A FORD-Powered 2-Seater Monoplane

by B. H. PIETENPOL

Designer of the Pietenpol Air Camper

PART I

WELL, Gang, here we are after a long wait, and let me tell you I think the waiting will be worth while if what the editors have told me is true. They say they have been so swamped with mail and inquiries regarding this job of mine, over which I have so carefully labored, that something had to be done. You probably remember that this little cross-country ship of mine was first announced in Andy's Shop Mail Box in Modern Mechanics last spring.

They couldn't wait any longer. They said, "Never mind the fussing and pottering. Get yourself satisfied that the ship is okey, and we'll run it in an early issue. You are too conscientious. Experts agree that the job is finished and a humdinger. Let's get it into type and do the job up brown there, too." So we flew up from our home town to Modern Mechanics' own flying field, and got "our pictures took."

Gene Shank, Westy Farmer, Harry Holcomb, and others hopped the little sky busters and said they were pretty hotsy totsy. You've been told all this in the Shop Mail Box. And now that I've seen the pictures, I'm willing to agree that the editors can make this the best airplane how-to-build that was ever published if I just do the necessary writing. So here goes:

After many experiments with building and designing light airplanes, after I had first successfully soloed in a Jenny at the end of four hours' instruction, after using the bi-plane and the parasol type of construction, and after using everything from an old Gnome "growler" to an Ace Four and a Model T Ford engine, I came to the conclusion that, (1) the parasol or high wing type was the simplest type of ship to construct—two spars, no center section and just one wing curve jig needed; (2) two people could be flown with the Model A engine, which offered the

Here is Pilot Pietenpol flying alone in the Air Camper. The ship is ideal for cross-country flying.

Glider Manual
Here Are the Profile and Prop Elevation Plans of the Pietenpol Ship

Fig. 1. Here are the outboard elevations and nose elevations of the Pietenpol Air Camper. The two-passenger ship is a fifth larger than the Heth Parasol, so familiar to Flying Manual readers.

most desirable features with the exception of its weight, of any power plant known, and (3) that the De Haviland type of wooden fuselage construction was the lightest and stoutest that could be had at a price within the reach of the average experimenter’s purse.

So the design here is the result of a lot of flying, a lot of experimenting, and is as near fool-proof as a low powered airplane can be.

To take up the features of construction in order of their building procedure, let us start with the fuselage, take it apart as a design, and show how to build it. I chose this for the reasons previously stated, and because I had built enough of them to know what they were like. In an early ship, substantially the same size as the one shown here, and which was powered with an Ace 40 horse four-in-line motor, the fuselage came through a crackup without splintering one iota. It was a pleasant surprise to me to be brought to the realization that the plywood would allow the longerons to bust into a hundred pieces with-

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**SPECIFICATIONS OF THE PIETENPOL AIR CAMPER**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of Wing, Complete</td>
<td>95 pounds.</td>
</tr>
<tr>
<td>Weight of Motor with Magneto</td>
<td>244 pounds, complete.</td>
</tr>
<tr>
<td>Weight of Radiator</td>
<td>21 pounds.</td>
</tr>
<tr>
<td>Weight of Propeller</td>
<td>15 pounds.</td>
</tr>
<tr>
<td>Total Weight of Ship Without Load</td>
<td>625 pounds with water.</td>
</tr>
<tr>
<td>Total Useful Load with which it can fly</td>
<td>385 pounds.</td>
</tr>
<tr>
<td>Square Feet of Wing Surface</td>
<td>140</td>
</tr>
<tr>
<td>Load per Square Foot</td>
<td>1,080 maximum load lifted.</td>
</tr>
<tr>
<td>Span</td>
<td>28 feet, 2 inches.</td>
</tr>
<tr>
<td>Chord</td>
<td>5 feet.</td>
</tr>
<tr>
<td>Take-Off Speed</td>
<td>40 miles, approx.</td>
</tr>
<tr>
<td>Landing Speed</td>
<td>35 miles, approx.</td>
</tr>
<tr>
<td>Flying Speed</td>
<td>60-75 miles.</td>
</tr>
<tr>
<td>Weight of Body, Complete</td>
<td>130 pounds.</td>
</tr>
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</table>

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out splintering. They broke up like a bunch of dead rubber, or argum, and were badly bent from a pancake landing made twenty feet too high, but there was none of the old toad-stabbing so common with the stick and wire type of fuselage. So I went ahead building them stronger, heavier, and perfectly trussed until I got the result that I have here, and which I am showing in the plans accompanying.

If you will take a look at the blueprint on page 000, you will see the chief features of the design are a well balanced profile with heavy lonerons and heavy bay struts. Don't, for goodness sake, build these any heavier than specified, for the ship as it stands leans very much to the heavy, rugged type, and would fly better, though not be so good for cross-country, if it were lighter all through. I thought it better to err on the side of ruggedness.

Covering this side baying are the long sheets of 3/32" plywood, or plywood, as I like to call it. This is laid in cold glue, or casein glue, which you can get in your local hardware store. It is a powdered glue made from distilled milk, or casein, and is mixed in chemically definite proportions with cold water, after which it must be used fresh.

There are gusset plates of the same material on both sides of the fuselage struts and lonerons at the points where they join.

The proper method of building up one of these fuselages is to lay the whole side out on the floor full size, and since it must be a wooden floor to take the nails outlining the bends of the lonerons, a jig is made up right on the floor and the lonerons bent in around the nails. The bay struts are carefully mitered in in their respective positions, and the gusset plates put on.

There is no need to use pressure in using cold water glue. All that is necessary is to see that the surfaces are liberally coated with the stuff, and that enough small brads of about 3/8" length are used to hold the gusset while the stuff is drying, which should be from one to two days. It will set in an hour, and undergo the union with the fiber of the wood and the chemical change which makes it so unusually strong in not more than two hours, but no motion or strain should be put upon it in airplane work for the length of time I have specified. There is no point in using a lot of nailing. The strength lies in the gusset plate and gluing. After the inside gusset plates are on, the whole side is flipped and the 3/32" sheet back to the rear of the cockpit, and the outside gusset plates, are put on.

Then, when both sides have been done, the two sides are lined up and the top and bottom bays are put in. You will note that there is a 1/4" floor of plywood set in under the lonerons and cross bays of the fore end of the cockpit. The stern plates and the stiffeners are put in, and the whole thing varnished to protect it from moisture. When putting on the plywood it is wise to paint the edges of the grain with paint. Then there will be no trouble with peeling.

The fittings for the motor mounts and the landing gear will be shown in a future installment.

There is a steel fuselage to be shown later, too. All engineered out to Department of
Here's a great piece of practical airplane engineering—the Pletenpol Air Camper, a remarkable two-place sport plane powered by a Ford motor. This shows Don Fluke and the author of this article in one of the five Pletenpol ships which the designer has built. The paragon prop. of war surplus stock, is easily obtainable, as is the Ford Model A engine. The combination makes an unbeatable flying proposition when hooked up with the Pletenpol design. Several ships of this design have been flown by Mr. Pletenpol on thousands of miles of cross-country travel.
Commerce requirements by Prof. Wise of the Mohawk Airplane Co., and while it is a nice job, it will not be easy for some to build. The fuselage I have just described has been used on all five of the ships which I have built to the plans herewith, all alike in every respect, and not one of them has ever had any complaint to offer an owner in service.

So until we come to the details of the fittings, I am going to dismiss the fuselage as having been completed.

But I should say something about covering. There are some details to come about the fairing and the cowling. There are also a few notes on the fastening of the motor mount. All these affect the covering, and it should be left to the last thing. But when you do put it on, put the cover on in the usual way: Make it like a pillow slip that fits on over the job tightly. Make it just a snug fit, and don't worry about a few wrinkles. The dope will take them out.

You will note as you study the plans that there is a fairing on the side of the fuselage. This is to give something of a streamline effect, and it can plainly be seen in the big full page photograph on page 22. Which statement calls to mind one thing that Andy will thank me for: Study the plans before you decide they are not clear. They have been checked by experts and pronounced complete. Of course, the full size blueprints done in the scale from which these drawings are reduced are a bit clearer, and I will furnish any of you sets for seven and a half bucks, care of Andy, but those given here are complete and should be studied to enable you to get the whole ship clear in your mind, piece by piece.

I would give not more than four coats of dope to the fuselage, and this should be of the nitrate kind, obtainable from any airplane supply house. More than that number of coats won't do any good, and you ought to give it that many to get it drum tight. It won't begin to be tight, either, until it has had that many coats. The first coat will go on and leave the fabric, which is grade A muslin, looking like a wet rag. After an hour or two it will begin to get thoroughly dried out and to harden the cloth just a little bit, but it will be far from stiff and taut. The second coat will go a long way toward making the fabric this way, and here I would allow the stuff a full day's time before applying the third coat. Then the third and fourth coats could go on the next day. I don't think a pyroxylin finish should be applied. I have found that the solvents used in paints like that soften up the dope and make the whole covering job sag like a sow's ear.

Although the Pietenpol design has flown thousands of miles, it has not been flight tested for stuntng except in the most simple maneuvers. Practical pilots who have examined it have reported it amply strong for stunting.

The little job shown in the photograph is painted with an orange made from a standard grade of enamel thinned with varnish. It looks very well and has stood up nicely. I am referring to 77W. Ship No. 899H is covered with aluminum powder in the dope. This stood up very well. In case your curiosity gets the better of you, let me say that the numbers on the planes are merely file designations and the W or H have nothing to do with anything but the system of
How the Fuselage Is Built Up

The first process in the building of the ship, if the wooden fuselage is chosen, is to lay the dimensions for the sides down full size on the floor.

When the sides have been assembled and glued with gussets, they are set up on a horse and joined by the top rails.

Then the fuselage is covered and doped in the usual manner.

The control cables are fastened to the stick at a height I have found by lengthy experiment to give the same aileron and flipper feel that the Waco has. Under the front seat there is the rudder bar, which has to be used because there is not room for pedals. One long torque tube handles both the sticks, and the torque tube handles all aileron action. The wires run only to the rear stick. The blueprint gives complete details, and anything I might say here would be repetition. The boring and drilling and Brazing of the collars is so simple as to need no explanation.

This first part, being in the nature of a get-acquainted chapter, is meant to give you a good idea of the ship and something of what is to come. And having told you about...
Simple, Easy to Build Wooden Fuselage Follows Time-Tried Principles

Here are the dimensioned detail drawings of the Pietenpol wooden fuselage as used on all ships built by him to date. It is a marvel of strength and has withstood unusually rough handling.

The building of the fuselage in wood, and having shown the plans for the control stick, I am going to close these constructional details and swing back into a recital of the capabilities of this little airplane, sort of giving you a look-see at her characteristics.

All who have flown the job say that she flies about like a Swallow T-P except that she is faster in the air. She takes off about like a Jenny, climbs about like a Waco, and has no trouble at all in handling two passengers. I have used my ship on cross-country work for a long time, and find the motor good for about 200 hours with only top overhaul.

Glider Manual
Pietenpol Steel-Tube

by B. H. PIETENPOL

Part II of the Pietenpol Air Camper Article

If you prefer a steel-tube fuselage for your Air Camper rather than the wooden job described in Part I, you'll find the plans for it below. Aileron fittings, construction of the wing using the special air-foil developed for his plane by Mr. Pietenpol, landing gear construction and other details are presented in this installment. The Pietenpol air-foil is designed to aid the Ford motor to lift his loaded two-place plane off the ground in a hurry.

YOU have just finished reading about the construction of the wooden fuselage for the Pietenpol Air Camper—now I'll go on and present the details of the steel-tube fuselage which many of you plane builders may prefer to the wooden type. The Air Campers which I have built for myself have all been fitted out with the wooden fuselage, which I have found to be entirely satisfactory, and easier for the average amateur to construct. Many of you boys, however, will prefer a steel-tube job.

Now this fuselage is unique in many ways. It is designed to meet all of the requirements of the Department of Commerce. All the load factors have been diligently worked out by one of the most skilled airplane engineers in the country. His name is Joseph Wise, of the engineering faculty of the University of Minnesota.

When I was talking about the publishing of the Air Camper plans with Weston Farmer, he suggested that we get a steel-tube fuselage designed which would satisfy all of the boys who wanted steel-tube jobs. The conversation we had ran something like this:

"I'm working up a steel-tube fuselage, too. We could run that," says myself.

"Good idea," answered Farmer. "But let's get one from Wise. He'll give us a detailed stress analysis, and while the job will not be any better than your time-tried wooden fuselage from the standpoint of usability or practicability, still it will have an added value to the fellows who would like to build either way or who would like to compare the two methods of going at the thing."

So Prof. Wise did the job, and the plans are shown in this installment. The tubing specified is of the standard variety, obtainable from any aeronautical supply house such as the Heath Airplane Co., 1727 Sedgeswick St., Chicago, Ill., or the Church Airplane Co., 4844 Nevada St., Chicago, Ill. The size of the tubing is shown by the letters alongside the different members in the drawings. For instance, ½"-.035 means half-inch diameter tubing of .035 gauge.

In building the steel fuselage, several precautions are necessary. First, you must have the right tubing in the right place. Second, the welding must be done by a man who knows how to weld. If you don't know how yourself, you can hire a welder to come to your shop. In a day or a day and a half he should be able to completely weld the fuselage together. Third, the material must be all cut to fit right to the dot and brightened up at the weld so you get a clean fit and one in which the weld is from tubing to tubing rather than filled in with welding rod too much. Given these conditions, the complete fuselage will in every way be equal to a factory job.

I will weld up these fuselages myself for

Fig. 2A. This shows method of fastening longerons together. Note manner in which struts "land."

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Fuselage Plans

Here's a view of the Pietenpol Air Camper coming in for a landing. It has a take-off speed of approximately 40 m.p.h., a landing speed of 35, and a flying speed of 60-75 m.p.h. Stick and wire or steel-tube fuselage may be used at the option of the builder. Cost of construction, exclusive of labor, averages between $350 and $450. About half of the cost is represented by the price of the motor, and the rest is accounted for by the plane's structural fittings.

anybody who wants them. I can give you a reasonable price, too. Or if I'm too busy to do it myself, I'll have a fellow weld it who knows his groceries.

The first thing to do is to lay out the sides and the top and bottom plans of the fuselage full size on a floor. Then the tubes are cut with a hack saw so that all the longerons are in place, and so that all the struts in the bays, of the right sized tubing, are in place right to the dot. Lay out the center lines and then make the center lines of the tubes coincide with the center lines of the fuselage as laid out. This assures that all the joints will hit at critical load points and that there will be no eccentric loadings on any of the tubes.

Then tack-weld each of the sides together. Then turn them bottom side up, and with the top longerons on the floor over the top view, tack in the cross members for the top. Jigs will have to be made to hold the work while you are welding it. These can be made from wood as well as not. By referring to the blueprint you can see that the cross frames run from 4 left to 11 right, and 3 left to point 12 right, and 1 left to point 14 right. All these tubes are \( \frac{1}{2}''' \) .035 S.A.E. 1025 tubing. Figure 1A shows how the fuselage, after being tacked, is put on a horse and weld-

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Steel-Tube Fuselage Has Been Stress Analyzed and Found Amply Strong

Fig. 1A. When laying out the sides and the top and bottom panels, use the center lines as absolute guides. Note manner in which the cross frames run. Fuselage has been stress analyzed.

ed up completely. The torch is applied joint by joint, going in a clockwise and rearwards direction.

This is done to avoid twisting. The alternate expansion and contraction of the metal would give you a badly warped fuselage if you jumped about hit and miss in your welding.

The detail of the joint at point 10 on the fuselage is shown to enable you to visualize how the weld should look.

All the dimensions are shown. It is not necessary to scale the drawing, although a scale is shown. This is more for handy reference than for anything else. Use the dimensions exactly as shown in the drawing and don’t deviate a hair, or the value of the stress analysis will be thrown to the winds.

At the fore ends of the fuselage, and at 2, 3, 13 and 12 there are the fittings for the struts and the motor mount. These will be dwelt upon at a later time. They are simple
Either Steel-Tube or Stick-and-Wire Fuselage Can Be Used in This Plane

to make and are welded in place. Fig. 2A shows the method of joining two different sizes of tubes. This is called fishtailing.

A lot of constructors have different methods of doing up the final finishing of the fuselage. After the welding has been done, leave the oxide on the steel tubes. Don't try to brighten them up with emery cloth as they'll only rust. Some fellows paint their steel stuff gray, others red, others dip it in linoil. I like that method the best, or if it can't be dipped, as of course cannot be done by amateurs, linoil can be painted on. It is transparent, more weatherproof than varnish, and one can see flaws as they develop. (Which isn't likely. Rust, weather, and the normal landing shocks encountered in use have little or no effect on a steel-tube fuselage. Routine inspection for failure, if made after unusually hard landings, or at least twice a year, will be ample to ward off any weakness which may develop.)

Aileron Fittings

But that is for the steel-tube fuselage—that little talk. There were one or two fittings to be talked about—left over from the last chapter.

These were the fittings for the ailerons. You remember we were talking about the making of fittings when that chapter came to a close.

The method of attaching the horns to the aileron spar can be readily seen by reference to Figs. 3A and 4A, when the time comes to put the wing together. Suffice it to say for the present that the horns, one for each aileron, are made of 20 gauge cold-rolled sheet, and are made with all bends cold. Never heat rolled steel in building aircraft. All of the properties of the metal go up the flue when heat is applied.

The dimensions of the horns are easily seen. The side view in Fig. 3-A is made in duplicate, and enough stock allowed for a gentle bending curve along its tore-edge. It is welded at the rear, and the section at A-A then becomes as shown in the drawing. These horns, two required, should be made accurately when the metal parts for the ship (which are the hardest, and which should be done first if you want to avoid discouragement in building the ship) are done up together.

A reinforcing strip which adds to the stiffness of the aileron more than anything else, is run from the ½" spruce aileron spar back to the spruce ¾" member in the aileron. There it is fastened with bolts as the drawing, Fig. 4-A, shows. In this drawing you will find the methods of attaching the leading and trailing edges of the wings. Good point to remember when building the wings, which step we come to next.

Fig. 5-A shows the wing curve I use. I
Showing How the Aileron Is Attached to the Spar

Here is Fig. 4A and on the opposite page is a drawing of the wing. This shows the wing horn anchorages and the wing construction. Note hinged flap at rear of wing in the opposite page, to admit pilot.

I don't know what to call it. I made it up myself after building a lot of wings. It has proven to be the best curve I can find for the ship. I started out with a Goettingen 387, but I couldn't lift hen feathers with that wing. It was light, and the ship weighed just the same, but it took a long time to get off the ground, and climbed slowly, so I junked it.

Now I'm a practical man. I don't know mathematics much—enough to figure out the major loadings, wing areas, and so on, but as far as saying "hocus pocus" to a Reynolds' number and having a wing coefficient pop out at me, I'll have to excuse myself. What engineering ability I may have is a result of lifelong skill at doing machine work. Westy Farmer tells me the best engineers are the fellows who graduated from the School of Hard Knocks, and I guess he's right. Somehow a fellow gets a sense of proportion about what is strong enough, and what isn't, by merely being around well engineered work all his life. Anyway this wing question didn't worry me any.

I knew that the centers of pressure in a parasol type of plane couldn't shift any more than enough to make the ship slightly nose heavy or slightly tail heavy on trials, and that when I had found out where the centers of lift were I could place them ahead or behind a little at a time until I had a flyin' sweetheart, as Andy says.

So all I worried about was getting a section with a good lift coefficient, and I didn't worry about the bugaboo of that dreadful name, either because I knew when I had hit the section that gave the best all around performance and carried the biggest load, why, the lift coefficient had to be good. As long as it was there and as long as I knew it was there, that's all I wanted to worry about. Where it was and how much didn't bother me. So we built up a bunch of wings, and flew them. The spar depth varied in all of them. I tried Clark Y, and a lot of others, but the section that outshone all the others is the one shown in Fig. 5-A.

Don Finke, a neighbor who flies as though he were born in a plane, and myself sketched it out one night out of our heads, and when we tried it we found we had a curve that was about as fast as the best of them, but would lift two people like a balloon, whereas others we had tried wouldn't get two people off without a long run.

I am told by experts...
that the curve is practically an Eiffel 36, with ordinates increased 25% all along the chord. Westy has all the dope at his fingertips, so he must be right. If so, that may account for the phenomenal performance and stability of this curve. Eiffel was a good engineer too, y’know. The Eiffel 36 was the curve used by the Curtiss Jennies.

The spar in the wing plan we finally used as being best and stoutest is shown in the large drawing of the wing. These spars handle a load directly proportion-al to the load of a Swallow TP spar. Each is slightly larger than a TP spar. We wanted to have the wing stress analyzed, but when Prof. Wise, who engineered the Mohawk ship analyses, took a look at the wing, he said, "Plenty strong! No need to go through any analysis on that job, unless you want to save weight."

And we didn’t want to do that because the ship flew like a homesick angel anyway, and for cross-country work—which we have done a lot of—we wanted her husky to the point of ruggedness. That she is as shown.

The spars, dimensioned 43/4" by 1", are spliced at the middle. The method of making the joint is shown. The fayed surfaces of the spars are carefully matched and the casein cold-water glue stuck on as described last month.

The three bolts of 3/16" nickel steel with
Landing Gear and Metal Fittings Are Shown in This Full-Page Drawing

Fig. 6A. Here are all the details of the landing carriage. The fastenings, the fittings and the method of their attachment are all detailed. Fittings are of cold rolled sheet steel, cold worked.

washers are sunk home through drilled holes. No need to take them up any tighter than to just make them sink the washers home even with the surface of the wood.

The spars, of spruce, of not less than 8 annular rings to the inch, are routed as the
Here's the Special Wing Rib Developed for the Ship by Mr. Pietenpol

This is Fig. 5A, and shows the Pietenpol wing curve, which is the result of long experimentation on the part of the builder of the ship. The gusset plates and cap strips are very heavy.

drawing shows. This routing is done to save a little weight, and must be done carefully, making sure that the rabbeting plane doesn't chisel in under the grain. The corners should not be as sharp as the section in the drawing shows, either. It would be better to work in a little fillet.

Both front and rear spars are alike.

The slanted openings are filled with cork wedges or spruce wedges where the wing ribs cross the spars. They are fastened in with casein glue. If you use nails to fasten the ribs to the spars, make them light brads and fasten them in near the edge.

The wing ribs themselves are made up in the usual manner with a template or jig. These ribs are exceptionally strong and heavy. The cap strips are of 1/2 x 1/2 spruce and the struts are of the same material, the plywood gusset plates of 1/16" 3 ply Haske-lite or similar plywood. Light nails and casein glue hold them in place. You will need 28 ribs.

Just one little correction while I am at it. The drawing at Figure 5A shows a dimension of 6" in the top center of the wing section just a little below and to the left of the figure 60°. See it? It's wrong. Should read 6 1/4" instead.

The wings are built up the regular way. Spars built first (no dihedral, Clotilde) and then the fittings fitted, slipped off and the ribs slipped on, then the cap and trailing edges fitted, and then the fittings, the tank, the drag bracing and finally the pillowslip covering of Grade A muslin for a cover.

In doping the wing, after the sack has been sewed to fit, and has been sewed to the wing, the edges along the ribs and the leading edge are doped with a good grade of nitrate dope. When this first doping has dried the next may be put on allover the surface of the wing. At the end of the second or third coat of dope the pinned edging is coated on and one or two more coats will finish the job. The first two or three coats of dope will not do much more than barely tighten up the cloth. The first coat will leave the covering smooth, the second will tighten that up somewhat and make it easier to put on the second coat of the stuff, where the third will leave the surface rather drum taut. At least an hour or two on good sunny days, and maybe even a day or two during damp weather should be allowed to slip by as a drying interval.

Now for the coloring of the wings. Some will like to use aluminum or bronze powder sprinkled into the dope on the last two coats. (More than five coats of dope should never be used on a wing as it sets up unusual strain on the surface.) Others will want to use paint. I used an orange paint on the ship you see in the photo of the undercarriage, and it worked well when half varnish was added. Just take a glossy paint and add half varnish and a little thinner until you have a normally thin mixture, and brush it on. It will need a lot of time for drying, though.
Mounting the Motor

by B. H. PIETENPOL

PART III

This article takes up the motor mount, struts and fittings, and the complete tail assembly of the Pietenpol Air Camper. The aero conversion of the Model A motor will complete this series.

YOU embryo airplane constructors, if you’ve been following these plans closely, have the “backbone” of your Air Camper—the wing and fuselage—all built, and are ready for the finishing touches which complete the plane.

Now it is time to go ahead with the “petits details,” as we used to murmur in France. Things like ailerons, control surfaces and such things really must be used on an airplane if you want to navigate her. That’s accepted practice among the best airplane designers.

Let’s start off with a flare back on the undercarriage. One or two fellows have asked for a word on that made up in steel. The drawings were presented last month, and I thought them so complete as to need no explaining, but it seems that a steel undercarriage—sometimes termed “trucks” by unknowing writers of pulp paper fiction—would be much desired by the all-steel fans.

I say don’t go in for the steel-tube landing gear. The plans as shown are for a gear similar to that of the old Jenny. Of course, you could clean it up some, and might possibly gain a few feet per mile bettered performance, but inasmuch as the Jenny gear was the creme de la creme of roughneck airplane bottoms, serving for fifteen years the needs of all crash landings of cub pilots, it has proven itself times beyond count. I didn’t want to go into steel-tube for the landing gear after experience had proven the one I designed, and which was shown last chapter, was ample, adequate and above all, cheap.

The question of where to draw the line at the exposition of directions for the building of a ship like this is difficult to settle. Some

How the Pietenpol Air Camper looks on the ground ready for “contact.” The ship is here shown alongside a six-footer; its size is readily appreciated. This job looks every inch a real airplane.
On Your AIR CAMPER

Don Finke at 3,000 feet and still climbing strongly. The inherent stability of these ships has been apparent in hundreds of hours of air use—there are no "bugs" in either the engine or the plane.

wait just a lot of dimensions repeated in the text that are a thousand times more eloquent on the drawings, and some would even have you tell them how to hold the hammer. And there are a few who, after having been told how to hold a hammer in the building of a ship, would ask you how many swipes to clout the nails on the head. So I am adopting the course of telling you the hidden quantities in the design, outlining the major methods of attack in building her, and am not concerning myself with questions like what speed would a Townend ring give her, and couldn't we put a steel undercarriage on her. I say go ahead and build her. The methods will largely furnish themselves according to your knowledge and the equipment you have at hand. All vital dimensions are on the set of plans. The design is remarkably complete. And we won't monkey with steel-tube undercarriages or other flarebacks. If you want to experiment with her—it's yer own option. I canna prescribe.

Let's look at the motor mount. That is one thing on which I could write volumes. And the mount I have designed after many a flunk in the School of Hard Knocks, is the one shown in the drawings in Fig. 1C.

Simple it is, and ties right in to the nose of the fuselage like mucilage on a piece of blotting paper. The whole mount suggests itself to me as being less an attachment than a part of the ship itself.

Two pieces of white ash, one of them 1" by 2¼" and the other 2" by 2½" (to allow for the accommodation of the oil pump on the left side of the motor sump) are rested directly on the beam anchoring the fuselage bulkhead. One ¼" n.s. bolt, with washers, of course, is run through a drilled hole on the 1" piece. Two are used on the 2" piece. Virtually, then, the engine bearers amount to 1" net thickness, and are supported at their outer ends by an A frame

THE PIETENPOL BLUEPRINTS
A complete set of large size shop blueprints of the Pietenpol Air Camper may be obtained for $5.50 from Modern Mechanics and Inventions, 520 S. 7th Street, Minneapolis, Minn. These plans show construction of both wood and welded steel fuselage.

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of $\frac{3}{8}$—20 tube. This tube is heavy enough for engines up to sixty or seventy horsepower. In fact, we built one of the ships powered with a five-cylinder Velie of 60 h.p. and the ding-husted little wagon flew rings around itself. We never had a moment's trouble. You note that the bolts on the ends of the A frames are sunk so that the bed of the
The Seats Are Simple—So Are the Turtleback Fairings Shown Here

Here are the detailed dimensions for the bulkheads, the seat supports, and the turtleback fairings.

motor does not interfere with the job. The wood bearers are set in, bolted and lined up. The A frame is made on the flat, and with a saw cut just forward of the fitting, sawn far enough through to just allow you to bend the frame into position, the forward ends are lined up.

Then the frame is taken off and the y-shaped gap filled in with a good weld. The 16 gauge reinforcing plate at the apex of the A is, of course, welded in before the frame is finally put in. It may pay you to make a jig for this job, but I dinna know. It all depends on you, as the radio singers say.

I can hear faint re-monstrating voices concerning those fittings which are used to anchor the A frame. Particularly with reference to the bottom fittings where the anchorage for the A frame is jogged up so as to give a slightly eccentric moment at the point. Don’t change it. I have never had a moment’s trouble with this design, and the jog is necessary to allow the cowling to go over the snout of the ship so that a clean job

Fig. 3C. The spar fittings for the strut attachments, as well as the pulley, turnbuckle clips, and strut ends, are clearly shown above.

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of fairing results. Otherwise there will be a bib on the bottom of the cowl which will not only not be clean looking, but which will whistle like a sour owl when the ship is in the air. I never did like to fly fire sirens.

The fittings are very simple. All details are shown in the plans. And they carry back far enough, to my way of thinking, into the longeron. They carry just enough bolts to carry the load on through, and not enough to weaken the grain of the wood. In several pancakes and a mild spin which we have experienced with the ships sent out to other hands, the motor fittings never gave way in a bust up.

The patterns for the cowling are shown in Figure 2C. This stuff is made of 18 and 22 gauge aluminum. The lighter gauge is indicated by the higher number, as you know. The lighter stuff is used for the front and rear strut cowlings and on the under motor cowling. There is no top cowling to the motor, and the cowling to the turtleback is made of the 18 gauge stuff. Note that there are holes drilled in it to take the very necessary padding lacing which must be used around the cockpit to keep a fellow out of serious arguments with the skin of his face and hands.

The fittings for the strut attachments and the metal work involved call for a dissertation. By a reference to Fig. 3C one may see the outer strut fittings, the center strut fittings, and the other strap work which goes into the wings.

The outer strut attachments are made of 13 gauge cold rolled steel, 1" wide and are 15" long in the unbent form.

The best way to work these into shape is to cut the blank, and then bend them to shape by gentle peening around a hardwood piece placed in a vice. Needless to say the piece must be of the same dimensions as the wing spar, as far as width is concerned, and it...
should be deeper so that after the fitting is bent the drilling can be marked out and the drilling done right through the wood to get the holes squarely in juxtaposition. (That last isn’t a flyin’ word, but as long as I get paid by the word, I thought I’d throw it in!)

You’ll note that there is a ¼” bolt of nickel steel running through the center of the fitting and that the bolt on the bottom side of the spar is 3/16”. Further, the bolt on the strut attachment is a 5/16” size. These are of the correct strengths to use. I have heard some criticism of this fitting by those who said that the fitting set up an eccentric moment about the neutral axis of the wing spar. That may be. But I do know that the center bolt is the proper distance from the center section strut to go right through the neutral loading point. Any slight eccentricity is of no moment, to my way of thinking, to that super-spar that goes into the wings of these little sky wagons. An elaborate strap fitting with tentacles in all directions might be better. Have never had an opportunity to see as in all of the flying I have done, and in all of the flying done by the others who own these ships, there has never been a suggestion of off center loading, even in crackups.

The center section strut fittings are something I am very proud of. I have never seen anything like them, and consider them clever because of the fact that the hanging feature permits of a doubling of metal at a critical point without throwing too many bolts (always a danger point in plane construction) through the wing spar.

These too should be made on a wooden form, preferably of oak or of ash, drilled, and then welded at the fillets—just at the corners, to hold the under fittings, or strut pendant, rigid.

The aileron pulley bracket in this drawing and the cable pulleys are self evident in detail and need no explanation. The wheels of the pulleys themselves may be out of old Jenny pulleys. They should be of aluminum or of lignum vitae and are adapted to the strap fitting shown in the drawing, which is designed for the ship.

Now about those struts. They are of No. 2812 standard aeronautical streamline tubing. The length of the front struts is seven feet, six and a half inches. The front struts are shorter because the angle between the fuselage and the wing fitting is less. The rear struts are an inch longer.

The streamline 1667 tubing (obtainable at any good supply house, like Johnson of Dayton, O.) is used for center section struts.

The wing struts have a 13 gauge anchorage which is of slightly peculiar construction. The loop of the 13 gauge stuff is made over a 3/16” by 1” tube which is afterward bored to 5/16”. The 13 gauge stuff is best bent around a drill rod of the same outside diameter as the tube. The only way to get this bending done is to do it hot, and great care
must be exercised not to overheat the metal, nor to heat it too fast, and to allow it to cool to black before quenching.

After the tube is finally in, the drilling is done. The tube really serves as a center for the drill. The strut and the fitting are clamped together in a pinch with a small stout "C" clamp while the strut is being fitted to the wing, which has in the meantime been propped to the right angle of approach and incidence, and the hole for the 3/16" n.s. bolt is drilled. When this is in the lip of the strut tube around the strap is filled in with a weld and the strut is complete.

In lining up the center section strut system, all the guy wires are run criss-cross in the usual way, of 1/8" stranded cable, solder sweated into turnbuckles. One exception: The left side has no criss-cross wiring. This must be left out if you want to be able to get your flying mate into the office up for 'ard. The right side is ample to take care of its 1/4 total of the load. So on the three sides of the center section, front left and rear sides
The Vertical Fin and Stabilizer Are the Acme of Rugged Simplicity

as plainly shown in Fig. 1, in the first instalment, there are the cross-cross wires. In this figure can also be seen the cross-cross stiffening system used on the wing struts. This is the system used on the Heath Parasol, than which there is no stouter ship flying as far as structural strength goes.

A good idea of the size of this plane can be had by a glance at this figure, too. It shows how the ship is about ½ larger than a Parasol. Let’s look at the empennage, or end spinach, next.

This as with all good airplanes and true consists of a flipper set, a rudder, and horizontal and vertical stabilizers.

These are of very rugged construction. As with the fuselage, each piece is built flat on the bench. There is a routed section at the fore edge of the vertical stabilizer which is rabbeded as deep as the 3/16" ribs. The curved parts are built of solid white pine faced and spliced to the routed section with plywood, casein glued. The drawings on both the rudder and the vertical fin are so clear that words are superfluous. The vertical fin is anchored to the fuselage with cold rolled steel clips. The hinges are of the same materials, and the hinge pins are clevis pins, long of about ½" diameter, cotter-keyed against sudden departure at critical moments. And while we are looking at the drawing showing the “end spinach” as the Hangar Gang likes to call it, let’s look at the ultra simple tail skid. Nothing but the fourth leaf of a model T Ford front spring. Don’t try to do the job of heating, bending and tempering yo’self, Andy, or you will sho’ sho’ have trouble. A plate running across the longerons inside the fuselage serves to complete the fastening system where the 5/16" bolt runs through. Or 2 5/16" bolts can be run through the longerons as the drawing detail shows in Fig. 4C.

Figure 5C shows the end view of the

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Fig. 5C. All the hinge details for the rudder and for the flippers are shown clearly. Clevis pins from turnbuckles are used for hinge pins. Grass does not affect take-offs, as tail is high enough.

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Another Detail Drawing of Simple Empennage

Fig. 6C. Here are the detailed complete dimensions for the vertical fin and for the rudder. Note construction of curved corners.

ship with the bracing system. The tail surfaces are covered with slips just as are the wings, and they are sewn and doped the same. Grade A muslin sacks of fairly close fits are made and then put on over the surfaces. Three coats of dope, well dried between, will be enough to carry the job along to the point where the drumtightness sets in, and so to the point when the ship gets her final coat of paint.

The flat plate of the horizontal stabilizer is made of rabbedted leading, side and trailing edges, with spruce cross members glued in with casein glue. Be sparing with the nails, and judicious with the use of glue, as with all other such joints, and the surface will last a long time. We have a ship which has been tethered out to the end of a hangar for a couple of sessions, and the surface is as stout as ever.

Be sure to test the surface for trueness in cross section after building, because nothing can be of more vexation than a warped stabilizer. This one is a flat plate and is not adjustable. It doesn’t have to be, as the tail carries no load. It performs the "weathervane" function in the ship.

Maybe I had better give you fellows an idea of the way this little crate flies before I go into the motor details, because when I get there the space will be limited and crammed to the brim so that there will be no room for a say so on her flying qualities.

Presuming the ship to be completed, all the little details taken care of and the last coat of shiny paint dried and taut, the next thing to do is to pick out a field. And a pilot.

If you are a novice and have had less than ten hours in the air, don’t try to fly any new airplane.

If you do you’ll come a cropper sure as thunder, and more particularly is it apt to happen with a light plane like this, because you must remember one thing: You have to fly these light ships.

The idea of a novice getting into a ship and taking her off the ground the first time in the air is boloney.

And it is all the more so if he built the ship himself as he’ll just have to do the job over again. Not that such ships are dangerous—far from it. Structurally they are as strong as a church. But their power is not of the soupy variety that will drag pilot and ship behind it like a shirt tail no matter what the pilot does.

They take, invariably, a little longer run. And they are, invariably, more sensitive to rudder when on the ground. Particularly those of the Parasol type. So it takes a man who knows what it is to be able to fly by wishpower and what an airplane will and won’t do.

No need to teach yourself to fly in this ship. You can always take dual, right in your own ship, you know. So—

Take the ship to a good field. And be reasonably sure that it is level. Bumpy fields, until you get the hang of the Ford motor, will make the motor spit on the ground, and will confuse the pilot. Use all the field, and let the ship run until she has speed enough to fly herself off the ground if you have field enough. Never attempt to stall her off, be-
The Pietenpol Air Camper is the Ideal Airplane for Summer Outings
cause, while the motor has more than enough wallop to shoot two fellows into the clouds, the prop is turning at a low speed, and is not effective until a certain measure of forward travel has been gained. To stall means that you lose the benefit of this forward speed, and that the ship falls off in pulling power for quite a while. If you don't have enough to get her off without a stall, go back and use the field over again.

Once in the air, let the ship climb herself. If you have to, you can soup the stick back, and she'll jump amazingly, but you'll stretch the flying out of her quickly and she should be nosed down as soon as the lift is gone from the seat of your pants. She'll pick up fast enough. Then, on turns, you must not overbank. Try a few gentle ones first at better than 500 feet, and get wise to the pendulum action which all Parasol planes have. Try out the rudder and note how sensitive and ample it is for getting you out of any pickle.

Let go her stick gingerly and see whether her fore and aft control is good. If properly loaded and balanced the ship should fly hands off. She may need a little rigging though.

In setting her down, don't try any fancy right and left hand side slipping until you get the feel of her.

So there you are, Gang. The salient points of this little sky-buster have been dwelt with at large in my text, and the very good and complete drawings have made good the balance of the directions. The whole job is really so simplified that only the super-simp will want her changed. I'll build you ships with solariums, swimming pools or anything else you want, but after all the real experimenting and planning I have done on this ship I can't see fit to change a thing. For the motor we have used, ideal for everybody, she is about as hot as you'll ever find a plane, and I'll bet that ten years from now the design will be pretty warm still. So build her as she stands. And don't ask me to change anything. The kitchenette airplanette for flying fieldettes is not yet, and I refuse to try to make the Air Camper anything but a good straightforward ship. The trick stuff is for other designs.

And before I sound off for the last time, let me tell you that the motor will be dealt with in Part IV. I am running a shot of the whole business end of the plane and this will serve to tie in with the drawing in Fig. 1C, so you can savvy how the job looks out on the tarmac with her bonnet off. She's a real treat for the eyes.

At a little field at the end of nowhere, Orv Hickman pitches tent while Westy Farmer puts the kettle to boil. Gene Shank is at the nose of the Camper cleaning the frost off the carburetor.

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The PIETENPOL-FORD MOTOR Conversion

by B. H. PIETENPOL

PART IV

This is the last of a great series of articles showing how an airplane can be built around the Ford Model A power plant for less than $500.

According to letters received by the editors, interest in the conversion of the Model A Ford motor as applied to my little ship has been mighty hot. I’m using Part IV of this series to give you the motor dope. Here it is—all of it.

The Ford motor makes an ideal power plant. It is rugged and very reliable. It is comparatively low speed, and can be serviced anywhere the ship may be forced down. And it is cheap enough to be easy to buy. The whole motor, brand new, costs but little more than a hundred bucks, and when converted as shown in this article will develop a good 38-40 h.p., which is enough to fly two people in the Air Camper monoplane, the design of which I have just finished giving to you cloud hoppers in the first three parts of this article.

At the flywheel end of the motor you will note that there are no changes to be made. The flange to which the flywheel fastens is left as is. Against it is fastened a length of Model T axle, the end of which goes into the differential. This is held in place with 7/16” bolts which are double fastened. By this I mean that the two flange faces are held together with nuts threaded onto the bolts, and that the ends of the 7/16” bolts are left to run out so as to be long enough to allow the retaining plate for the propeller to be placed over them and fastened and cotter-keyed on.

You will find the axle will not be thick enough to fill out the hub of the standard Lawrence 28 war surplus prop which is used with this motor, so a wood turned birch bushing will have to be made and fitted tightly over so that the propeller is on center. Then a 16 gauge retaining plate is made and the prop is on the motor for good. Yet it is readily demountable.

We have used this prop installation for a long time and it has yet to fail us. I believe it to be far more rugged than is necessary.

View of left side of motor installed in the Pietenpol Air Camper. Note the location of the radiator and the individual exhaust stacks.
Fittings for Pietenpol Conversion of Ford Motor Shown in This Drawing

THE FORD MODEL "A" MOTOR AT ONE STAGE IN ITS CONVERSION INTO AN EFFICIENT AIRPLANE POWER PLANT

1/2 20 GA WATER CONNECTIONS

SPARK PLUG

EXHAUST STACK

CARBURETOR

NOTE THE TWO MAGNETO BRACES OF 16 GA TUBES

WELD END PLATES

DETAILS OF THE REPLACEMENT EXHAUST STACKS

FASTENING CLIPS WELDED TO STACK FROM END

WELD

1/2 20 GA. TUBE

16 GA.

CENTER STACKS CUT, FITTED, AND WELDED AS SHOWN TO ALLOW CLEARANCE FOR INTAKE MANIFOLD. MAKE ONE SO ONE L.

CAM SHAFT

3/8 SCREW THREADED INTO SHAFT

TACHOMETER DRIVE

3/8 CENTER DRILLED AND SLOTTED TO FURNISH DRIVE

TACHOMETER HOUSING CONNECTION

THE ADAPTATION OF THE INTAKE MANIFOLD TO GIVE PROPER ANGLE

THE ENGINE HOLD-DOWN BOLTS

LEATHER

WHITE ASH BEARER

HUB PLATES 1/2 DIA. 12 GA. STEEL

Dowel Holes in Rear Plate

15/16 1/2 HOLES ON 3/8 CIRCLE

CHANNEL STEEL MAGNETO SUPPORT

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The crank case will have to have some work done on it to revamp the oiling system. A feed pipe from the oil pump will have to be let into the forward crankshaft bushing. The face of the crank web takes all the thrust, and since it is designed for all of the clutch and de-clutch loads of the husky Ford car, we have found that a thrust joint or bearing is a waste of time and money, as the bearing as it stands will thoroughly take care of all of the prop thrust loads. We ran one of our ships 240 hours and found slightly less than 1/64" wear at the bearing. Which proves that it will handle the comparatively light load very nicely.

The center bearing, you will note from the middle view on opposite page, is fed from the same oil pump take-off. To the right of the figure is shown the method of drilling the bearing casting and tapping the pipe into the journal.

The splash pan is rebuilt. You will find that a welded apron up front is needed. This catches the drip from the front bearing. Also the pressure line from the fuel pump is run forward and exhausted on the apron under No. 4 cylinder, which in the case of an airplane installation becomes No. 1 cylinder and will so be called in order from this point on. Cylinders Nos. 2, 3, 4 have oil dams built in the pan so that there is assured a supply of oil at all times. The ordinary indentations in the Ford pan allow the oil to travel toward the tail of the ship too fast, and the front crankpin bearings do not get the splash feed they need if these are left out.

Off in the right hand corner a chip can be dog-cared off the corner of the pan to allow for the surplus to drip back into the lower base. The edge must be bent up 1/2" to allow a good reserve of oil to be carried in the splash.

The method of leading the pipes through the base is made very clear by the drawing, as it shows how the brass nipples are brazed into the crank wall and how the pipes are led from this point to the places where you want the oil to be delivered.

The regular cover plate of cast iron on the valve chamber is too heavy and you will have to make a 20 gauge plate to replace it. This saves several precious pounds of weight and is better looking as well as being tighter.

The intake manifold is rebuilt to be shorter. There is a tendency on the part of
Here's the Drawing Showing All the Details of the Ship's Control System
This sectional drawing of the Ford Model A engine as it is built for automobile use. The prop and the magneto mounting have been drawn in to show where they fit. Compare this illustration with the two full page drawings elsewhere in this article, and you will realize how very little needs to be done to convert the Ford motor to airplane use. Designer Pietenpol recommends 1600 r.p.m. as the best speed to run the motor; the engine develops about 35 horse power at this rate.
the intake to frost up, and the shorter you make the intake pipe the better performance you will have. Also there is need to get the carburetor outside and away from interference with the motor bed, so the change is imperative. By removing the carburetor, and the manifold, and sawing out a 3/16" slot in the back side of the neck, the carburetor is made to be level and is automatically made to clear the cowling.

Welded, the installation can be made and will prove highly serviceable. You see, I have found by experiment the amount of cut needed to get the carburetor level when the ship is flying level.

There is only one detail of the oiling system as yet left unexplained. That is the need for an oil ring to be soldered around the aft end of the crankshaft.

The drawing shows how this is put in. It is necessary to use this device to keep the motor from throwing oil all over the magneto, which would soon short.

The water pump must be shortened 1 3/4" to place the water pump pulley in line with the pulley on the crankshaft. The regular Ford pulley is used, and the regular Ford belt. We have found that they are perfectly satisfactory.

The method by which a fabric universal joint is built into the end of the crankshaft is shown in the drawings in diagrammatic form. It can be altered to suit the magneto you use.

Also the bracket I show is made to fit the type of magneto we used. We found that the reliability of the magneto and the extra weight saved, together with the added ease in starting, was well worth the extra cost involved in getting a war surplus magneto and fitting it on. There is a snap to that old magneto spark that gives the motor extra heart when you have about five thousand feet of alty and the road gets bumpy.

You will note that a light water outlet to the radiator is to be made. This can be made out of light sheet metal of about 20 gauge and should have an uptake long enough to allow a good hose clamp connection to be made.

With the oil system changed according to the drawings, which is an absurdly simple operation when you come to look at a Ford motor and realize how close it already is to being an airplane power plant, and with the magneto and the water and carburetor alterations made, there is very little left to do to make the motor a complete airplane plant except the fitting of stacks and the fitting of controls.

The end plates for the crankshaft and for the cam gears are very simple and are shown in complete detail. They are cut out of 16 or 18 gauge plates and their cutting and fabricating can be done from cardboard patterns made direct from the motor. The method of making the cup for the oil ring previously mentioned can plainly be seen also.

The method of making the tachometer fitting and putting it to the end of the camshaft is simple. A 3/8" hole is drilled in the center of the camshaft and the 5/32" center-drilled rod for the tach drive end is fitted in.

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This Photo Was Snapped From the Hangar Roof, Giving a Top View

The pilot on the ground alongside the ship is a six-footer, which gives a good idea of the relative size of the plane. The photo was snapped from the roof of an airport hangar.

The dimensions for the exhaust stacks are shown in the drawing. They are made of 20 gauge tube and have tabs welded on them to keep them in place under the hold-down bolts.

Dimensions for the hub plates of 12 gauge cold rolled steel are shown in full.

The oil intake pipe on the base will have to have a slight bend made in it to allow the water pipe to pass.

The radiator is a half section of a war surplus MF flying boat radiator. I can supply you with these if you cannot get them from any local supply house.

There is also being run with this article the full size cross sectional view of the Ford motor as it is used in an automobile. The parts used in the car are left in the drawing, with the exception of the magneto mounting, and the prop is shown in phantom drawing to prove to you how very little needs to be done to the Ford motor to make it an airplane engine. By comparing this drawing with the other two full page illustrations, you will be able to see what little difference there is between this engine and the so called converted one, which really is not converted at all—just "adapted."

I also append the power chart for the motor, which will show you airplane design fans what you can expect from the motor if you use it as I have here. If you want to design your own ship this curve will show you what power you can expect and what the revs will have to be. Note that at 1,600 revs there is plenty of "soup" left in the old gal yet. And there will have been very little falling off in torque at these r.p.m.'s. That is why I chose 1,600 as being the best revs to run the motor at.

In use, treat the engine like you would any other airplane engine. Don't take off with a cold motor, and watch your mixture and your <i>e.g.</i> temperatures very closely. A remote temperature gauge should be used and the motor ought to be run between 140 and 160 degrees Fahrenheit.

And that just about covers all that need be said about the Pietenpol Motor Conversion, simple as it is.

You'll find the engine simple and dependable—one easy to repair, and capable of carrying you and your crate thousands of miles.
Oiling System of Model A Motor Must be Changed for Use on Airplane

**Diagram of Oiling System**

- **Pressure Feed to Center Bearing**
- **Details of Oiling System**
- **Copper Tube Inserted Loose in Oil-Pump Outlet**
- **Diagram of Oiling System to Front and Center Main Bearings**
- **Crankshaft Bushing**
- **Pressure Feed Pipe from Oil Pump**
- **Pipe Nipples Brazed to Inside of Crank-Case Wall**
- **Flying Soldered to Shaft**
- **Threaded End of Model T**
- **Details of Universal Joint Mag. Coupling**

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