slower than the pitch of the forward set of blades so that at the cruise position both sets of blades are again at approximately the same pitch angle. This different schedule for the two sets of blades will provide the high effective camber desired in the take off regime and the low effective camber desired in the cruise, feather and reverse regimes.

It should be noted that the cam tracks 38 and 40 are provided in essentially flat surfaces 76 and 78 normal to the pitch changing axes 16 and 18 respectively and that the flat surfaces are indexed circumferentially to the same extent that axes 16 and 18 are circumferentially indexed.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departing from its spirit and that various changes can be made which would come within the scope of the invention which is limited only by the appended claims.

I claim:

1. A variable pitch, variable effective camber propeller comprising two banks of axially spaced blades mounted for pitch changing movements in a hub in relatively fixed hub arms, a single sleeve in said hub having a separate cam track for each blade, a cam follower in each cam track one said follower for each blade, each follower connected with its respective blade, means connecting said hub with said sleeve to limit rotation of said sleeve in said hub, a piston in said hub and in said sleeve, means connecting said piston with said sleeve for axially translating said sleeve with respect to said hub and blades, said cams shaped to change the pitch of all of the blades in the same direction and simultaneously change the pitch of one bank of blades with respect to the other upon axial movement of said piston in one axial direction.

2. A variable pitch, variable effective camber propeller comprising two banks of axially spaced blades mounted for pitch changing movements in a hub in relatively fixed hub arms, a single sleeve in said hub having a separate cam track for each blade, a cam follower in each cam track one said follower for each blade, each follower connected with its respective blade, means connecting said hub with said sleeve to limit rotation of said sleeve in said hub, a piston in said hub and in said sleeve, means connecting said piston with said sleeve for axially translating said sleeve with respect to said hub and blades, said cams shaped to change the pitch of all the blades in accordance with a predetermined different schedule for each bank of blades.

3. A propeller having two banks of blades mounted in a hub for pitch changing movements but fixed axially and circumferentially with respect to said hub and each other, an axially movable sleeve in said hub, one set of cam tracks in said sleeve for one bank of blades, including a separate cam track for each blade, a cam follower operatively connected with each blade and positioned in its respective cam track, a second set of cam tracks in said sleeve, fixed with respect to said first set, for the other bank of blades including a separate cam track for each blade, a cam follower operatively connected with each blade and positioned in its respective cam track, a sliding connection between said sleeve and said hub limiting relative rotational movement of said sleeve and hub, said second set of cam tracks having different characteristics than said one set to provide different schedules of pitch change for said two banks of blades, and means for moving said sleeve axially of said hub.

4. A propeller as claimed in claim 3 in which said moving means includes an hydraulically actuated piston inside of and connected with said sleeve.

5. A propeller as claimed in claim 3 in which each said cam track is in a substantially flat face of said sleeve, in a plane normal to the pitch changing axis of its respective blade, and there are as many flat faces for each set of cam tracks as there are blades in each bank of blades.

6. A propeller as claimed in claim 5 in which the blades of one bank are displaced circumferentially from the blades of the other bank and the substantially flat faces on said sleeve for one set of cam tracks are correspondingly displaced circumferentially with respect to the substantially flat faces for the second set of cam tracks.

7. A propeller as claimed in claim 3 in which said sliding connection includes a straight axially extending cam track in said sleeve, located circumferentially between the cam tracks of said sets of cam tracks, and a cam follower supported by said hub circumferentially between the blades.

8. A propeller having an axis of rotation and including two banks of blades with the blades of each bank being similar in length, hub means for mounting said blades, each of said banks including a like number of blades, said blades having twist, the blades of both banks being driven at the same speed in the same direction, the blades of one bank being angularly indexed at a predetermined acute angle about the axis of rotation relative to the blades of the other bank, means for varying the pitch of the blades of both banks including means varying the pitch of the blades of one bank relative to the pitch of the blades of the other bank comprising a pitch changing device in said hub means including a movable sleeve having separate cam tracks for the two banks of blades and a hydraulically actuated piston inside of said sleeve for moving said sleeve, means connecting said device with each bank of blades said connecting means moving each bank of blades according to different preselected schedules and including cam followers on the blade operating in said cam tracks.

9. An aeronautical propeller having a take-off position, a cruise position and a feather position including hub means having an axis of rotation, front and rear sets of blades mounted in said hub means for pitch changing movement on pitch changing axes and for simultaneous rotation in the same direction and at the same speed, each of said blades decreasing in pitch throughout its length to provide twist, the blades of the rear set being mounted behind cooperating blades of the front set said cooperating blades being indexed at a predetermined acute angle about said axes of rotation relative to the blades of the rear set, means for varying the pitch of all set blades simultaneously in the same direction and means for varying the pitch of one set relative to the other set to provide different schedules of blade pitch change for said two sets, said pitch varying means comprising a single axially movable sleeve in said hub means having cam tracks for each set of blades cooperating with cam followers on the blades and means for moving said sleeve with respect to said hub to simultaneously change the pitch of both sets of blades according to their different schedules, whereby in

the take-off position the front cooperating blade is at a lower pitch angle than the rear cooperating blade to provide high effective camber and as the pitch of both blades increases towards cruise and feather positions the pitch of the front blade will increase faster than that of the rear blade to bring said cooperating blade toward the same pitch to provide low effective camber.

10. A propeller as claimed in claim 9 in which the propeller has a reverse pitch position and said cam tracks position the front and rear sets of blades at substantially the same pitch in the reverse position, then increase the pitch of the rear set faster than that of the front set in changing from reverse toward the take off position to provide an effective high camber at take off.

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