Differences Between the Thomas Morse S-4B and S-4C: Lessons and Questions From an Ongoing Restoration (Part 1)

Jim Rundle and Don Funke
www.tommycomehome.org

Three years ago, the members of the Ithaca Aviation Heritage Foundation (IAHF), in Ithaca, NY, had their dream come true when a generous donor gave the organization an original Thomas-Morse Scout. The machine is one of the few remaining examples of the “Tommy,” an advanced trainer that served during the last year of World War I on nearly every training base in the country. Our aeroplane, like all of the Tommies, was built here in Ithaca in 1918.

Thomas-Morse aircraft have special significance for us in Ithaca. Nearly all the company’s original buildings, such as the one seen above, still stand as reminders of their colorful history. IAHF volunteers have even been privileged to conduct some of our restoration work in the woodworking shop of the same South Hill plant where most of the production work was originally done on the Scouts, using 100 year old machine tools that were in use at the time. Because of its importance to the whole community, our organization is determined to restore this aircraft as closely as possible to its original configuration, just as it was when it left the South Hill
plant almost 100 years ago. We expect it to be flown, and then to become a permanent exhibit in Ithaca.

The example we received had the appearance of an S-4C model, the second and most common model of the Tommy, but we soon realized that the aircraft had an S-4B fuselage onto which C wings and elevators had been substituted for the original surfaces. The conversion had not been thorough; it had been displayed as a C, but almost certainly not flown that way.

Our Tommy on display at the Hangar Theater in Ithaca, NY, showing off a brand new lower wing. The restoration group has completed a full set of new wings, except for the ailerons. Note the straight trailing edge of the aileron, something we now plan to change. Also note the rearward slant of the cabane struts (see text).

Photo: Authors

We were excited to discover that our aircraft was a B model, not only because it is rare, but because it means that our Tommy was part of the very first army order received by the Thomas-Morse Corporation, an order that put Ithaca on the map as a manufacturer of aircraft. We decided to restore it to its original S-4B configuration. In the process, we have learned a lot about the S-4B that, to our knowledge, has not appeared in print. We hope to shed some light on this little-known aircraft, as well as stimulate other knowledgeable people to contribute information.

Since our aircraft does not have original S-4B wings or elevators, we have to build reproductions. The Old Rhinebeck Aerodrome has generously allowed us to examine, measure and photograph their original B Scout. Most of it is covered in fabric, so we have had to infer many of the internal parts from the external configuration. The exception is that the port side of the Rhinebeck Scout is uncovered, which gave us valuable information about the cockpit controls. Inside the wing, however, the cable and pulley mechanism is mostly hidden; likewise we cannot examine the structures for the ailerons and elevators. Unfortunately, we have not found any documentation for the S-4B except for old photographs, which do not show these important details. If any of our readers have photos of a B restoration, drawings, or any other information that could give us guidance, we would deeply appreciate hearing from you.

Origin of the B Model Tommy Scout

The S-4B Scout was the first advanced trainer ordered and received by the U.S. Army. Along with its successor, the S-4C, it gave cadets graduating from dual instruction on Jennies a chance to practice aerobatics in a single-seat aeroplane that was much more maneuverable and much more like the European aircraft that many of them would be expected to fly. The practice in Europe was to use obsolete fighters in this role, but the U.S. had no fighters, so no advanced trainers existed when we entered World War I in April, 1917.

Fortuitously, the Thomas Aeroplane Company had developed a design for a small single-seat scout, the S-4, in 1916, that was capable of meeting this new need. The small company had very little construction capacity, but the growing likelihood of war contracts for aircraft led the Morse Chain Corporation, also in Ithaca, to propose a merger, which happened in January, 1917. The S-4 design still existed only on paper, and the United States was not yet involved in the war in Europe, but Thomas-Morse quickly built a prototype from this design, and also built a giant addition to its factory.

Once the U.S. joined the war, things happened fast. In June, the company shipped the S-4 prototype to the army’s testing field at Hampton, Virginia. Just two months later, details for a modified production model, later designated the S-4B, were in place (letter from Thomas-Morse to U.S. Army, published in Profile Publications No. 68 by Frank Strnad). On October 3, 1917, the army ordered 100 of them.

A Thomas-Morse S-4 prototype, possibly at Hampton, Virginia, c. June 1917. Note seam on cowl passing through the exhaust port.  
Photo: Aerofiles
Overview of Differences Between the B and C Models

After the S-4B went into service, the army requested modifications that resulted in the more familiar C model. The most obvious changes were to the shapes and areas of the ailerons and elevators. The S-4B had large, distinctively curved ailerons and elevators, whereas the C Scouts had straight trailing edges on these surfaces, resulting in a significantly reduced total area. A closer look shows an important change in how the ailerons were actuated. The B model used cables for aileron control, whereas the C model used torque tubes in the manner of Nieuport scouts. The original aileron control cables of the B model had caused problems from expansion and contraction when the Scouts were sent out to training bases, so the army had a Nieuport 17 sent from France to the Thomas-Morse plant to serve as a model for the S-4C’s new aileron mechanism.

The B Scout was powered by a 100 hp Gnome rotary engine built under license by General Vehicle Company in Long Island City, NY. In Profile Publications No. 68, Strnad notes that the C model was designed to use the Le Rhône 80 hp rotary engine, built under license by the Union Switch and Signal Company in Swissvale, Pennsylvania, in place of the troublesome Gnome, but the first 50 C models were delivered before the Le Rhône became available. He also writes that the C Scouts were equipped with a machine gun mount, while the B Scouts were not. Original photos are consistent with this, and our own B Scout has no gun mount.

The Le Rhône engine was lighter than the Gnome, so when it was substituted the top wing was moved back three inches to compensate. This modification is visible in side views of the B and C models. On the B Scout the cabane struts, when viewed from the side, are at right angles to the top longeron, but on the Le Rhône C Scout they are raked to the rear. To achieve this, the cabane struts of the Le Rhône C Scout were made longer and...
the interplane struts were made shorter. After the war many B Scouts were adapted to take the Le Rhône, including our machine and the Rhinebeck Scout. These aircraft also had their top wings moved back and the struts adjusted to suit. The photo on the previous page showing our Tommy at the Hangar Theater clearly shows the rearward slant. We observed the same modification on the Rhinebeck Scout.

In the process of restoration we have also discovered many less obvious differences that we will describe. We will also describe our proposed mechanisms for actuating the controls that we intend to build next year (unless we obtain documentation on the original parts before then).

**B Scouts Today**

The Tommy Scouts that survive today in museums and private collections are mostly the later S-4C Scouts, of which about 500 were built during the war. In contrast, the Thomas-Morse S-4B is a rare bird. The only completely original B Scout airframe today is the one currently displayed at the Old Rhinebeck Aerodrome in Rhinebeck, New York (however it has a Le Rhône engine substituted for the original Gnome, and the necessary strut changes). The National Museum of the Marine Corps in Quantico, Virginia, displays a Scout restored by Century Aviation that has original B wings combined with a reproduction of a B fuselage made using parts from the prototype S-4. The aircraft is displayed to represent the B Scouts used by the Marine Corps during World War I at their flying school near Miami, Florida.

Our own aircraft has a B fuselage, but the top wing and the empennage are from a C, while the bottom wing and cowl are most likely from the prototype. This would mean that both our aircraft and the Quantico machine have parts from the prototype. We think this is true, and further, that our B fuselage and the B wings on the Quantico machine came from the same aeroplane, and that our wings and cowl once flew on the prototype fuselage!

The evidence for this comes from several sources. Our cowl is a unique two-piece cowl with a seam running through the exhaust port - this same seam is visible in old photos of the prototype. We have never found another Scout with this type of cowl. All S-4B cowls we have seen have a seam behind the exhaust port, and the exhaust port itself is larger. In addition, all S-4C cowls are single-piece with no seam. As for the wings, a photograph in Profile Publications No. 68 is identified as the prototype, which was modified in Tampa, Florida, by substituting C wings. We know that this aircraft and our B Scout were together with the same owner in Minnesota after that photo was taken, and both were later donated to the Aeroflex Museum. Therefore, the opportunity for the exchange of parts existed for many years, during which time the aircraft were taken apart, shipped, stored and reassembled. In addition, the lower wings of our aircraft were constructed very crudely, consistent with a rush to complete a prototype, and very different from all that we have seen in production machines. We also know that the army criticized the workmanship of the prototype, forcing the company to issue a response proposing modifications for a production model and assurance that workmanship would be improved.
Wing Mounts, Fuselage Cross Members, and Attachment of Flying Wires

The B Scout has an unusual attachment for the flying wires. On the C model, the turnbuckles mount to brackets protruding from the fuselage. On the B models, however, the flying wires are threaded through guide tubes that are part of the brackets to the center of the fuselage, and the turnbuckles are attached to the center of tubular steel crosspieces. The forward flying wires attach to a crosspiece just below the motor mount, while the rear flying wires attach at the forward wing mount to a crosspiece reinforced with triangulated diagonal steel tubing. At the rear wing mount, the same kind of steel, reinforced cross brace is present, but no turnbuckles are attached.

On the C model there is a spruce cross brace with a metal brace below for the wing mounts. On both the B and C models, the flying wires attach at the firewall and at the front lower wing mount. It is only the method of attachment that differs, not the position of the attachment.

On both B and C Scouts, the rear wing brackets include a drilled flange for mounting floats, but only the B Scouts ever used them. The U.S. Navy purchased six S-4B Scouts with floats which were designated as the Thomas-Morse S-5. The National Naval Aviation Museum in Pensacola, Florida displays an S-4C with floats, but there is no record that any C models were ever equipped with them.

We also found that the longerons on the B model were routed to an I-beam section, but on the C model the longerons are not routed.
Above: Our S-4B showing the lower rear wing mount. No flying wires attach at this point, but it is braced with diagonal tubing just like the forward mount. A drilled flange on the bracket was used for mounting floats. Below: Allen Johnson’s S-4C (in Texas) showing where the turnbuckles for the rear flying wires attached externally at the lower forward wing mount. The metal cross brace for the wing mount is not triangulated with diagonal braces. Instead, a parallel spruce crosspiece braces the longerons in the same manner used at other stations on the fuselage. The front of the fuselage is toward the left of the picture. Note that the longeron is not routed.

Photos: Authors
Above: The motor mount and forward lower wing mount of our S-4B showing the guide tubes for the forward flying wires and the internal attachment of the turnbuckles.

Photo: Charles Harrington

Above: An S-4C Scout showing the turnbuckles mounted outside the fuselage. This particular machine formerly belonged to Ed “Skeeter” Carlson of Spokane, Washington, and is now based at Eaglesmere, Pennsylvania.

Photo: Authors

Aileron Actuation and Wing Details

The aileron cables are moved by a control horn fitted to the front end of a longitudinal torque tube to which the control stick is attached. The aileron cables exit the cowlings through two indentations in front of the forward cabane struts. The cables rise along the leading edge of the forward cabanes and enter the wing just ahead of the forward spar. On the Rhinebeck B Scout, the pulleys are just inside large, round, reinforced inspection holes and are clearly visible. They appear identical to the pulleys used on the stick for the elevator cables (on the Quantico B Scout, the holes in the wing for the cables appear to be narrow slots).

We do not have access to the exposed wing structure of any original B Scout, so the exact arrangement of the
pulleys that turn the cable back toward the aileron horns is not known to us. Clearly there is a set of two pulleys in each outer wing half - an upper pulley for the cable that is moved directly by the crank and attaches to the top side aileron horn, and another below it for the return cable that extends across both wing halves and connects the lower horns of both ailerons so that they move up and down in opposition. By feeling the bottom wing covering on the Rhinebeck Scout, we were able to locate the axle of one of the pulleys using light finger pressure.

From this we have inferred the likely configuration of the pulley mechanism inside the wing. One of our volunteers, David Waterman, a professional designer and engineer, has created drawings of the pieces we intend to fabricate in order to mount the pulleys in the wing. Of course, we would prefer to have drawings of the actual part and the arrangement, or any photos of the area without the covering that might have been taken during a restoration. Unfortunately, neither has surfaced as of this writing.
Above: The aileron cable entering starboard wing to a pulley. The cable shown gives “up” aileron on the starboard wing.

Above Left: Our current plan for the inboard pulley, showing a cable that is attached to the starboard end of the control horn under the cowl. The other cable is connected to both lower aileron horns. Above Right: Our current plan for the outboard pulleys, showing guide tubes through the wing spar directing the cables to the upper and lower aileron horns. The actual design on the S-4B is not known to us, but we believe it must be very close to this.
Coming up in Part Two

In the next piece we will discuss differences in the actuation of the elevators, including photos of the unusual pulley system used. We will also show the differences in the tail skid area, the rudder bar and other details. Finally, we will explain what we have learned about the interesting provenance of our Tommy.

Can You Help Us Complete This Project?

Please visit our web site at www.tommycomehome.org to learn more about this project. Please note that some of the items we are looking for are located under the "Wanted" tab. Any help locating these parts would be greatly appreciated. In addition, we are seeking monetary or parts donations. The Ithaca Aviation Heritage Foundation, Inc. is a not-for-profit corporation which has 501(c)(3) status. Your donation to IAHF will be tax deductible in accordance with the IRS Code. Donations can be mailed to IAHF, c/o Randy Marcus, 119 East Seneca Street, Ithaca, NY 14850, or can be made online at IAHFs website.
World War I Aeroplanes, Inc.

P.O. Box 730
Red Hook, NY 12571
USA

(845) 835-8121   ww1aero@gmail.com

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