A MULTIPLE RUBBER BAND MOTOR FOR MODEL AIRPLANES!

15¢

MODEL AIRPLANE NEWS

AND JUNIOR MECHANICS

Automatic Switch for Flying Models

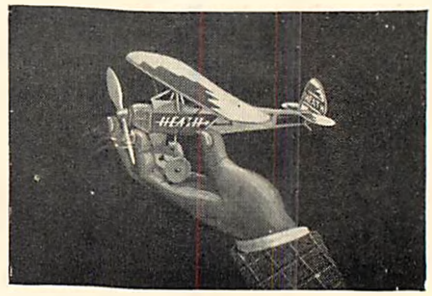
Tractor Model Plans

JUNE, 1931

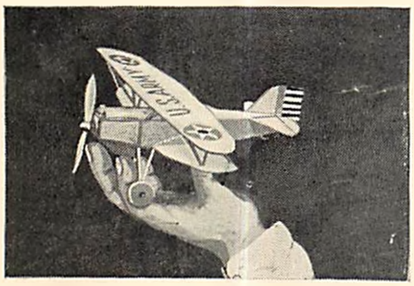
Rickenbacker's Famous "Hat-in-the-Ring" Spad Squadron on Patrol Over Cantigny

Model Engineers!

The Midgets *are* Here!



Midget Heath Parasol.
12″ Wingspread. Tissue supplied in Beautiful Green.

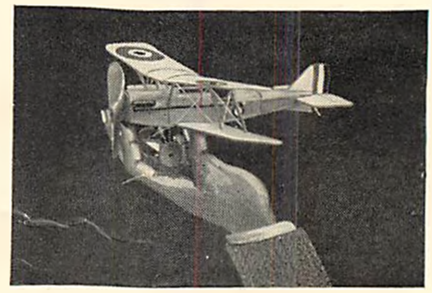


Midget Curtiss Army Hawk 12 inch Wingspread. Note markings, supplied with kit. Tissue for coverings sent in standard Army Colors.

JOIN US

in the Latest Sport

Build and Fly Midget Scale Model Airplanes. National offers you the latest in the Art of Model Airplane Building. Own a squadron of Midget planes. Any Midget Construction Kit only $1.10 postpaid.



Midget S.E. 5.
12″ Wingspread. Tissue supplied in British Army Colors.

The Midgets Fly Beautifully.
Are Easy to Build.
Very Light in Weight.
Do Not Crack Up Easily.
Hundreds of Flights are possible.
Construction Kits contain Best Materials.
Ready made fittings, full size plans, etc.
Each Model Beautifully Colored.
Genuine Japanese Tissue is supplied in all necessary colors.

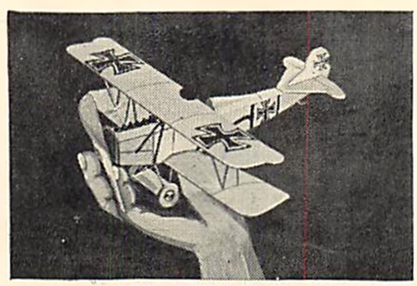
All Details of the Real Plane accurately reproduced. Looks and flies like the Big Airplane from which it is copied. Note markings on S.E. 5, also Cylinder heads, and exhaust pipe.

All other Midgets are equally accurate and complete. Examine each model pictured and find them for yourself.

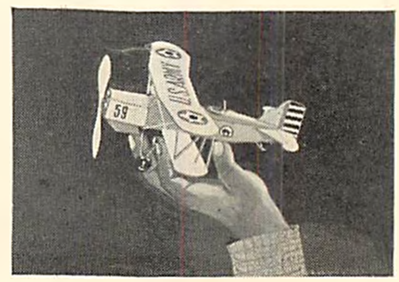
BEST OF ALL: Midgets are very low in price. Every Boy can afford one or more.

Only $1.10 for any Midget Construction Kit. Sent postpaid. Only $4.00 for any Midget, sent postpaid Ready to Fly.

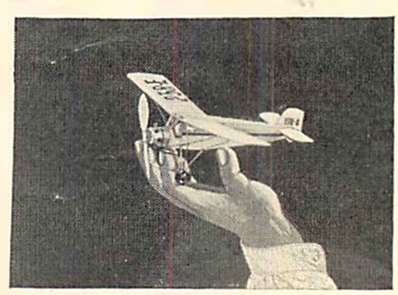
National Midget Models Will Do What We Claim!



Midget Fokker D-7.
12″ Wingspread.
Tissue in Red and Black.
Markings supplied in kit.



Midget Curtiss Falcon.
12″ Wingspread. Tissue supplied in Standard Army Colors.



Midget Curtiss Robin.
12″ Wingspread. Tissue supplied in yellow and orange with markings.

Travel Air Mystery Ship

(Photograph of model built from National Kit)

2 ft. Flying Model of Capt. Hawks' famous Coast to Coast Record holding Ship. Complete construction kit contains all necessary material, Cowling made, Celluloid pants, Blueprint included. Kit Postpaid only **$3.50.**

WANTED

MODEL AIR PLANE BUILDERS

We offer to Boys and Men everywhere who like to build model airplanes an exceptional opportunity to cash in on their experience. For particulars write

National Model Airplane & Supply Co.
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Just Out! Brand new 36 page illustrated catalogue. Lists all National Model construction sets and a complete line of supplies. Shows many new parts for building model airplanes which have never been offered before. 5c.

We supply schools, clubs, Y.M.C.A.'s, etc. No C.O.D. All goods sent with money back guarantee. On all orders for less than $1.00 add 15 per cent for packing. Orders $1.00 or more add 10 per cent.

We want one dealer or agent in every town to handle National Model Airplane Sets and Supplies. Because of their proven quality, a National model dealer with sets and parts to suply immediate wants can make big money. Write for full details.

National Model Aircraft & Supply Co.

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3 HOUR SUPPLY SERVICE

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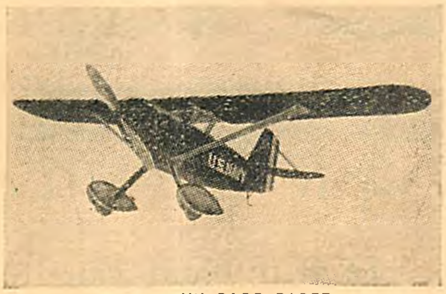


U. S. NAVY PAGE RACER
28" Wing Spread.
A Real Racing Type of Ship used by the U. S. Navy.
Contents of Kit: Celluloid wheels, true pitch propeller block, tissue, large tube cement and large can of dope. All wood parts cut to dimensions. Rubber motor, full-size plan. Wire parts bent and formed.
Postpaid $2.50

36" strips		
1/16 x 1/16	.01	6 for .05
1/16 x 3/32	.01	6 for .05
1/16 x 1/8	.01	6 for .05
1/16 x 3/16	.01	6 for .05
1/16 x 1/4	.01	6 for .05
1/16 x 3/8	.02	6 for .10
1/16 x 1/2	.02½	7 for .15
1/16 x 3/4	.03	8 for .20
1/16 x 1	.03	8 for .20
3/32 x 3/32	.01	6 for .05
3/32 x 1/8	.01	6 for .05
3/32 x 1/4	.02	6 for .10
3/32 x 1	.03	8 for .20
1/8 x 1/8	.01	6 for .05
1/8 x 5/32	.01	6 for .05
1/8 x 3/16	.01	6 for .05
1/8 x 1/4	.01	6 for .05
1/8 x 5/16	.02	6 for .10
1/8 x 3/8	.02	6 for .10
1/8 x 1/2	.02	6 for .10
1/8 x 3/4	.03	8 for .20
1/8 x 1	.03½	8 for .25
1/8 x 1 1/2	.03½	8 for .25
1/8 x 1 1/4	.03½	8 for .25
1/8 x 1 3/4	.04	4 for .15
5/32 x 5/32	.02	6 for .10
3/16 x 3/16	.01½	11 for .15
3/16 x 1/4	.02	6 for .10
3/16 x 5/16	.02	6 for .10
3/16 x 3/8	.02	6 for .10
3/16 x 7/16	.03	8 for .20
3/16 x 1/2	.03	8 for .20
3/16 x 3/4	.04	4 for .15
3/16 x 1	.04½	5 for .20
1/4 x 3/16	.03	8 for .20
1/4 x 1/4	.01	6 for .05
1/4 x 5/16	.03	8 for .20
1/4 x 3/8	.03	8 for .20
1/4 x 1/2	.03½	8 for. 25
1/4 x 3/4	.04½	5 for .20
1/4 x 1	.05	6 for .25
5/16 x 5/16	.03½	8 for .25
3/8 x 3/8	.05	6 for .25
3/8 x 7/16	.05	6 for .25
3/8 x 1/2	.05	6 for .25
3/8 x 3/4	.06½	5 for .30
3/8 x 1	.08	4 for .30
7/16 x 7/16	.06½	5 for .30
3/8 x 1	.08	4 for .30
1/2 x 1/2	.07	3 for .20
1/2 x 5/8	.10	3 for .25
1/2 x 3/8	.10	3 for .25
1/2 x 3/4	.10	3 for .25
1/2 x 1	.09	3 for .25
1 x 1	.17	2 for .30
1 x 1½	.30	4 for 1.00
5/8 x 3/8	.25	5 for 1.00
40" strips		
1/16 x 1/16	.01½	5 for .07
1/8 x 1/8	.02	6 for .10
1/8 x 3/8	.03	8 for .20
1/8 x 1/2	.03	8 for .20
1/8 x 3/4	.04	4 for .15
1/8 x 1	.05	6 for .25
3/16 x 3/8	.03	8 for .20
3/16 x 1/2	.04	4 for .15
1/4 x 1/4	.04	4 for .15
3/16 x 1/2	.04	4 for .15
1/4 x 1/4	.04	4 for .15
1/2 x 1/2	.09	3 for .25

SHEET BALSA

36" lengths

1/32 x 2	.05	3/32 x 2	.06½
1/32 x 3	.07½	3/32 x 3	.09½
1/20 x 2	.06	3/32 x 6	.19
1/20 x 3	.09	1/8 x 2	.07
1/16 x 2	.06	1/8 x 3	.10½
1/16 x 3	.09	1/8 x 6	.20
1/16 x 6	.12	3/16 x 2	.09

AIRSEAL BALSA

Scientific Balsa Wood is the lightest and best Balsa grown and is imported from South America. Model aeroplane experts at every corner of the globe have used our balsa for both their flying and scale models. Scientific Balsa Wood is Kiln Dried-strait grained stock, especially prepared and cut to convenient usable sizes.

3/16 x 3	.13½	1/4 x 6	.28
3/16 x 6	.25	3/8 x 2	.15
1/4 x 3	.15	3/8 x 3	.21
1/4 x 2	.10		

PROPELLER BLOCKS

⅜ x ½ x 5	.01	¾ x 1⅛ x 8	.05
⅜ x ¾ x 6	.01½	¾ x 1⅛ x 10	.04
⅝ x ¾ x 7½	.02	¾ x 1⅛ x 11	.05
¾ x ¾ x 7½	.02	⅞ x 1½ x 11	.06
½ x ⅝ x 6	.01½	⅝ x 1¼ x 12	.06
½ x ¾ x 5	.02	¾ x 1½ x 12	.07
½ x ¾ x 6	.02	1 x 1⅜ x 12	.08
⅝ x 1 x 7	.02	1 x 1½ x 13	.09
⅝ x 1 x 8	.02½	⅞ x 1½ x 14	.09
⅞ x 9/8 x 10	.03	⅝ x 1⅜ x 16	.12

PLANK BALSA

36" lengths

1 x 1½	.22	2 x 3	.60
1 x 2	.27	2 x 6	.90
1 x 3	.35	3 x 3	1.15
1 x 6	.60	3 x 6	2.20

BAMBOO

Strait-grained no-knot bamboo.
1/16 x ¼ x 15 .... .01
Per dozen .... .09

JAPANESE SUPER FINE TISSUE

A strong light tissue for covering your commercial models.
Large sheet—2 for .... .05
Per dozen .... .25

EXTRA SUPER FINE TISSUE

Absolutely the finest, lightest and most economical tissue for covering experts endurance models.
Per sheet .... .05
Per dozen .... .50

CLEAR DOPE

This is genuine model aeroplane experts dope thinned down to meet the requirements of model airplane usage.
2 oz. bt. .... .10
Per pt. .... .75

COLORED DOPE

Real pigmented aircraft dope. Do not confuse this with dopes of inferior quality. Colors: International Orange, Galatea Orange, Fokker Red, Spartan Green, Silver, Loening Yellow, Curtiss Blue, Black, White.

SCIENTIFIC DOPE THINNER

2 oz. .... .08
pt. .... .60

ACETONE

To thin out your heavier liquids.
2 oz. .... .08
pt. .... .60

AMBROID

Genuine Ambroid manufactured by the world's largest makers of ambroid. Used exclusively by the best model builders.
2 oz. .... .15

COLORLESS CEMENT

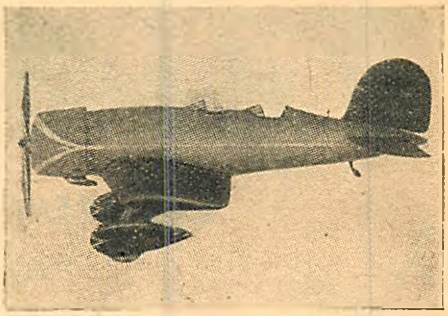
At last colorless cement that is all it should be. Used by experts at Detroit.
2 oz. .... .15

CELLULOID WHEELS

Lightest and strongest wheels for model aeroplanes, bushings included.
1⅜ diam. pr. .... .10
1⅞ diam. pr. .... .15
3 diam. pr. .... .30

ALUMINUM TUBING

⅛ outside diam. per ft. .... .07
3/16 outside diam. per ft. .... .10
¼ outside diam. per ft. .... .12
Washers ⅛ for light indoor models
per doz. .... .01½—per gross .... .15
Washers ¼ for outdoor models
per doz. .... .01½—per gross .... .15



LOCKHEED SIRIUS—CONSTRUCTION KIT
18" Wing Spread.
Contents of Kit: All wood parts cut to size. All wire parts formed. Tube of cement, rubber motor, true pitch propeller block, tissue, and full size plan.
Packed in an attractive box.
Postpaid $1.00

SHEET ALUMINUM

12" wide .005 per ft. .... .13
.010 per ft. .... .20

THRUST BEARINGS

Very light.
Large size .035 hole each .... .02—per doz. .... .20
Small size .025 hole each .... .02—per doz. .... .20

SCIENTIFIC "EXPERT" RUBBER

Scientifically prepared by the world's largest manufacturer of model aeroplane rubber.
Four sizes.

.045 sq.	4 ft. for .01	225 ft. skeins	.50
3/32 flat	3 ft. for .01	225 ft. skeins	.70
1.8 flat	3 ft. for .01	225 ft. skeins	.70
3.16 flat	2 ft. for .01	225 ft. skeins	1.00

DUMMY RADIAL ENGINES

9 cylinder dummy whirlwind motors made of celluloid 3" in diam. and very light each .... .33

MUSIC WIRE

Strong, light, used by every model builder.
Sizes: .014, .020, .028, .034; 3 ft. per .01.

We carry a full line of plans for model aeroplanes. 10c each; 3 for 25c.

Fokker Amphibian, Lockheed Vega, S.E. 5 British Pursuit Plane, Stinson City of Chicago. Many more are to be added to this list.

We also have the complete line of A.M.L.A. Scale Model plans. Each drawing is approximately 34"x44".

Boeing P-12 Pursuit	.20	Stinson Lycoming	.20
Vought Corsair	.20	Waco Taper Wing	.20
Fokker F-10	.20	Lockheed Sirius	.20
Lockheed Vega	.20		

PLANE COMPANIES

Order your kits direct from us and receive them quicker. All kits are sent postpaid.

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Streamline Pants takes any wheel from 1" to 1⅞" diam. In perfect proportion with our N.A.C.A. cowlings. Price pr. $ .30.

N.A.C.A. Cowlings (black celluloid), each 23c

Featherweight Compressed Air Motors

Finished tank 3"x3"x20" with 3 cylinder motor mounted. Tested ready for use
$6.98 complete America's lowest price.

Tanks for all model airplanes. 3x3x20" price, $4.00; 3x3x24", $4.50; 3x3x30", $5.00.

Finished motors (endorsed by Air Commerce Reserve). Ready to run ⅝" bore, weight 2 oz. All motors are given a thorough test. Makes 7,000 revolutions per minute. Complete ready to be attached to tank $3.25.

America's lowest price for a knockdown motor kit, all parts are ready to be assembled. They are drilled, formed and shaped to correct size. 1 set complete $.99.

IMPORTANT, ORDERING INSTRUCTIONS

Orders will absolutely not be filled unless you comply with instructions below.

1—Orders under $.25 will not be accepted.
2—Add $.15 for packing and postage on orders up to $1.50.
On orders of $1.51 and over add 10 per cent for packing and postage charges.
3—Add 10c extra to above charges on balsa blank orders less than $1.50 west of the Mississippi and Canada.
3—Postage stamps, Canadian or Foreign Coin not accepted as payment.
5—Remit by check, postal or express money order. Make payment to Scientific Model Airplane Co., 224-226 Bergen Street, Newark, N. J.
6—Each and every article purchased from us is guaranteed to be of the highest standard.
7—All orders will be shipped 3 hours after receiving them.
8—Orders amounting to $1.00 and over are sent postpaid.

Send 2c stamp for latest summer catalog containing world's lowest model aeroplane prices.

SCIENTIFIC MODEL AIRPLANE CO., 224-226 Bergen St., Newark, N.J.

DEALERS AND CLUBS WRITE FOR SPECIAL PRICE LIST.

Model Airplane News

AND JUNIOR MECHANICS

Vol. IV No. 6

Published by Harold Hersey

Edited by Capt. H. J. Loftus-Price

CONTENTS

JUNE, 1931

In Our Next Issue

Without going into details, these are some of the things in our next issue:

A startling tandem endurance model—full-size plans.

An Airistocrat flying model—full-size plans.

Chapter 2 of our engine course.

Chapter 2 of our radio course.

and

Plans for a miniature compression motor.

Where in the world could you get anything to equal the above list for 15c.? And that isn't all. Other things in the July issue will surprise you.

Another wartime cover by Ray Wardel for your picture gallery.

Be sure to order your July MODEL AIRPLANE NEWS now. On all news stands June 23 next and only 15c. a copy.

New Address

Please note that the editorial offices of MODEL AIRPLANE NEWS are now located at 570 Seventh Ave., Room 1901, New York City. Advertising offices at the same address in Room 1205. Telephone LAckawanna 4-0783.

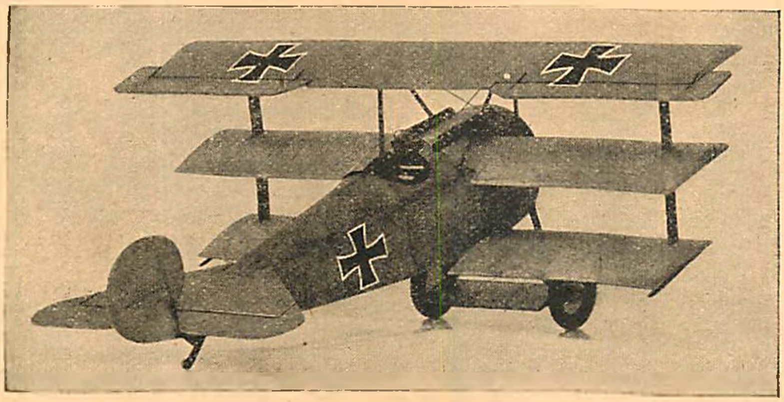
Published Monthly by GOOD STORY MAGAZINE COMPANY, INC., Myrick Bldg., Springfield, Mass
Editorial and General Offices, 25 West 43rd Street, New York City
Harold Hersey, President Pauline Sandberg, Treasurer Frank Moran, Secretary
J. W. LeBaron, Advertising Manager, Graybar Building, 420 Lexington Ave., New York, N. Y.
Entered as second-class matter June 5, 1929, at the Post Office at Springfield, Mass., under the Act of March, 3, 1879.

Price 15c a copy in U. S. and in Canada. Subscription price $1.50 a year in the United States and its possessions; also Canada, Cuba, Mexico and Panama.
All other countries $2.00 per year.

Chicago Advertising Office: 333 North Michigan Ave., C. H. Shattuck, Manager.
London Agents: Atlas Publishing & Distributing Co., Ltd., 18 Bride Lane, London, E. C.

Another Cleveland Achievement! A Complete kit of the remarkable plane piloted by

"The Red Knight of Germany"



Again Cleveland's pace-setting genius in creating authentic flying models of the hard-to-get famous planes brings model enthusiasts another opportunity—to be first—to become more skilful model builders—to have something real to show for time and effort used.

BARON MANFRED VON RICHTHOFEN'S OWN

FOKKER TRIPLANE

An unusually beautiful model of the plane most feared by Allied pilots—feared, for at its controls sat Germany's most audacious airman—the idol of his nation. This Cleveland-Designed ¾" scale brilliant all-red Triplane with its 17¾" span, 14⅛" length, and 6⅞" height, is colored just like its famous prototype with a few black details which deftly set it off. It has twin Spandau guns, movable ailerons, a complicated fuselage design which we have simplified (even a beginner can make it), all the necessary Maltese Crosses, Redicut ribs, and propeller blades, all the cut "Blue Diamond" balsa wood, rubber, paper, colored dopes, cements, etc.—to say nothing of the full-size, completely detailed drawings and instructions. Order Kit CB-6 only $4. postfree. (Foreign orders, 25c. extra.)

Head Your War Line with COL. E. V. "EDDIE" RICKENBACKER'S SPAD XIII

NIEUPORT SCOUT

(French 1917)

Loved and flown by practically all Allied pilots. The clever little Cleveland - Designed model has a span of 20¼" and 13" length; brilliant yellow wings and tail; black fuselage and struts. Completely detailed, machine guns, etc.; full-size drawings, easy-to-understand instructions and everything else needed. Order Kit CB-4, only $4. postfree. (Foreign orders, 25c. extra.)

FOKKER D-7 BIPLANE

(German 1918)

The pride of the German "Flying Circus." Realistically duplicated in Cleveland-Designed 22" span, 16¾" length model. Dark green wings and tail surfaces, orange fuselage and struts. Maltese Crosses, copyrighted full-size detailed drawings, easy-to-understand instructions, and everything needed—included in kit. Order Kit CB-3, only $4. postfree. (Foreign orders, 25c extra.)

COL. RICKENBACKER
AMERICA'S ACE OF ACES

(shown on the cover of this month's issue leading his famous Hat-In-The - Ring Squadron.) Most prized war model of all is this ¾" Cleveland - Designed model of the plane that was conceded to be the ace of the Allies air force. 19¾" span; 15¼" length. Yellow wings and tail surfaces, green fuselage; wing circles, stars for the wheels, and Hat-In-The-Ring insignia. Kit includes Cleveland's copyrighted full-size detailed drawings, easy-to-understand instructions—everything! Order Kit CB-2, only $4. postfree. (Foreign orders, 25c. extra.)

ALBATROSS D-3 (German, 1917)

Nicknamed the German "Spad." The "hell-diver" of its time. This Cleveland-Designed model is beautifully streamlined like the original, with a span of 22", and 18¾" length. Orange wings; light blue fuselage, tail and struts. Complete with full-size drawings, easy-to-understand instructions—and everything! Order Kit CB-5, only $4. postfree. (Foreign orders, 25c extra.)

TWO NEW IMMENSE CLEVELAND ORIGINATIONS

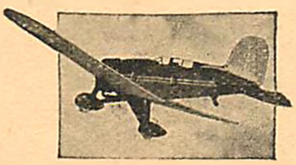
CLEVELAND ROBIN FL-201

A new big outdoor Cleveland-Designed profile fuselage model that can be assembled completely in less than a day. And fly—boy, oh boy! The science embodied in its design assures remarkable flights—so even if you are a beginner, don't be afraid to order this large kit. Very easy to build. Span is 33", length is 20"; has yellow wings and tail, red fuselage and wheel discs, motor cowl, struts, etc., neatly touched up in black. Outrides the wind; easily attains duration of one minute and distance of 500 feet. Complete with copyrighted full-size drawings, and everything needed. Order Kit FL-201 ....

Only $2.20 postfree
(Foreign orders, 25c extra)

CLEVELAND SIRIUS FL-202

Another new Cleveland-Designed profile fuselage model that will be the summer flying sensation. For beauty and fine flying qualities—it's a honey! Takes off and lands as though controlled by a human pilot, and rarely, if ever, noses over. Lands at a good speed, its two wheels rolling on the ground for quite a distance, and the tail skid dees not touch the ground until the model has almost come to a dead stop. Truly graceful! Big 34¾" span, 23" length. Beautifully colored red wings and tail surfaces, everything else black. Exceptional value. Complete with copyrighted full-size drawings, and everything needed. Order Kit FL-202.



Only $2.20 postfree
(Foreign orders, 25c extra)

Be Sure to get your copy of this great
NOTEBOOK—CATALOG

It's the most talked-about book among model enthusiasts. Every aeromodelist should have a copy. Lists 18 other Cleveland-Designed models in colors; and the complete stock of Blue Diamond Engineered supplies. (Inserts for new War Line and later models mailed later to all catalog holders, but keep this page as there will be no sheets for a short time. Send 25c. at once, and we'll rush your copy to you. (No free copies.)

NOTICE: The sale of drawings for all Cleveland-Designed models has been discontinued. All SE (outline) drawings now 10c. each, or $1.00 per doz. (24 kinds.)

"Knew Nobody Else but Cleveland would have anything to offer like this"

Gentlemen:

I saw your April advertisement and the wonderful line of World War time fighting planes you have to offer. I wish to say that the Cleveland line is by far the best line of model planes anyone may want to build. Not only is the construction easy, but after you have the plane built, you know what kind of a plane it is supposed to be. Every thing is carried out in your planes so they look the same as their big brother when they are finished. With the very simplified and easily understood working drawings that come with the kit, it is impossible to make any mistakes in the construction of the model.

When I saw this offer in the magazine I knew right away that nobody else but Cleveland would have anything to offer like this, and for that reason I am writing this letter, and enclosing a money order for the following:

1 kit CB-1 "Boeing Fighter"	$ 4.00
1 kit CB-2 "Rickenbacker's Spad"........	4.00
1 kit CB-3 "Fokker D-7"	4.00
1 kit CB-4 "Nieuport Scout"	4.00
1 kit CB-5 "Albatross D-3"	4.00
	$20.00

Yours truly,

(signed) GEORGE W. DIEFENDERFER'

Fullerton, Penna.

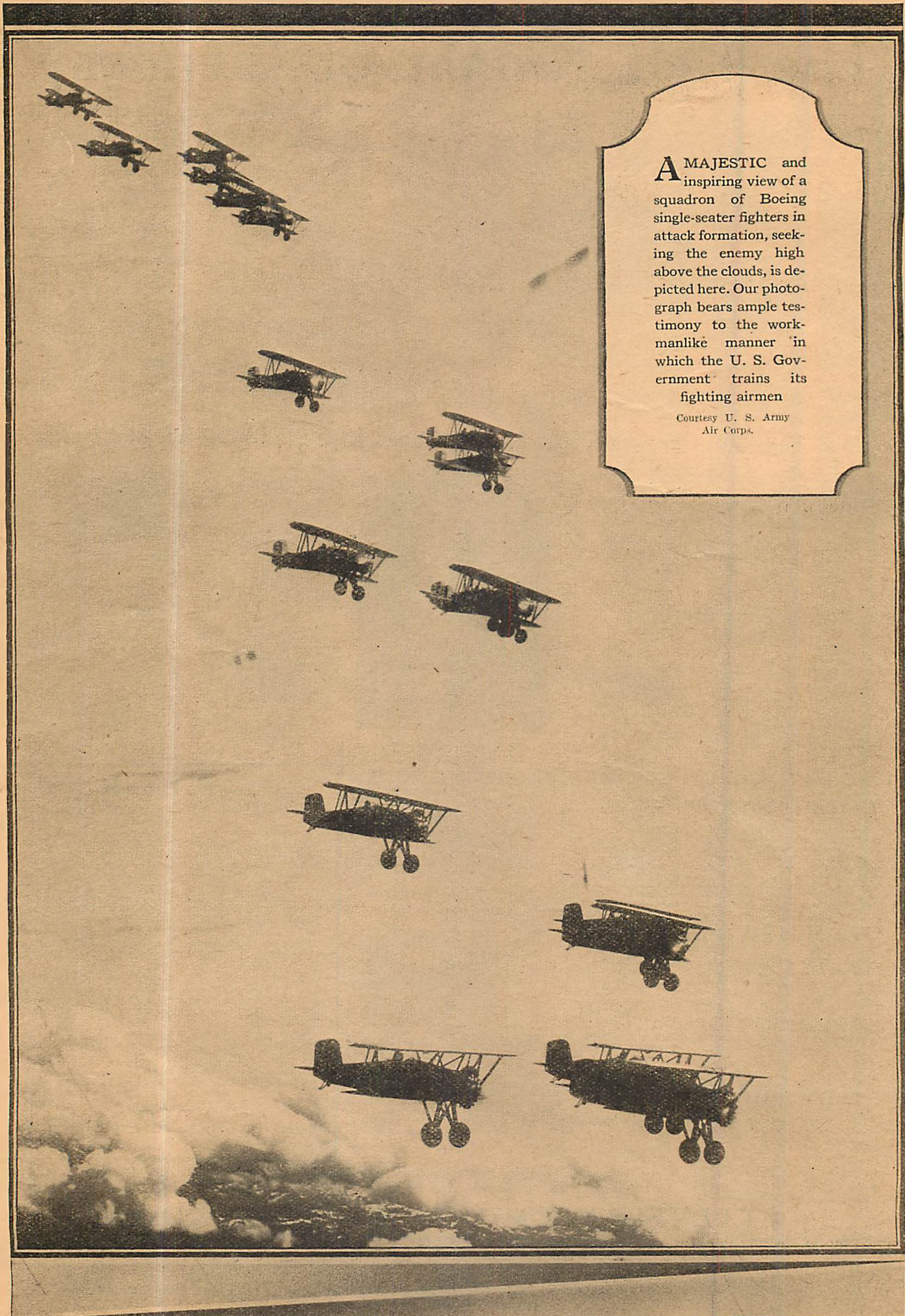
Model Builders: Write and tell us what models you would like to see "Cleveland-Designed"!

Ask Your Leading Store for these and other Cleveland-Designed Models—if they haven't got them, order direct. Ask them if there's an N. A. M. E. Chapter in your town, too.

CLEVELAND MODEL & SUPPLY CO.

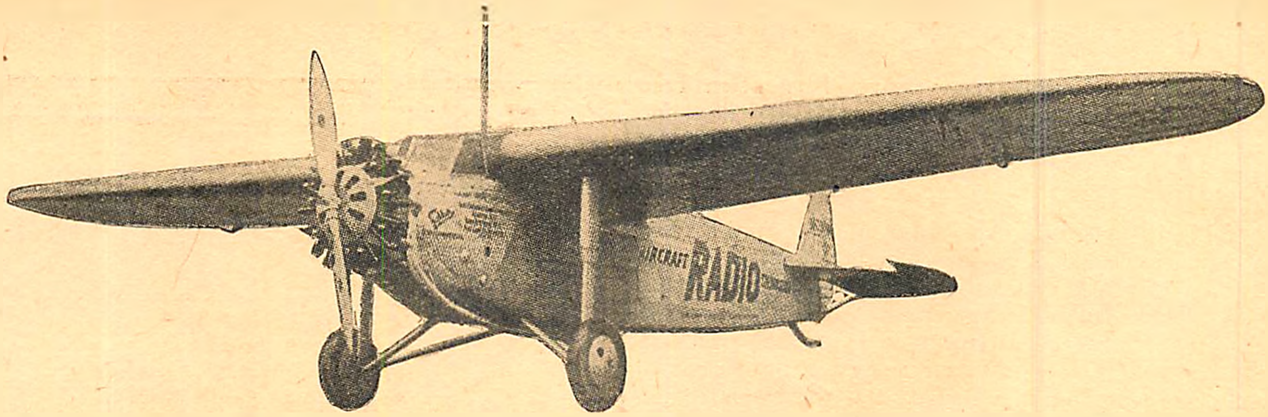
1866N West 57th St. *Model Aircraft Engineers Since* 1919 Cleveland, Ohio, U. S. A.

"Cleveland Blue Diamond" is the symbol of honest quality, reasonable price and immediate service



A MAJESTIC and inspiring view of a squadron of Boeing single-seater fighters in attack formation, seeking the enemy high above the clouds, is depicted here. Our photograph bears ample testimony to the workmanlike manner in which the U. S. Government trains its fighting airmen

Courtesy U. S. Army Air Corps.



Complete Course in Aerial Radio

A Cardinal Point in Progressive Aviation

INTRODUCTION AND GENERAL PRINCIPLES

RADIO, in its present form of perfection, is a comparatively modern invention, but the idea of transmitting signals without connecting wires dates back many years, and several names are connected with the early experiments that were made around the middle of the eighteenth century. Since it would be difficult to say how far the science of radio-telegraphy was advanced by any particular experiment, it would be unfair to lay emphasis on any of the names involved; but the discoveries of Faraday, Loomis and Marconi are too outstanding to be passed over without mention.

In 1831, exactly a hundred years ago, Faraday, an Englishman, discovered that electromagnetic induction existed between two flows of current even when the latter were entirely unconnected. The method of this discovery and its immense importance in the science of electricity and radio will be explained later.

In 1866, Dr. Mahlon Loomis, an American, successfully demonstrated the principles of transmitting signals from an antenna.

In 1897, Marconi demonstrated that he could send signals, without the aid of intermediary wires, a distance of 1¾ miles. The fact that this discovery was regarded as stupendous at the time will make the reader appreciate how far and rapidly this science has advanced to the present day, when the linking up, by radio, of countries at opposite ends of the earth, can be accomplished in a matter of seconds.

In the home, over land, over water and now in the air, radio has spread civilization, increased safety and broadened the scope of international communications to an extent unequalled, probably, by any other single invention. To the person who takes up the study of radio an unlimited field awaits, a field that as yet remains untrammeled by any limiting barriers.

To understand radio one must first understand the fundamentals of electricity, and although a proper study of these two subjects is obviously outside the scope of these articles, it is hoped that by studying them intelligently month by month as they appear, the reader will acquire an understanding sufficient to enable him to pass the theoretical portion of the commercial radio operators' examination. The practical side will, of course, depend on himself and the amount of practice he puts in on radio.

WHAT IS RADIO?

Radio is the transmission of electromagnetic waves which radiate in all directions from the point of transmission.

In presenting this series on a most essential factor in successful flying, Radio;

Allow us to present, also, the author of the course. He is Captain Leslie S. Potter, known to you through his famous Course in Air Navigation *published in* MODEL AIRPLANE NEWS.

A pen picture of him, in his own words, reads:

"Served in the ranks, East Surrey Regt., 1914-1917 in France, Egypt and Servia. In the Royal Flying Corps as 2nd Lieutenant and Lieutenant from 1917 onwards. Engaged in night bombing during the war. Wounded once, enteric fever once (Servia) and shot down once. From end of war till end of 1929 served in England, Egypt, India and Iraq. Two local risings in Iraq. Resigned commission as Captain (F/Lieut.) in R.A.F. in Nov., 1929."

These radio or electromagnetic waves have often been likened to the widening ripples that follow the dropping of an object in water. The comparison is good and may be considered still further by reference to Figure 1.

A STONE dropped in the water at point A will cause a displacement of water corresponding to its size. The water displaced causes bulges at B and C known as ripples. These bulges, seeking to return to their normal level, cause further displacement at D and E; which in turn react still further till their energy is insufficient to create disturbances on the surface and the ripples cease. The water, originally displaced, causes an equal displacement round the circumference of a circle, of which A is the center. The ripples, consequently, are circular and extend in circular formation.

In the case of radio waves, the sending of a suitable current from an antenna provides an impulse similar to that created in the water by the dropping of a stone. The waves travel in all directions, as shown in Figure 2, with a speed of 3 x 108 metres per second—the velocity of light, which is, for practical purposes, instantaneous. The speed with which these waves will travel is unaffected by the power of the transmitting station. Waves from a low-powered station emanate at exactly the same speed as those from a high-powered station; the only difference being that the impulse, in the first case, being less, will have a correspondingly shorter radius.

The velocity of a wave, as, also, its energy is, however, impaired by the nature of the medium through which it is passing. It should be remembered that radio transmission is not a continuous wave spreading in ever wider circles, any more than the ripple at C in Figure 1 is composed of the same water as the ripple at D. It is the impulse that is passed on.

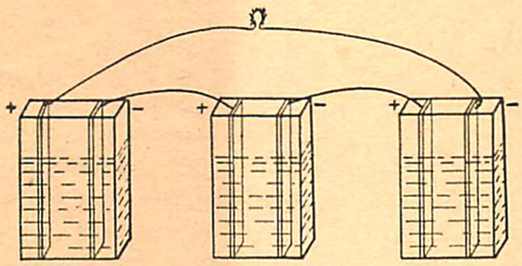


FIG. 8 SERIES CONNECTION

The velocity of waves passing through water or solid substances will be greatly reduced, as also their power. Referring again to Figure 2, the velocity of waves from transmitting station A to ship C will be greater than the velocity of similar waves from A to receiving station B, which is the same distance. Further, the signals received at C, other things being equal, will be greater than those received at B.

For the purposes of this diagram A has been shown in a position which is one highly unlikely to have been selected as the site of a radio station. The presence of an obstruction such as a hill will temporarily break up the formation of electromagnetic waves or impulses. These will reform again some distance beyond the hill, but a nearby receiving station will receive disturbed signals. If it is too close it may be unable to receive at all from one direction.

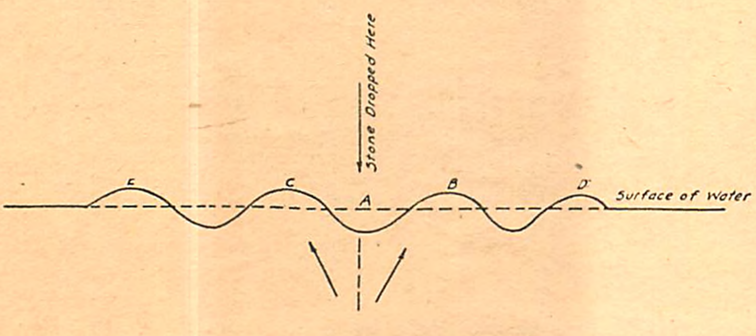


FIG. 1. ACTION OF STONE IN WATER

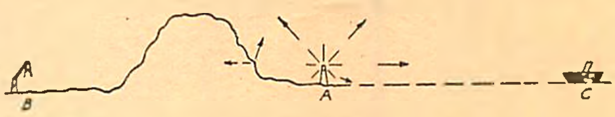


FIG. 2 - DIRECTION OF RADIO WAVES

ELECTRICITY

The next question that becomes obvious is, how are these waves or impulses created? Since the motive power of radio is electromagnetism, we will deal with these elements first.

What is electricity? How many times have you asked yourself this question? You know what it does and probably how it is produced, but how many know what it is? There is some excuse for this, since even today some of the theories advanced by well known scientists remain at variance. It is, however, agreed that every atom of matter is charged with minute particles called electrons.

In a neutral atom there will be an equal number of positive and negative electrons as shown in Figure 3. The electrons round the side are the negative electrons and these are detachable. The positive electrons in the center are named the nucleus.

WHEN an electron is removed from an atom by jarring or other methods, the equilibrium becomes destroyed. The removal of a negative electron will leave a positively charged atom, as shown in Figure 4, because the atom is predominated by positive electrons. In matters electrical it is usual to refer to a positive charge by a plus sign, and a negative charge by a minus sign.

The strong tendency of electrons is always to maintain an equality of balance. Thus a free electron will always be attracted by a positively charged atom—one possessing less than its complement of electrons.

In Figure 5 we have two bodies, one negatively charged and one positively charged. While they remain in this state there is said to be a difference of potential between them, but connect them by a wire and there will be an immediate flow of electrons from the negatively charged body until the equilibrium between them is restored and no difference of potential exists. This flow will set up a momentary current along the wire, and thus it is established that an electric current is the motion of immense numbers of electrons along a conductor.

If, instead of negatively and positively charged bodies, we connect either end of a piece of wire to the negative and positive terminals of a battery, as in Figure 6, one end of the wire will be positively charged and the other negatively and the same flow of electrons will follow. In this case, the flow will be maintained because, owing to the chemical action going on inside the battery, one of its terminals will be held positive with respect to the other, and the electrons will continue moving along the wire seeking to restore an equilibrium.

This will continue as long as the circuit remains closed—as long as the switch is on, the key pressed down or whatever medium is being used to control the current flow. The electrons will move along the wire to the positive terminal, through the battery and continue again round the circuit.

In course of time the battery will become weakened until it no longer has the ability to maintain the difference of potential between its terminals, when the electrons will establish once more their proper equilibrium and cease to move round the circuit. The current will then stop.

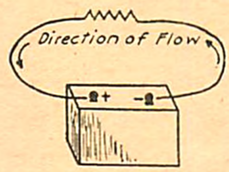


FIG. 6 CONTINUOUS CURRENT

It will be noted from Figure 6 that the direction of electron flow is shown from negative to positive. It is often supposed that an electric "current" flows from positive to negative. Since, however, an electric current is simply another name for electron flow, and this is as shown in Figure 6, it is now generally accepted that current flows from negative to positive.

BATTERIES

When a battery has the ability to maintain a difference of potential between its + and — terminals, it is said to develop electro-motive force; written e.m.f., better known perhaps as voltage. To explain this better, we will return to the water analogy again. Water in a pipe will remain motionless unless some pressure is applied to make it flow.

It is the same with electricity. Electricity is always present in a circuit, but it does not become active until a pressure is exercised and it is made to flow. The amount of this pressure is given in volts. The battery and the generator are the two mediums for supplying pressure. It is measured by a voltmeter.

It has now been explained how a battery or a generator, by its abilities to preserve a difference of potential between its terminals, creates a flow of electrons or an electric current. The amount of this current is measured in amperes by an ammeter. Water flowing in a pipe will be of the same volume throughout the length of the pipe, and the amount of the flow will depend on the amount of the pressure and the size of the pipe. (There are also other considerations, but we will come to these later.)

With electricity it is exactly the same. The strength of the flow is the same at all points on the conductor, and the volume of the flow depends on the size of the conductor, and also on the amount of pressure or voltage.

The construction of a generator which operates through a driven armature and a magnetic field of its own creating will not be explained at this moment, but a discussion of the dry and wet cell battery will help the reader to understand the chemical action involved in preserving a difference of potential.

None of the so-called dry cells are actually dry, but their greater convenience in transportation has made them popular for certain uses. A dry cell battery must be discarded when exhausted, but a wet cell battery can be recharged by the simple method of passing through it a current in the opposite direction to its discharge. The chemical action is similar in each type of battery

To make a simple wet cell battery all that is needed is a glass jar with an opening wide enough to insert two metal plates, a small quantity of salammoniac or sulphuric acid and two strips of different metals. Carbon (+) and Zinc (—) are probably two of the best, but copper (+) or tin (+) and iron (—) or lead (—) may also be used, and there are several others. The signs are given to show the terminals that will be represented by the different strips of metal if they are used in the order shown.

PLACE these two metal plates in a jar in the manner shown in Figure 7 and fill up the jar with a solution of sulphuric acid and water, or salammoniac and water. In the first case a 1:20 mixture will give a workable solution; in the second case a mixture of 1:4. In order that better connections may be made, two pieces of copper wire of suitable length should be soldered to the plates. The jar should then be left for a period. The process is then briefly as follows:

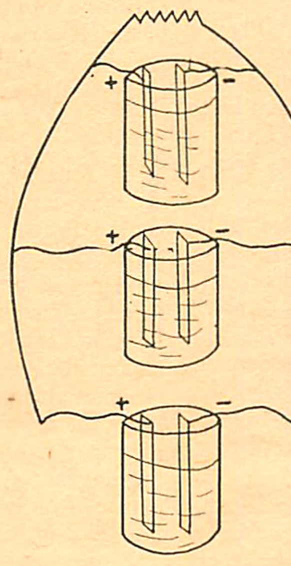


FIG. 9 - PARALLEL CONNECTION

The action of the solution in the jar is two-fold. A certain amount of hydrogen in the water will be released and will appear to rise from the copper plate in the form of bubbles. It is assumed in this case that copper and zinc plates are being used. Particles of zinc will be drawn off the zinc plate and gradually consumed

(*Continued on page* 37)

von Richthofen!

By B. D. Kneen

BARON MANFRED VON RICHTHOFEN was considered by Ludendorff, German Chief of Staff, to be "worth as much to us as three divisions." He shot down eighty British planes and killed more than one hundred Allied flyers; the greatest official record of any ace in the World War.

The day Germany declared war on Russia, von Richthofen, then a cavalry officer, mounted his company and under cover of darkness galloped six miles into Russia, seized the priest of a town, and held the place for some time without bloodshed. This began the war that ended only with the Russian revolution.

He saw no fighting, was ordered to supply service, and became so angry he wrote his commander: "I have not gone to war to collect cheese and eggs." Like Col. Bishop of Canada, he joined the air service to get out of the mud. He went to Cologne in May, 1915, for training as observer. On the Russian front he flew with Lieut. Zeumer, early ace who made a great name for himself despite a tubercular condition.

von Richthofen and Zeumer went to the Western front before airmen were fighting each other. They began using revolvers, rifles and hand grenades, but did little damage to the British planes. Richthofen did bring down an Allied machine when he used a machine gun. Later he met a French plane carrying a machine gun. The two planes flew alongside each other, taking pot-shots as they went. Suddenly the French plane spiraled down, landing tail up in a shell-hole. This was not counted in Richthofen's list, as no official record was then being kept.

von Richthofen met the German ace, Boelcke, who had a record of four Allied planes, and suddenly decided to become a pilot. He despised motors, knew nothing about them, and was hard to train, failing twice in his tests. He arrived at the front in March, 1916, and was given a two-seater, to his displeasure, as he wanted to fly and shoot at the same time. However, von Richthofen had an extra machine gun installed for his own use. A French pilot failed to see this gun and coming within range, Richthofen shot him down—his first official victory.

On the Russian front he "strafed" ground troops with machine guns and bombs, creating havoc among the Cossacks. Meantime, the British wiped out the German air force. Richthofen was picked for a new German combat squadron for the Somme salient, and began his great career with a victory on September 17, 1916, bringing down a British plane with two officers. Both were killed. Shortly afterward Boelcke was killed and Richthofen took his place as squadron commander, one of three survivors of the original group.

von Richthofen led his squadron in a great air battle, with some eighty planes engaged on both sides. He brought down two more, and now began to record each victory by having a silver cup made with all details engraved on it. He had sixty of these when the silver gave out.

" . . . . I have not gone to war to collect cheese and eggs."

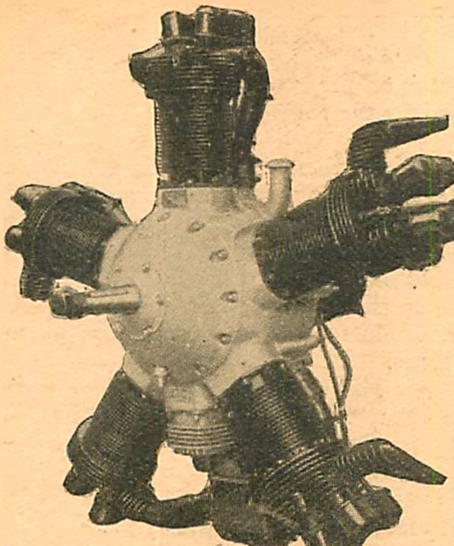
On November 23, 1916, he shot down Major Lance George Hawker, leading British ace, dealing the Royal Air Force a heavy blow. Hawker dived on von Richthofen, opening fire. The latter turned sharply to the left, Hawker following. A mad circling ensued, each trying to get in position to "ride" the other's tail.

Neither could gain this advantage. They circled furiously, at the same time descending. Finding himself far behind the German lines, Hawker began looping. When only one hundred yards above the earth he started for home. Richthofen fired steadily, but his gun jammed when they were only fifty yards in the air. Suddenly it started firing again, a bullet caught Hawker, and he plunged to earth.

IN four months von Richthofen was the leading German ace and its greatest hero. In flaming red Fokker he fought almost continuously. Probably his greatest single day was April 29, 1917, when, with his brother Lothar and another pilot, they met three Spads who attacked. The wind drove the fighters behind the German lines and each of the Germans got his man.

von Richthofen's antagonist started to land, but the German attacked again. "His whole plane went to pieces," Richthofen reported. "His wings dropped off like pieces of paper, and the body of the machine fell like a stone, burning fiercely. It dropped into a swamp. Only the end of the plane's tail was visible and marked the place where he had dug his own grave."

Some hours later von Richthofen shot down a two-seater escorting a photography plane, but it took 2,000 shots and a long flight. The (*Continued on page* 42)

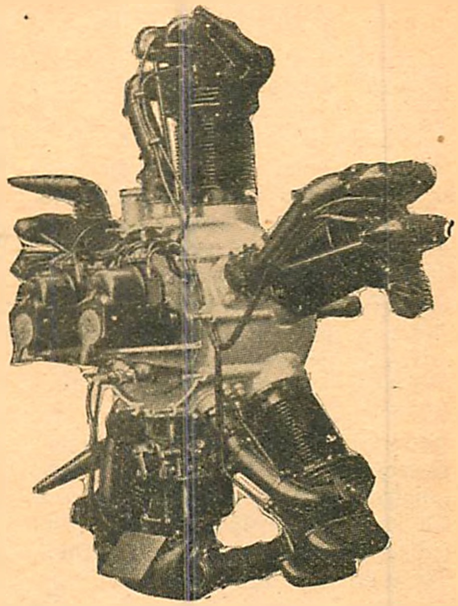


Front view of a Kinner engine

The Airplane Engine

By

Lt. (jg) H. B. Miller



Rear view of a Kinner engine

Article Number One of A Simple, Instructive and Constructive Series

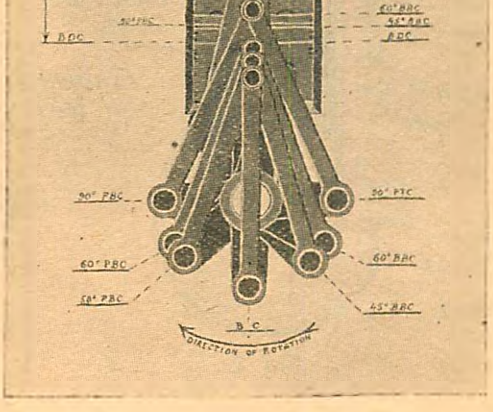
THE airplane engine is unquestionably one of the most highly developed pieces of machinery in use today. This high state of perfection has been attained only within the last decade. We must thank the military needs of the World War for turning the minds of our best engineers towards aeronautics. This interest was sustained by the rise of commercial aviation beginning immediately after the close of hostilities.

That this development in the design of airplane powerplants has steadily progressed is easily proved. The transcontinental airmail was established by the Post Office Department in 1821. Wartime ships, the old DH-4's powered with the famous Liberty Engine, were used on this route. Considering the lack of ground equipment such as radio broadcasting stations, lighted airways, etc., the daring pilots did excellent work in getting their cargoes through on schedule. Buffeted about by storm and blizzards they pushed their planes and engines to the utmost, but the toll in human life was great.

The engines lacked sufficient power to permit carrying fuel for a long flight. Consequently, if a pilot lost his route at night, he generally exhausted his fuel supply before he could relocate his position. The alternative then was either to attempt a dangerous landing in the dark or to jump blindly out of his cockpit and trust to the efficacy of his parachute. It is remembered that Colonel Lindbergh made two of his four jumps under these conditions.

As good as the Liberty was in its day, it suffered frequent mechanical failures. Especially weak were the first tower shaft gears which controlled the movements of the various accessories such as generators. These weak spots were strengthened up as they were discovered, but forced landings continued to be a more or less common occurrence.

In order to insure as good service as possible it was necessary to overhaul them at intervals of approximately one-hundred and fifty hours. This increased enormously the cost of maintenance and reduced proportionately the income that was accruing to the operators.



THE recent endurance flights combined with the transoceanic hops have proved to us that our airplane engines of today have reached a high state of reliability. Even more have the consistently maintained schedules of our air transport companies offered us reason to believe that an engine can be made to operate for any reasonable length of time without failure. All that is necessary for the operating company, after the careful design of the manufacturer, is to provide an intelligent upkeep and overhaul crew. A small number of careful precautions taken in time will insure that the engine will operate continuously if it is provided with sufficient fuel and lubricating oil.

A careful study of the design and operating principles will provide one with the necessary knowledge to intelligently handle and understand the airplane engine. To insure a complete understanding one must go to the basis of the production of power. A discussion of the movements of each part which makes up the engine will lead to a thorough explanation of the modern airplane powerplant.

As a source of power the use of steam antedates internal combustion engines. As we may suppose, attempts were made long ago to use steam engines as a propelling force for airplanes. Sir Hiram Maxim used such a powerplant in his early experiments with which he hoped to build a machine that would fly.

It can now be definitely stated that steam is impractical for use in airplanes. The efficiency of the reciprocating steam engine is seldom above fifteen per cent. Combined with this is the relatively enormous weights necessary in the generation of steam. Heavy boilers and a large supply of water would remove the possibility of the plane carrying any payload. Steam turbines would provide greater efficiency, but all such appliances are not only heavy but extremely cumbersome.

Attempts have been made to use a vapor engine in a way similar to the steam engine. Instead of vaporizing water, practical methods have been sought to vaporize such substances as mercury. This vapor would then be led off to act on a piston or turbine. These attempts have been largely impractical, however, in the face of the constant development that is taking place in the engines which are commonly in use today.

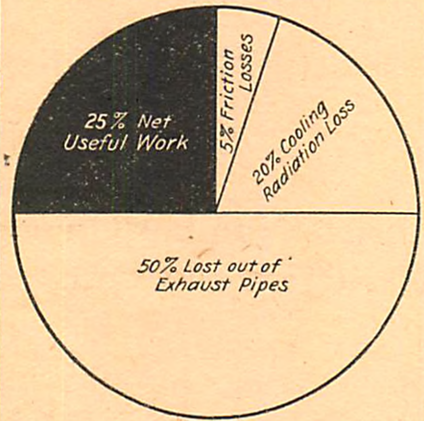


Fig. 5
Disposition of Heat Contained in Fuel.

All engines which are now used on aircraft are termed internal combustion engines. That is, the combustion of the fuel takes place within the cylinders themselves. These powerplants make use of the extremely high heat which results from the rapid burning of the fuel.

It is well known that the expansion of air results after heating it. This is the principle of the old-type "hot-air balloon." Similarly, the heat of combustion acts on the air which has been pulled into the cylinder by the suction created by the downward motion of the piston. As the air expands it pushes the piston downward which in turn revolves the crankshaft and turns the propeller.

SINCE the fundamental operation of the internal combustion engine is the rapid burning or explosion of the fuel within the cylinder, let us closely examine what takes place during this process. For the time being, our interest will lie only in a single cylinder. This cylinder must have a charge of fuel drawn in, must compress it, must ignite it or set it on fire, and must then make use of the power developed by the expansion of the gases.

IT is possible to perform these four steps in two strokes of the piston; that is, during the time the piston moves down and up again to its original position. In this case the engine is said to be operated on the "two-stroke-cycle" principle. Or, it is possible to accomplish our four requirements during the time the piston makes four strokes. In this case the piston would travel both downward and upward two distinct times.

This type of operation is known as the "four-stroke-cycle" principle and is the one commonly used today. Nevertheless, the "two-stroke-cycle" engine must be discussed for it has many adherents who believe in the possibility of its application in the future.

Let us place our piston on top dead center of its stroke; that is, it has reached the height of its vertical travel. (See Figure 1.) The space between the cylinder head and the piston is filled with the compressed gases and is ready for combustion. At this point ignition occurs following the arcing of high voltage across the electrodes of the sparkplug. The hot gases expand and push the piston on its down stroke. As it travels downward the piston creates a pressure on the fresh gaseous vapor which is present in the crankcase. Further, this back pressure closes the automatic valve which has admitted gas from the carburetor.

As the piston continues further in its downward travel it uncovers the exhaust port (Fig. 2) in the side of the cylinder wall which permits the escape of the burnng gases which still have considerable pressure. A further small amount of piston travel and inlet port (Fig. 3) is uncovered. Now, the gases in the crankcase which are under pressure are forced up through passage (Fig. 3) and so find their way into the cylinder chamber.

Since both the exhaust and the inlet ports are open at the same time the fresh gases would escape, if they were to pass straight across over the top of the piston. To pre-

TWO STROKE CYCLE

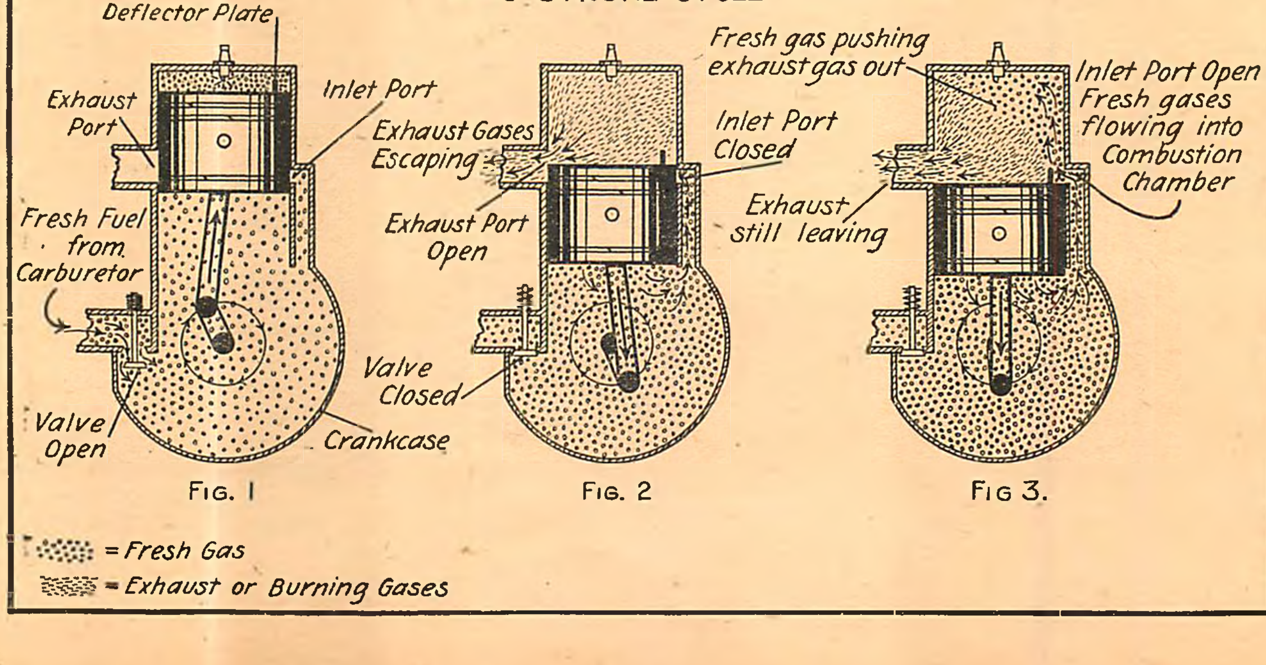
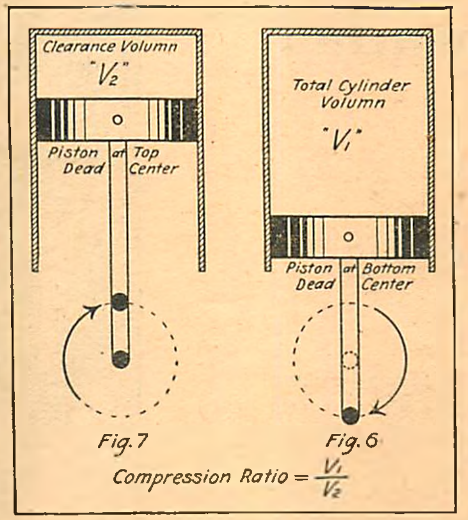


FIG. 1 FIG. 2 FIG 3.

vent this a deflector plate (Fig. 3) is mounted on the piston. This deflects the incoming gases upward and so helps in pushing out any remaining burnt gases.

The piston now begins its upward journey and closes both openings of the cylinder. On this stroke the piston compresses the gaseous fuel that has entered through the inlet port. The volume of this gas is reduced to a small part of its original dimensions. At approximately the top of the piston travel ignition *again takes place* and the cylinder repeats this cycle continuously so long as fuel is fed to the crankcase and so long as mechanical failures do not occur.



It is thus seen that the entire function of the cylinder has taken place as the piston traveled down and returned to its original position. In other words, every downward journey of the piston is a delivery of power, and the crankshaft has revolved once during this process.

The main advantage of the two-stroke-cycle engine is its simplicity and lack of moving parts such as valves, camshafts, etc. The absence of valves further eliminates a difficulty frequently encountered—that of warped valves.

THE many disadvantages, however, outweigh the few advantages. It requires more fuel for a given amount of power because some of the pure, incoming gases will escape through the exhaust port. It is inefficient because not all of the burnt gases will be scavenged from the cylinder, and, hence, a full charge of fresh gas will not enter the combustion chamber to be compressed and ignited.

Since the crankcase must be used as a reservoir for the gaseous fuel, it must be made gas-tight and this form of construction adds much useless weight. Further, if the gases in the crankcase should catch on fire, the resulting crankcase explosion would be most serious. For these and other minor reasons the two-stroke-cycle engine has not received a cordial reception among aeronautical engineers. This type of cycle is used almost exclusively on slow-speed marine engines.

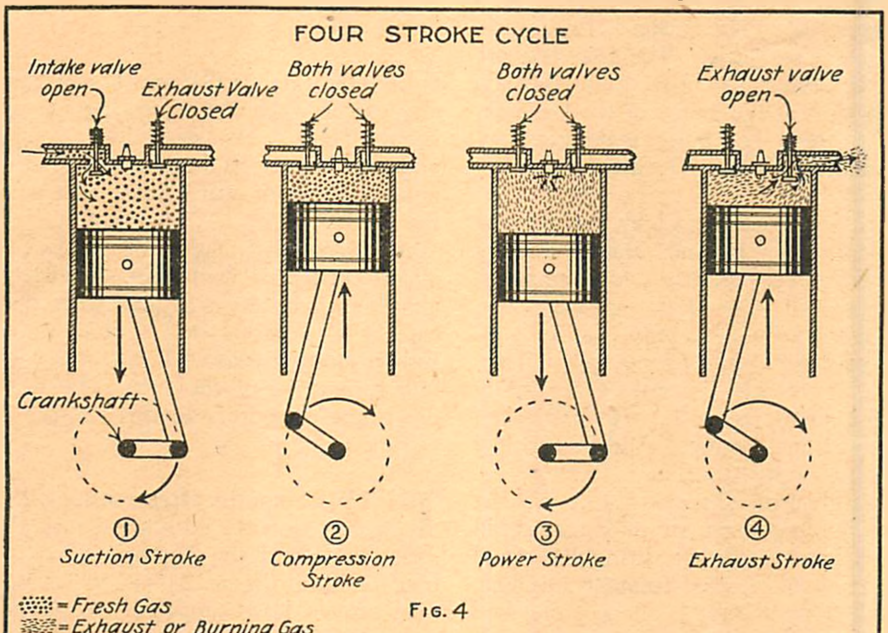


Fig. 4

For a study of the "four-stroke-cycle" engine let us look at Figure 4. Our piston is again assumed to be just starting its downward travel. By means of the camshaft the intake valve is opened, thus permitting the vaporous mixture of gasoline and air to rush in and fill up the space created by the retreating piston. During this procedure the exhaust valve is closed. At last the piston reaches the bottom of its travel and begins to move upwards.

Now the intake valve closes and leaves the combustion chamber air-tight. The up-rushing piston compresses the charge of fuel into a very small volume. At approximately the peak of compression a high voltage is permitted to arc across the electrodes of the spark-plugs and the charge is ignited. Burning rapidly, great heat is created which expands the gases under high pressure. This pressure forces the piston downward at a rapid rate and transmits a rotary motion to the propeller.

As the crankshaft revolves further the piston once again begins its journey upward. As it does so the exhaust valve opens for the first time and the burnt gases are pushed out into the atmosphere. When approximately all the waste gases have been emitted the exhaust valve closes and the intake valve opens. The piston is now in a position to begin its downward movement and the cycle has been completed.

It is seen that four distinct movements of the piston have been required to perform the four necessary functions of the cylinder, hence the name "four-stroke-cycle." The engine operating in this manner is more economical because of the more complete scavenging effect of upward rushing piston.

Since more burnt gases are driven out of the combustion chamber, more space is left for fresh fuel. This provides better flexibility and permits the pilot to increase the speed of his engine by as small an amount as five revolutions. Unless this close range were possible, formation flying would cease to exist. It permits the transport pilot to bring his heavily loaded plane into a landing with his engines turning over exactly as he desires.

The four-stroke-cycle principle is used on all the airplane engines in common use today and our discussions in this series of articles will deal only with this type. As we have seen, some engineers believe that the two-stroke-cycle principle has some advantages that are well worth developing. In spite of this, however, no signs at present indicate that such an engine will replace those we are now using with such good success.

THE basis of any type of powerplant is, of course, heat. We burn coal or wood in order to generate steam to be used to turn a turbine. Similarly, we burn a gas vapor in order to move the piston in an internal combustion engine. The common factor of all the various means of generating power is heat. In other words, to develop power we must first generate heat. Heat, then, must be a form of energy which we convert into (*Continued on page* 36)

Bishop, of Canada!

By Orville H. Kneen

A GERMAN airdrome is awaking. It is nearly dawn of June 2, 1917. Seven machines are warming up, mechanics hustle about, German pilots are preparing to go forth and hunt Allied flyers.

Suddenly out of the gray sky a British plane roars furiously down on the 'drome, raining machine-gun bullets. One man falls—his comrades drag him back. The avenging plane zooms up, circles, firing steadily. Machine guns on the field open fire on the plane. Bullets spat-spat through the taut wings, but the lone attacker turns and dodges in the fiery hail.

Now a German plane roars down the runway and takes the air. The lone flyer dives on the newcomer just as it rises, hailing it with hot lead until it sideslips and crashes. Another takes the runway. The British attacker drives it crashing into a grove of trees.

Two more machines take off in opposite directions. The attacker climbs, with a German close behind him, for a thousand yards. The German has now caught up. The British pilot turns, opens fire, makes two whirling circuits, and with a short burst of fire sends his third German plane crashing onto the field.

The fourth enemy approaches. The Briton's ammunition is getting low, but he goes into battle. The fight is short and savage, the invader emptying his entire drum—his last—at the German. Now he is at the mercy of the German, who is still unhurt. Anxiously he circles, seeking a way out—and then the German turns and flies away.

THE Briton heads for home, climbing high and turning west. To his sudden horror, he finds himself directly under four enemy scouts—and completely out of ammunition. If they see him there will be one last crash—his own.

He flies directly under the scouts, his only chance to escape being seen. He goes directly south for a mile. Then he suddenly slips away, apparently unseen! Once safely on his way home, he began to feel sick. He had taken off at three o'clock without breakfasting. And he had had a lot of excitement for an empty stomach.

While his comrades still slept, Bishop—for it was he who had made this astounding one-man raid against all advice—arrived over his home airdrome, firing his signal lights excitedly. When he had crawled from his machine, mechanics found it riddled with bullets, but not one had come within two feet of the lucky pilot!

That was a day's work for most airmen. Bishop, however, was actually disappointed that his score was only three. He had set out to get four!

That was only one of scores of sensational exploits of William Avery Bishop. von Richthofen, Germany's premier ace, had a score of eighty Allied planes which included some driven down but not destroyed. Had these been included in Bishop's victories, he would have had well over a hundred! All British victories, to be credited, had to be verified by observers on the ground. Bishop's final total was seventy-two.

The Greatest Living Ace

". . . . Then I climbed into the clouds and went home."

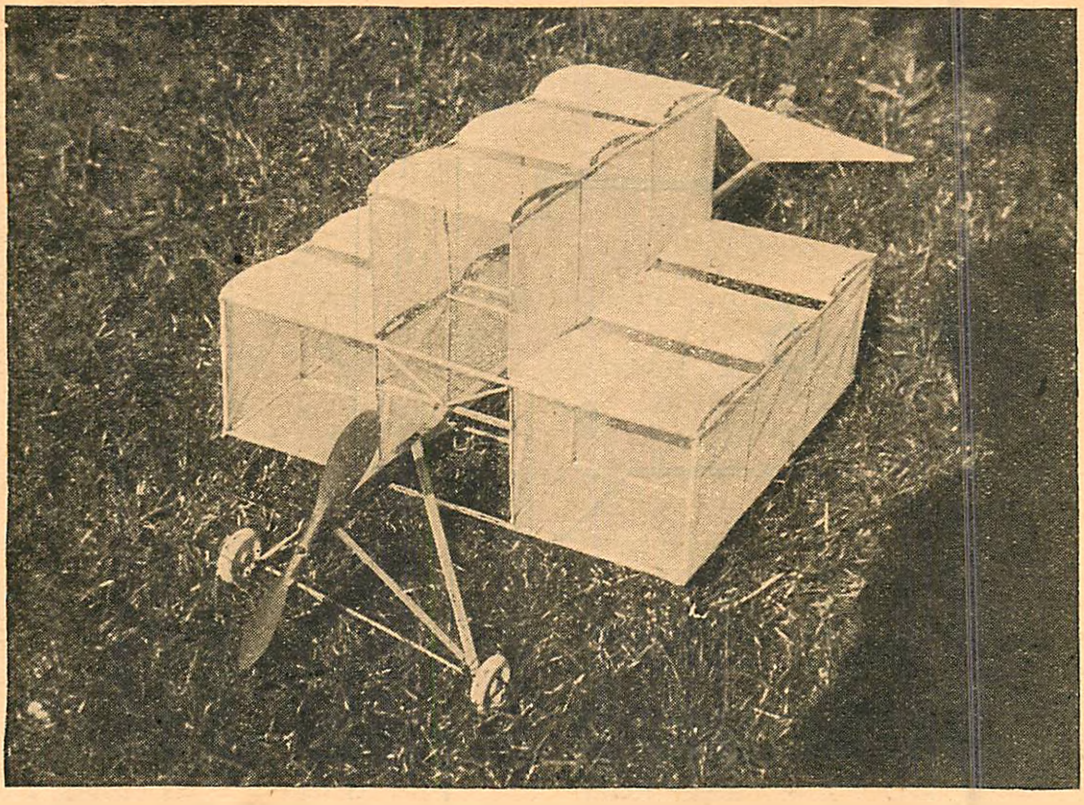
Like the famous German ace of aces, Bishop was a cavalry officer when the war began—a subaltern in the Mississauga Horse. As he plodded along in the English mud with his horses, he began envying the swift, smooth and mudless flight of war planes. He applied for transfer to the air force.

Also like von Richthofen, he flew at first as an observer, almost entirely in formation. However, as pilot, he fought almost entirely alone, at least three out of four of his combats being "on his own," quite unlike the German ace. Bishop mostly attacked fast scouts, and frequently crashed into formations of the enemy, by dash and speed sending down one or more. In this manner he attacked as many as nine at once.

IN TWO months after reaching France, in early 1917, he had won the Military Cross, the Distinguished Service Order and the Victoria Cross. The latter came to him for his airdrome exploit, which was confirmed by German airmen later captured. Later he added another bar to his D.S.O., and also won the Distinguished Flying Cross.

His remarkable eyes enabled him to pick up an enemy aircraft at a great distance. A master of machine gunnery, he was not only one of the greatest of aerial sharpshooters, but was able to repair his gun quickly when it jammed by pulling to one side. Guns frequently jammed, and life and safety depended on rapid fixing or getting away.

Skilled in sky strategy, he fought for good positions, picking the weak points of his opponents. Usually he fired only at close range, aiming at a vital spot. With all his fights Bishop was never (*Continued on page* 34)



Build a Flying "Crate" and Learn Something!

By Prof. T. N. de Bobrovsky

THERE is a general tendency these days to publish plans of conventional and modern types of airplanes for model builders, but I am convinced that the average model builder can and does learn more from models which incorporate original ideas—as, for instance, this special tractor model depicted in the photograph and plans.

This type of plane was first patented by Mr. Frank Wiemann of Warren Point, N. J., who has kindly permitted me to publish these plans.

This model belongs to the class of the Lidenthal type of airplane and you will find it most interesting to study.

If we start to analyze the model we will see the motorstick with a tractor type of propeller, landing gear, and the conventional type of horizontal tail. The wings, however, are entirely different. At first sight the model looks like a kite of the Hargrave type but differs from that in that there is more wing surface, and that the upper surfaces are made of three short wings having wing profiles.

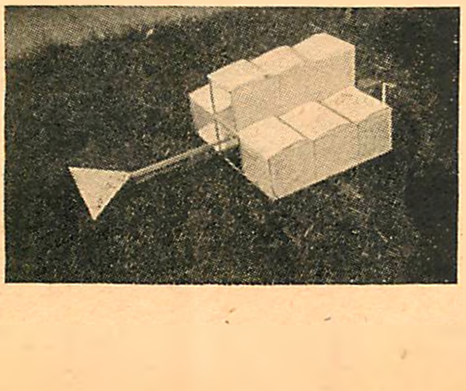
You will notice, also, that there is no rudder and that the sides of the lifting surfaces are closed in like the old French Voisin type of plane. Don't be misled into believing that because this tractor model is so different from other designs you will not obtain good performance. A little care and patience will do much to creating many enjoyable hours with this model.

The best kite is the original Hargrave type, which is the reason why it has been used for scientific experiments—such as Marconi's radio telegraphic experiments, Nansen's and Amundsen's polar expeditions. The French Air Corps used the same type of kite for observation purposes, sending up an observer in the kite.

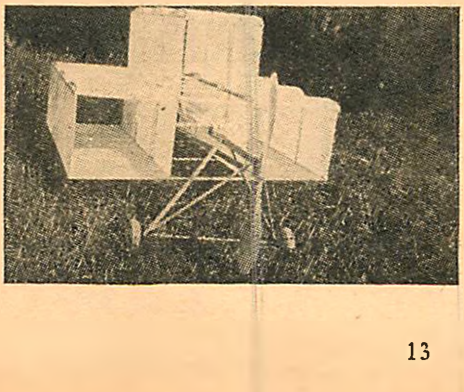
Those of you who built the "Arrow" model, published in these pages in the January issue, learned that models correctly built with large chord make good flyers.

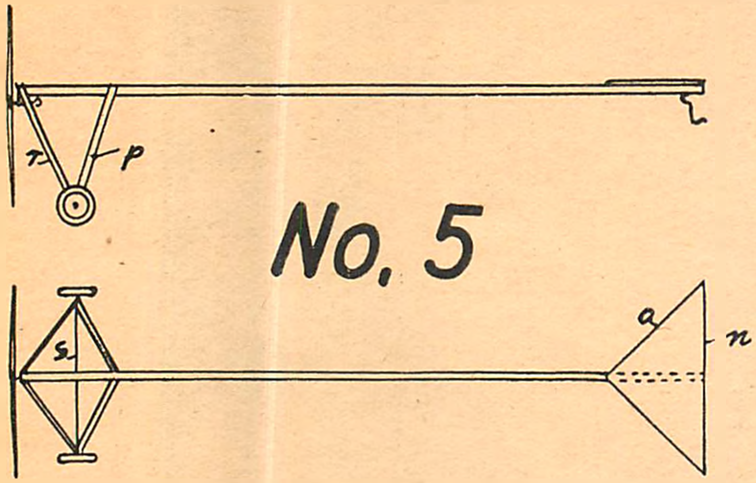
In the early years of aviation, the stability of the Voisin and Farman biplanes was made possible through the use of large side surfaces. Later these surfaces were eliminated for various reasons. The surfaces as such lessened the angle of vision from the cockpit, made it impossible to make a steep bank in turning, and generally decreased speed.

Many airplanes which were built later still retained



A Tractor Model that is Different, Interesting and Instructive





No. 5

vertical fins on the wings—even the Burnelli Guggenheim plane last year comprised such eliptical surfaces mounted at the wing-tips.

The present tractor model is not hard to make. Three photographs and five drawings give you ample additional detail to that contained in the text. Study the drawings carefully, and be sure to make each piece to the right dimension.

WING STRUCTURE

First make twenty-seven ribs, the outline of which is shown in drawing 1, using 1/16 inch medium balsa. Next follow with the leading and trailing edges. Drawings 1 and 2 show that you need three leading edges, marked "i," made of 16½ inches long x 3/16 inch square medium balsa. Make them round on one side.

The trailing edges are made from 16½ x ⅜ x ⅛ inch medium balsa, cut to correct length, and shaped as shown in drawing number 1, which, with drawing number 2, also shows the assembly of the three wings. This assembly is the next job to take in hand. After drying, cover the wings on both sides with Japanese tissue, fastening this to the wooden parts with banana oil or thin paste.

Drawing number 1 shows the struts "a," "b" and "c," of which two of "c," four of "b," and two of "a" should be made. Make the "c" struts round—using sandpaper for the purpose. The "a" struts should be streamlined in the usual manner, while the "b" struts are made oval in shape. Ambroid the struts in correct position on the three long wings, and at the other end of the struts ambroid the three upper wings. The whole upper wing structure is now complete.

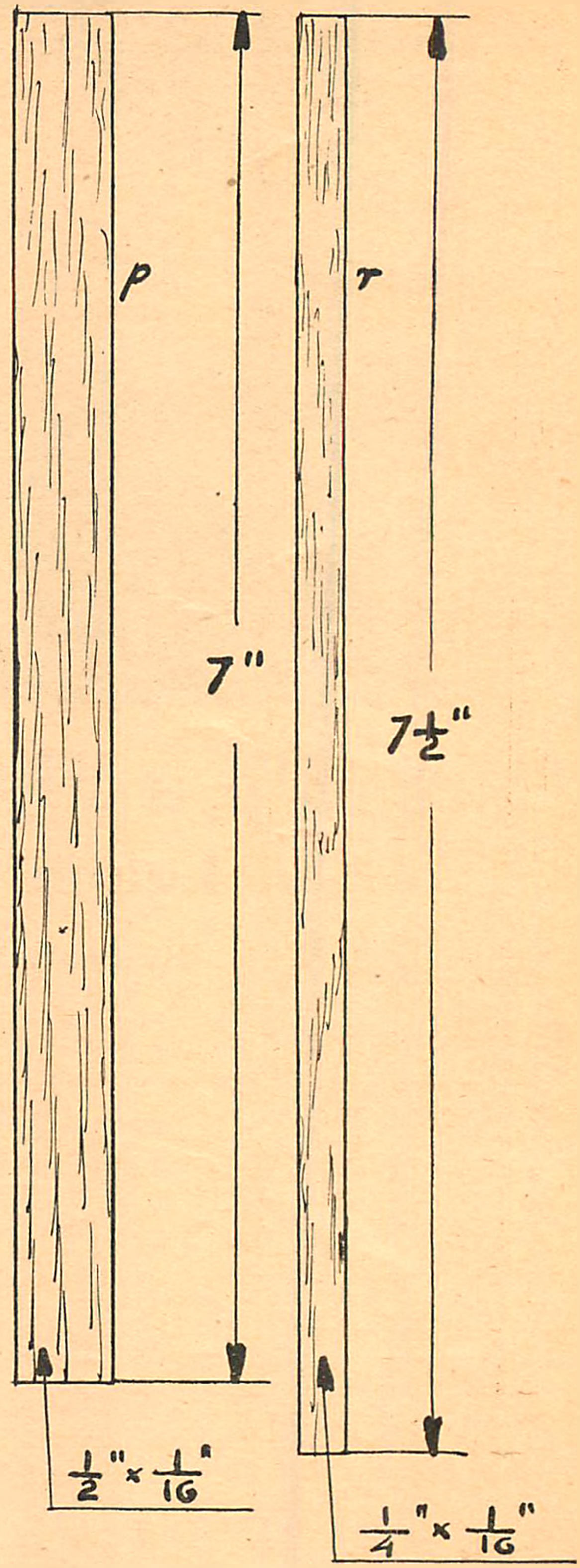
After this has dried thoroughly, work can be started on the lower wing frame, shown in drawing number 3, and marked IV. You will need four pieces of medium balsa for the structural members "f," as depicted in drawing number 4, using 1/16 x ⅛ inch balsa 14½ inches long. Make one each of spare "e" and "h," each 16½ inches long. For "e" use 3/16 inch square hard balsa, and sandpaper it round in shape. For "h" use 1/16 x ¼ inch balsa, and streamline it in the usual manner.

In drawing number 3 are shown six small spars marked "g." Two of these are 4¾ inches long, and four of them are 5⅝ inches long. You can use soft balsa for these spars. With the pieces "e," "f," "h" and "g" build up the structure marked "IV."

It is easily seen that the two shorter "g" spars are in the middle of the lower panel. The position of the pieces "g" from the leading edge "e" are 4¼ inches or 9⅜ inches respectively. Now cover the skeleton, except—as shown in the drawing—the middle parts.

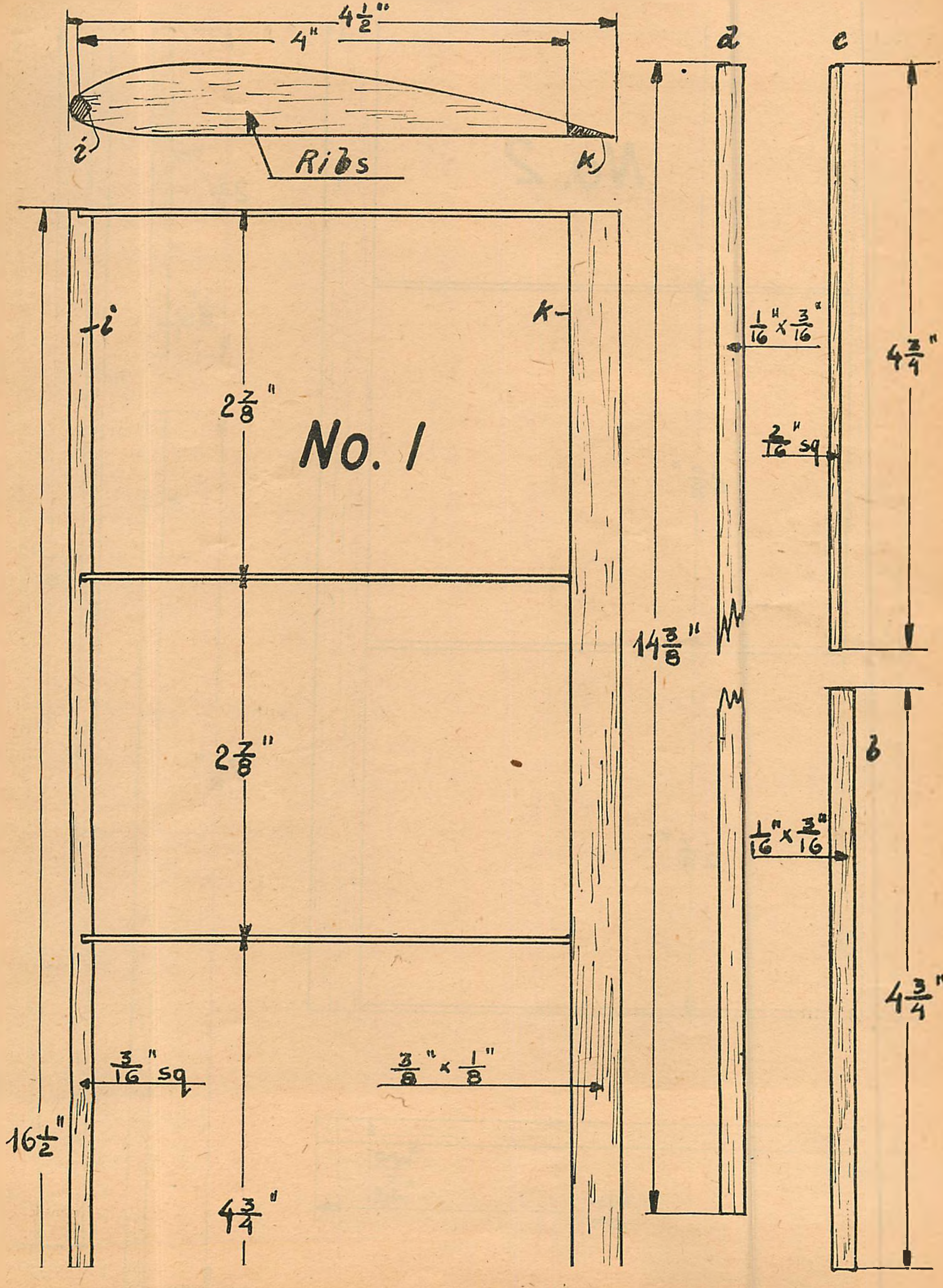
Next make four pieces of round strut "c," eight of oval strut "b," and four pieces of streamlined strut "a." Drawing 3 shows the detail for this operation. Now cut out two oval pieces of "m," as depicted in drawing number 2. Follow drawing 3 for the making and sandpapering to streamline shape of two pieces of "b," and ambroid them to the positions shown in the drawing 3, and sketch 111. The "1" and "2" struts carry the motor-stick.

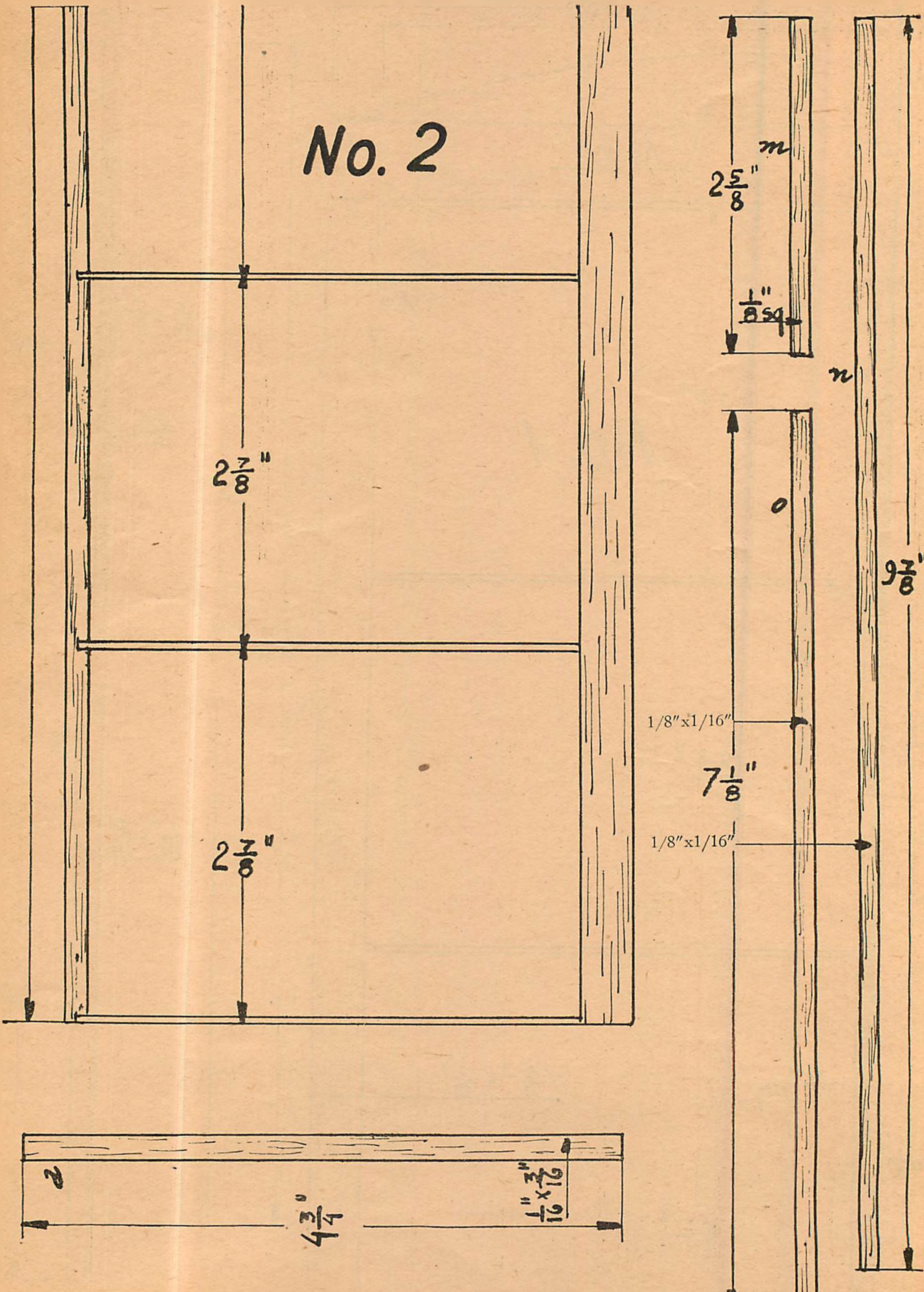
We have now finished with the wing structure.

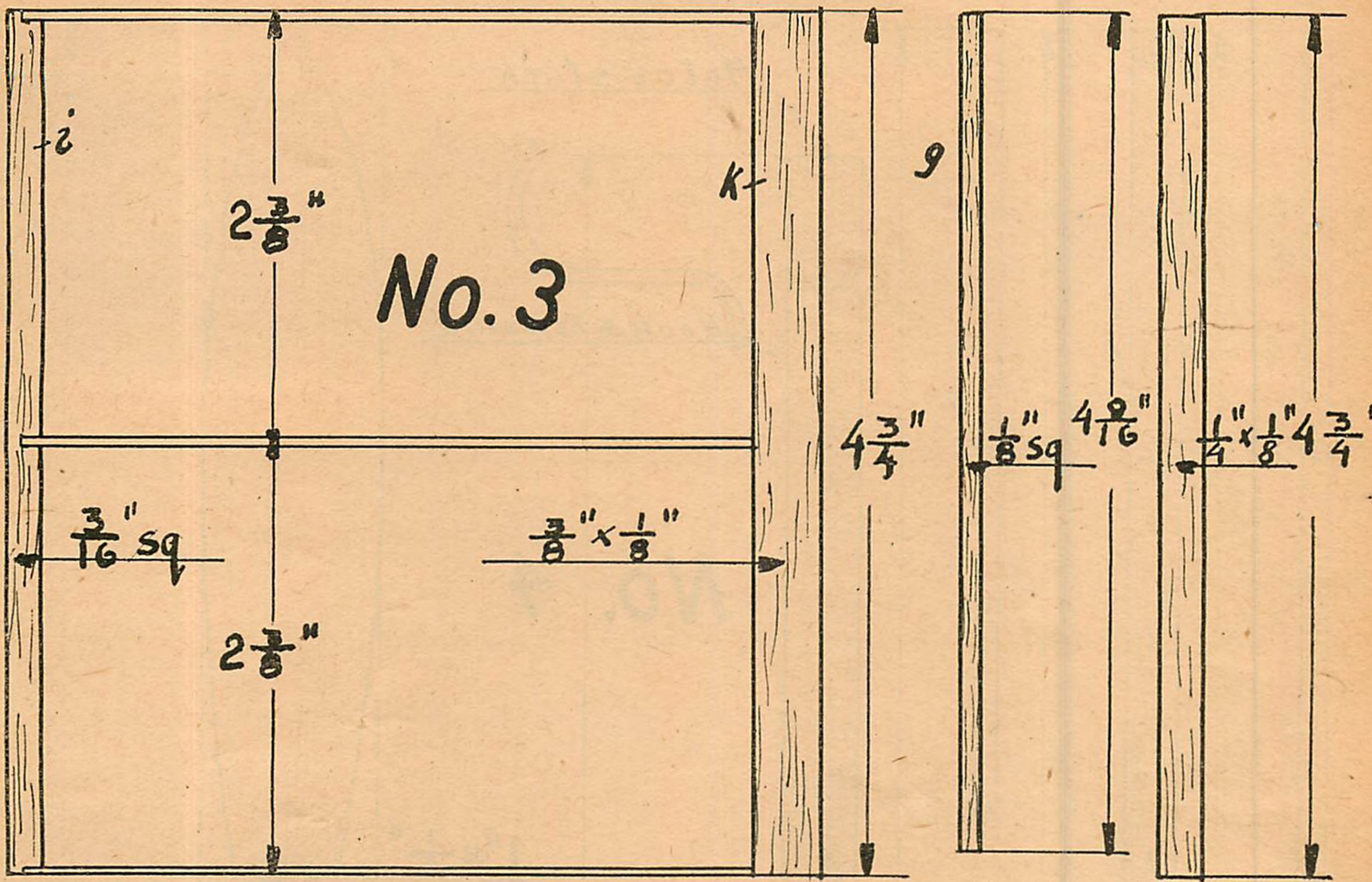


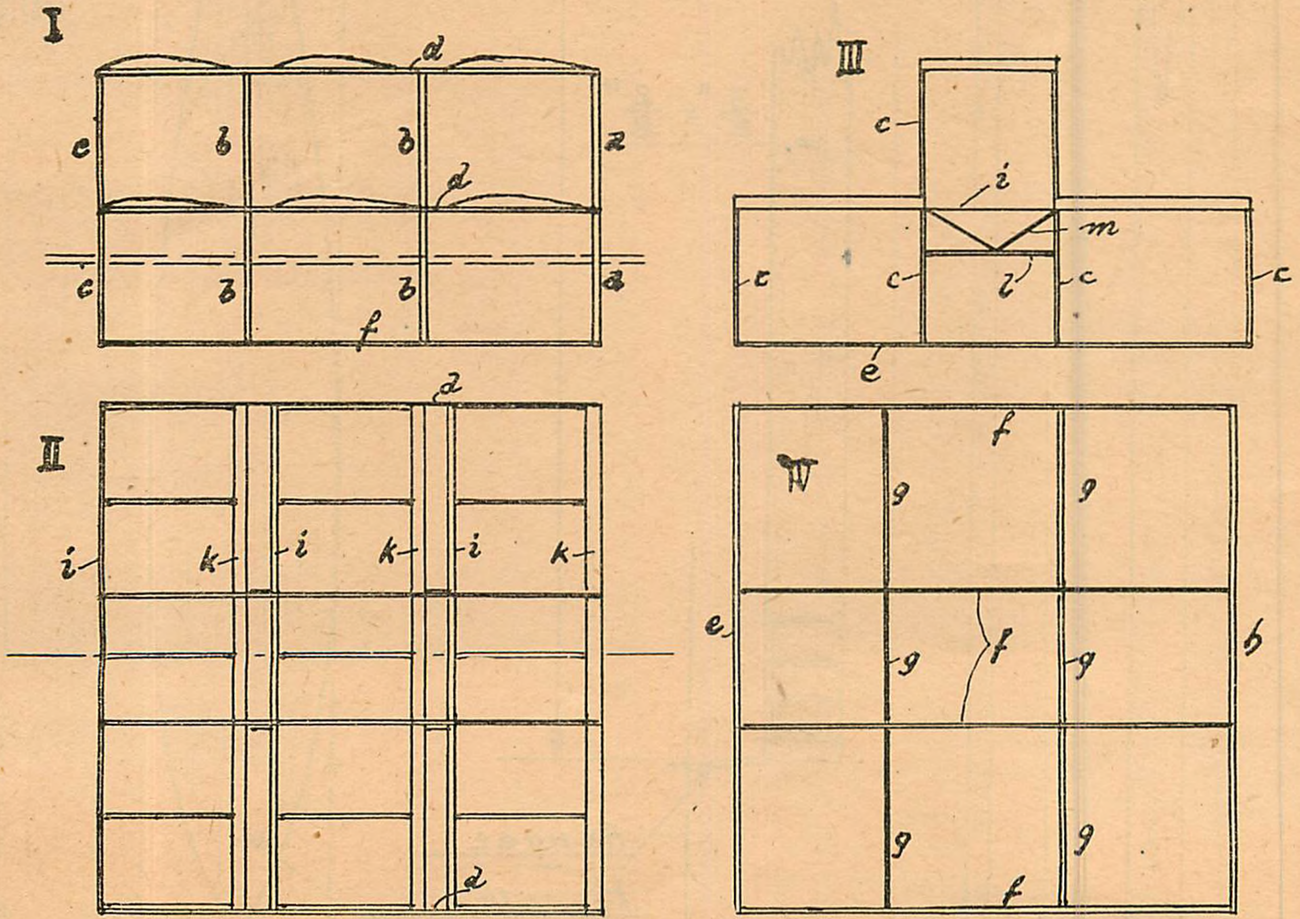
MOTOR-STICK

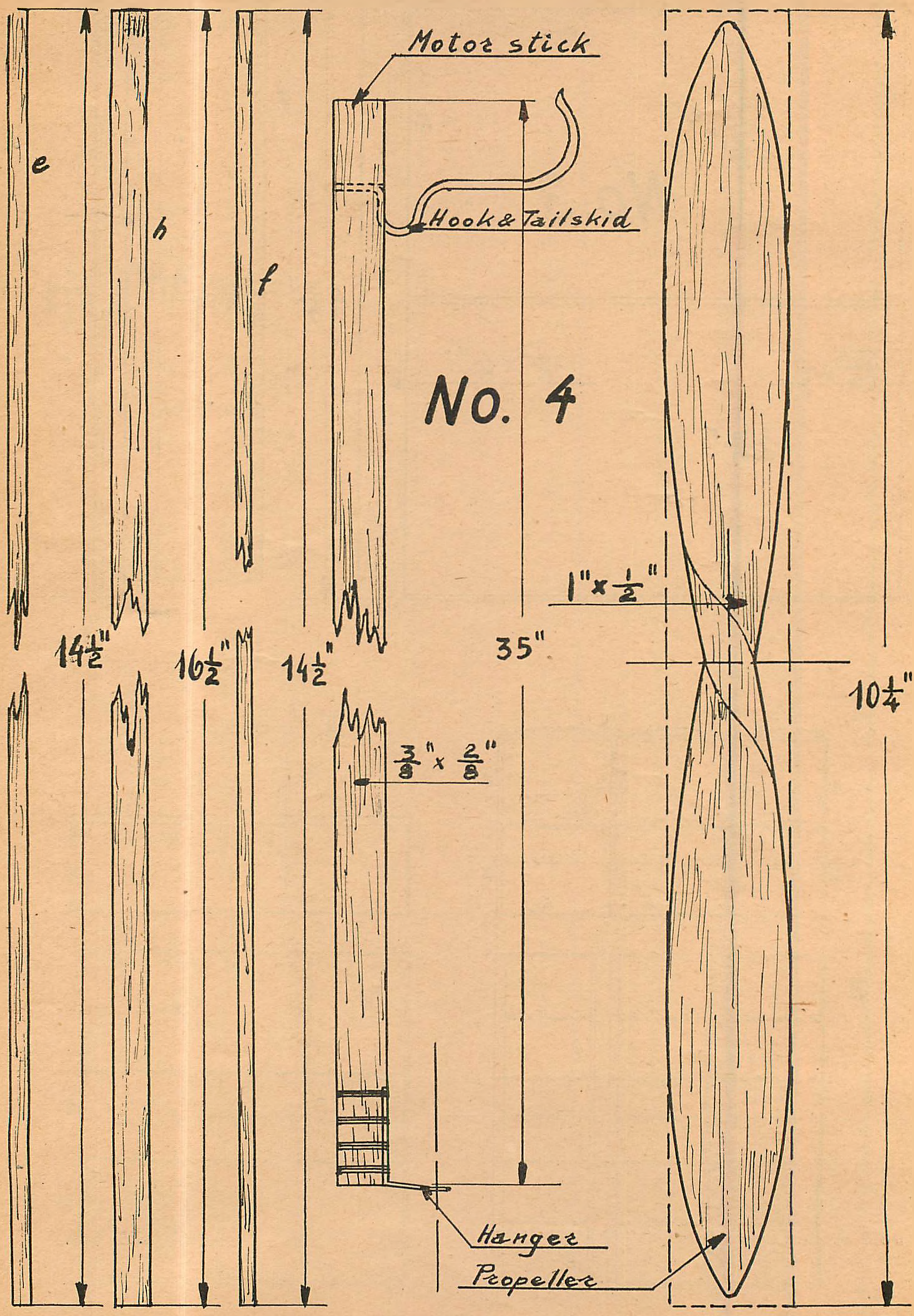
Drawing number 4 shows the motor-stick, which is made of hard balsa, 35 x ⅜ x ¼ inches. The rear-hook and tail-skid are made of one piece of steel wire, and the mounting of this part is shown in the (*Continued on page* 38)


4 1/2"
4"
i
Ribs
k
a
c
1/16" x 3/16"
4 3/4"
2/16" sq
14 3/8"
i
k
2 7/8"
No. 1
2 7/8"
b
1/16" x 3/16"
4 3/4"
3/16" sq
3/8" x 1/8"
16 1/2"
4 3/4"

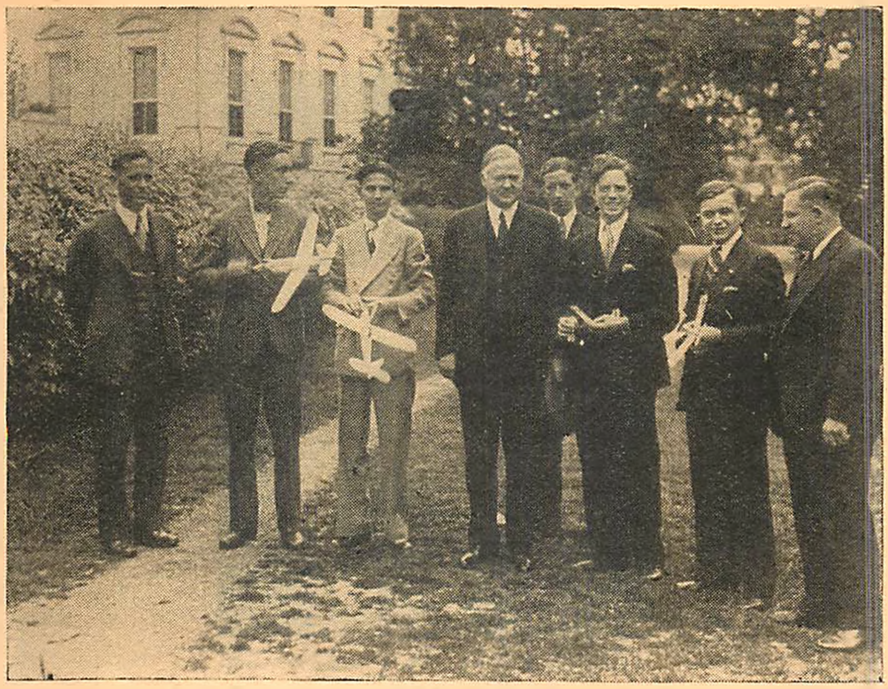

No. 2
2 7/8"
2 7/8"
m
2 5/8"
1/8" sq
n
o
1/8"x1/16"
7 1/8"
1/8"x1/16"
9 7/8"
p
1/16"x3/16"
4 3/4"


No. 3
i
k
g
2 3/8"
2 3/8"
4 3/4"
3/16" sq
3/8" x 1/8"
1/8" sq 4 9/16"
1/4" x 1/8" 4 3/4"


I
II
III
IV
a
b
c
d
e
f
g
h
i
k
l
m


Motor stick
Hook & Tailskid
e
h
f
No. 4
1" x 1/2"
14 1/2"
16 1/2"
14 1/2"
35"
10 1/4"
3/8" x 2/8"
Hanger
Propeller

The American Sky Cadets



President Hoover and the Champion Model Builders of 1930

AT the third annual convention of the Model Aircraft League of Canada held in the Chateau Laurier, Ottawa, important changes were made in the arrangements for the 1931 national meet for the Dominion. Last year the first Canadian meet was held on July 3 and 4 but it was found that the early date conflicted with school examinations particularly for those who travelled from Vancouver and other Western cities.

The early meet was also inconvenient for those who wanted to compete at the model aeroplane championships in the United States. Therefore, it was decided to adopt Friday and Saturday, August 28 and 29, for the Canadian meet this year. Ottawa, the Canadian Capital, was again selected as the place for the event. The outdoor championships will be conducted on the first day at Uplands Field, the local airport, with the indoor championships at the huge Ottawa Auditorium on the Saturday.

Arrangements were made for Canadian representation at the 1931 National meet in the United States to compete for the Lord Wakefield Trophy which was won by the United States last year in England. In 1930 Ross Farquharson of Vancouver, B. C., represented Canada at the British titular competitions.

The All-Canada meet this year will be held in conjunction with the Central Canada Fair at Ottawa and a show of scale models from all parts of the Dominion will be a feature of the annual exposition. These scale models will be judged for championships in their various classes during the week of August 24 at the Central Canada Fair.

William Chaffee, Dayton, Ohio (left), and Kenneth Mudie, Detroit, Mich. (right), two 1930 Champion Model Builders; and Mitchell V. Charnley, A.M.L.A. Judge (center)

A new division was established for the All-Canada meet consisting of a flying semi-scale model class and the machines will be judged on the following basis: thirty per cent for duration of flight; thirty per cent for workmanship; thirty per cent for closeness to scale, and ten per cent for performance in take-off and landing. This will be an outdoor class and the chief restriction is that the competing aircraft are to be rubber - driven. There will be both senior and junior classes in the new division.

The meeting decided against the giving of cash prises but there will be many valuable trophies and other important awards.

Several points were cleared up in connection with measurements of aircraft for model contests. In the case of indoor fuselage models, the fuselage will be one-fifteenth of the length squared while outdoor models are to have a fuselage which is to measure one-tenth of the length squared.

The reports showed that the League had a membership of 2,500 while total receipts from all sources in 1930 were $22,605.45. Major-General J. H. MacBrien, C.B., C.M.G., D.S.O., of Ottawa was re-elected president while the secretary is Major G. M. Ross of Ottawa.

The chairman of the National Contest Committee is Prof. J. H. Parkin, director of aeronautical research of the National Research Council of Canada, Ottawa.

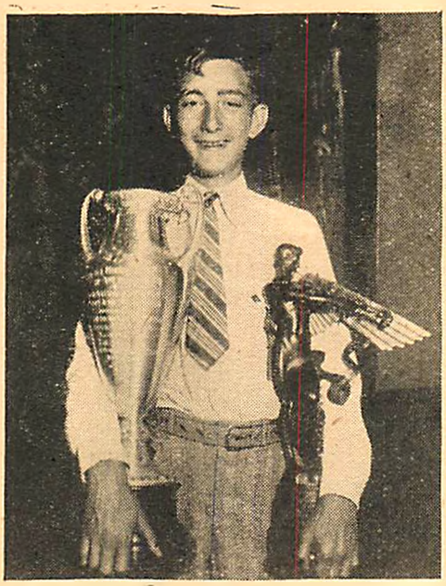
THE Canadian League has a Glider Committee of which W. H. McIntyre of Ottawa is the chairman.

Last year twenty-three glider clubs were organized in various parts of Canada and the league committee has general supervision of their activities.

It was decided to request the Canadian Government to prepare a curriculum of training and stand of practice for glider pilots and to issue approval of drawings and specifications for gliders. In other words, it was decided to ask the Government to assume official control of gliding in Canada and to provide for certificates of airworthiness and glider pilot licenses.

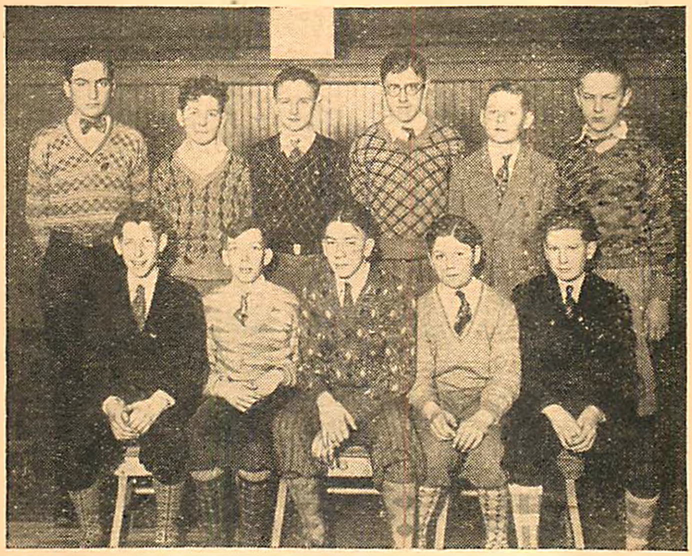
National Contest in Dayton

Four model airplane champions are going to win for themselves free airplane trips to Washington, D. C., this summer! These boys, the flying and scale model champions of America, will be the guests of the Ford Motor Company. All four will be selected at the Fourth National Airplane Model League of America Contest to be held in Dayton, Ohio, June 29-30.



Donald Burnham, West Lafayette, Ind., and his trophies

THE contest will begin bright and early on the morning of June 29. There will be two days jammed full of activities. Special permission has been obtained from the War Department to hold the Contest at Wright Field. This Field, as every model builder knows, is the headquarters of the Material Division of the U. S. Air Corps. Here every piece of equipment used by the air forces of the Army is first tested and approved before it can be purchased as standard equipment.



Members of the Lafayette Escadrille, Marquis de Lafayette Junior High School, Elizabeth, N. J.

With the finest laboratories of their kind in the world, Uncle Sam is prepared to test anything in the way of aviation equipment from goggles to bombers. As guests of the Field the contestants will be given an opportunity to test their adaptibility to flying in the flight tutor owned at the field. The latest military ships will be wheeled out on the great apron in front of the hangars and their design explained in relation to the requirements made on them in service. The planes will then be taken aloft and flown to demonstrate the explanation. Think of it, an illustrated lecture in which the illustrations are real airplanes.

Then there are the model contests. The Mulvihill Outdoor Duration, the Stout Outdoor Fuselage and last of the Flying group the Wakefield International. Last year the American Outdoor Champion, Joseph Ehrhardt of St. Louis, won this famous British trophy and brought it to America. English model builders have been preparing all year to win it back.

Of course, we must not forget the Scale Model contest. More than ten thousand exact scale model plans have been distributed to model builders. With that many interested contestants there is sure to be a grist of models sent to contest headquarters at Dayton.

Members of the Detroit, Mich., Sky Cadets, who broadcast over WJBK each week

THEN come the banquets, the trip for the champions in the Ford Trimotor to the Nation's Capital, the visit to the White House to meet the President, sightseeing in Washington and the return trip by airplane to Dayton.

Merrill Hamburg, Secretary, 300 Davis Avenue, Dayton, Ohio, will mail full particulars on application.

The Indoor Contest has been dropped from the list of 1931 events due to the lack of a suitable building in Dayton. The following is a digest of the rules:

All contestants must be under twenty-one years of age.

Mulvihill Outdoor Contest: Models to be eligible in this contest must have main supporting surfaces (wings) of at least 125 square inches in area; wings must be double-surfaced; models must weigh at least one ounce

(Continued on page 35)

A Multiple Rubber Band Motor

By Dick Cole

More Power to Your Models!

THE cry of every builder of flying model airplanes is for more power, or the same power spread out over a longer flight range. On fairly large flying models, a compressed air motor can be used, the pressure tank for the motor forming the fuselage of the model. However, the purchase or the building of a miniature compressed air motor is quite a costly job and beyond the range of the average model airplane fan. Nevertheless, the widely-used rubber band motor can be designed so as to afford very satisfactory power for experimental models.

Sketch I will instantly visualize the new idea. Instead of using a single group of rubber bands attached directly to the propeller shaft, four groups are connected to auxiliary shafts which are geared to the propeller shaft. In the sketch shown, the ratio between the driving gear is 4 to 1, so the propeller will turn four times as long as if driven by a single group of the rubber bands.

With a 2 to 1 gear ratio, the propeller shaft will have twice as much potential power for twice as long. Instead of using only four rubber bands, six can be used. In fact, there is almost no limit to the various combinations that the fundamental design offers. However, for general experimental work on model planes, the four strand 4 to 1 gear ratio motor will be found most suitable, so this article will deal with the construction of this style.

At the outset, it is well to mention that the difficulty in getting suitable gears need not deter anyone from making this motor. If an old alarm clock, speedometer, or the lake, will not yield the gears, there are numerous "stock gear companies" throughout the country where the exact gears can be bought by mail order for a few cents. Their addresses can be obtained from the advertisements in any of the "mechanics" magazines.

Assuming that we have the gears and the pinion rod stock, let us proceed. Consult Plate II. The first operation is to shape two balsa wood blocks: one to serve as body for the gear assembly, the other as an anchor for the rubber bands. The dimensions of these units are given in Figures 1 and 2. The next operation is to turn down the pinion rod stock as shown in Figure 3. Next, solder the driving gears to lengths of 3/32" drill-rod, as in Figure 4, and bend the rod end into loops for the rubber bands.

Now make bushes for the shafts of .015" sheet aluminum. Rather than tap the metal to fit around the shaft, it is better to cut the aluminum to exact size so that the edges just meet, and then bind the piece tightly to the shaft with iron wire. Then heat in the flame of a blow-torch and allow it to cool slowly. When the iron wire is removed, it will be found that the aluminum bush fits the shaft very closely.

The next operation is to fit the bushing alignment plate to the balsa wood block. This is quite obvious as illustrated in Figure 5. The bushing holes must be laid out very accurately. The center of the bushes for the driving gear shafts are exactly 5/8" from the center hole. Note that the ends of the alignment plate are bent over staple-like. In addition, the plate is glued to the block with any good glue.

AFTER the holes have been drilled for the bushes, they are coated lightly with cold glue and pushed into place. If the shafts show the slightest binding, the holes should be lapped out by using a little very fine emery and oil on the shaft.

Note that the driving shaft bushes are flared at the front end. These bushes must take the thrust of the rubber bands and must be anchored securely in the block. Very small washers, alternately brass and steel with a highly polished face, serve as thrust washers. The group of washers, as well as the bushes, should be kept well-oiled with a thin, high-grade oil.

The motor driving head can now be assembled permanently. The next operation is to fit the piano wire into the rear anchor block, to which the rubber bands are attached. We must now make the housing, or body, for the motor. This also serves as fuselage of the model plane. The construction should be quite obvious from consulting Sketch III.

The body is a hollow, octagon-shaped tube made of 1/16" balsa wood. Small octogon hoops of .015" sheet aluminum inside the tube hold it in shape. The outside is wrapped at intervals with silk thread similar to a trout rod. The joints in the balsa wood strips should be carefully beveled and

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A LETTER FROM THE PUBLISHER

—oo—

THE SECRET'S OUT!

It's evident from your letters of congratulation that you all enjoyed our recent serial, "The Mystery of the Silver Dart," by Ray Creena, as much as I did. So I think it's only fair to let you in on a secret. It concerns the author of that thrilling yarn.

"Ray Creena" didn't sound like flesh-and-blood to me, and tracked to his lair, none other than your own editor, Capt. H. J. Loftus-Price, was revealed!

His excuse for such sphinx-like silence is that he wanted to see how the readers of MODEL AIRPLANE NEWS *would like the story for its own worth.*

Now he tells me it's being published in book form on May 28, 1931, by the Mohawk Press, 350 Madison Avenue, New York City, and that what you read in this magazine is only the first half of a rip-roaring aerial yarn, with greater thrills and action in the second half of the book than can be described.

I feel that your bookshelf will be incomplete without a copy of "The Mystery of the Silver Dart."

(Sgd.) HAROLD HERSEY,
Publisher, MODEL AIRPLANE NEWS.

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securely glued. This body must be made rigid as it is subjected to twisting torque when the motor is wound up.

The front motor head block and the rear anchor block fit snugly within the tube. The tension of the rubber bands will hold them in place, and they are instantly accessible for changing the rubber bands or trying different gear ratios.

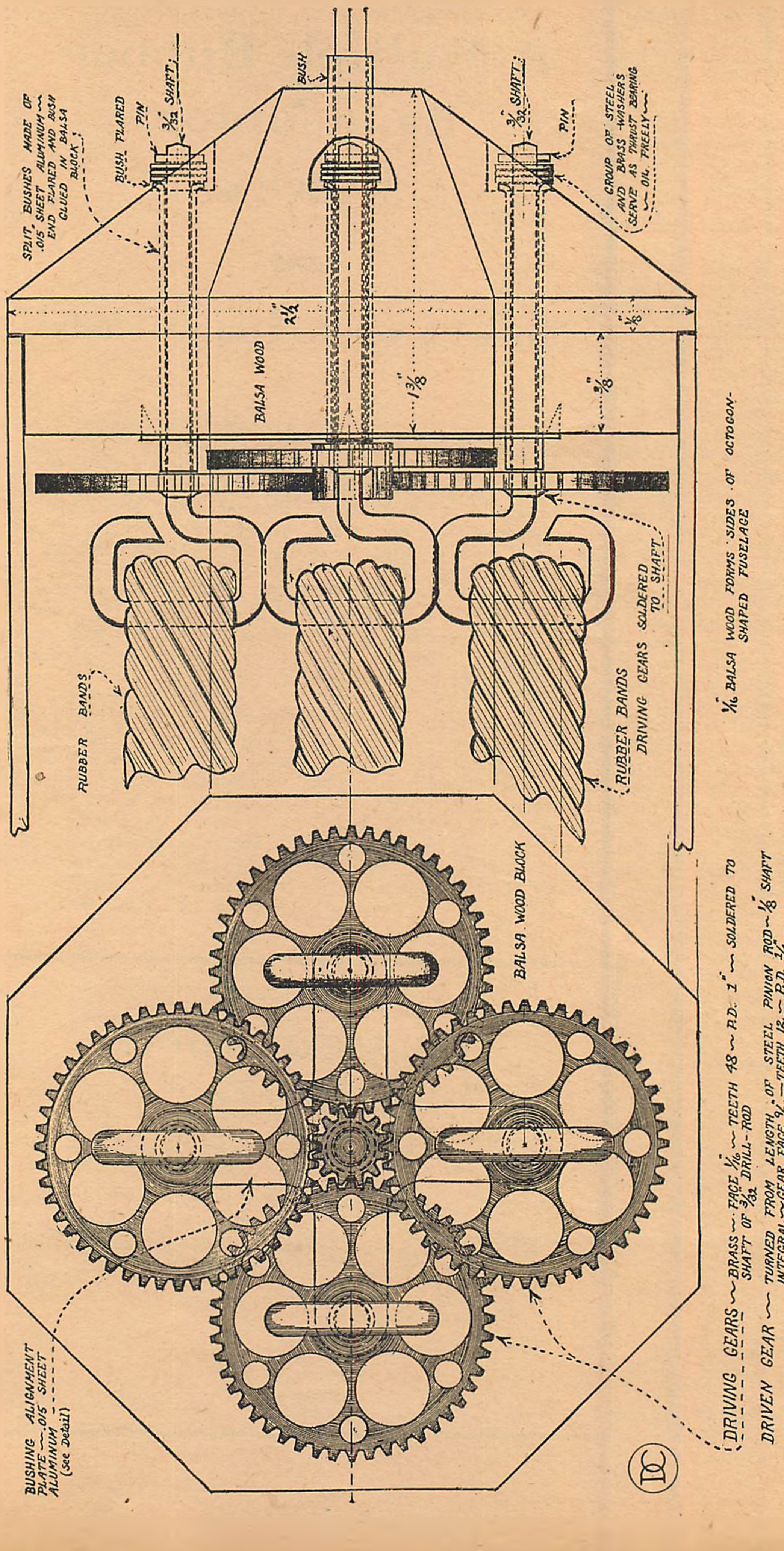
Undoubtedly every experimenter with this motor will wish to try out different gears, rubber bands, propellers, etc. When ordering the gears it is best to get a variety, but it is absolutely essential that the sum of the pitch diameter of the driving gears and the pinion rod stock be 1 1/8". Otherwise the bushes will have to be relocated.

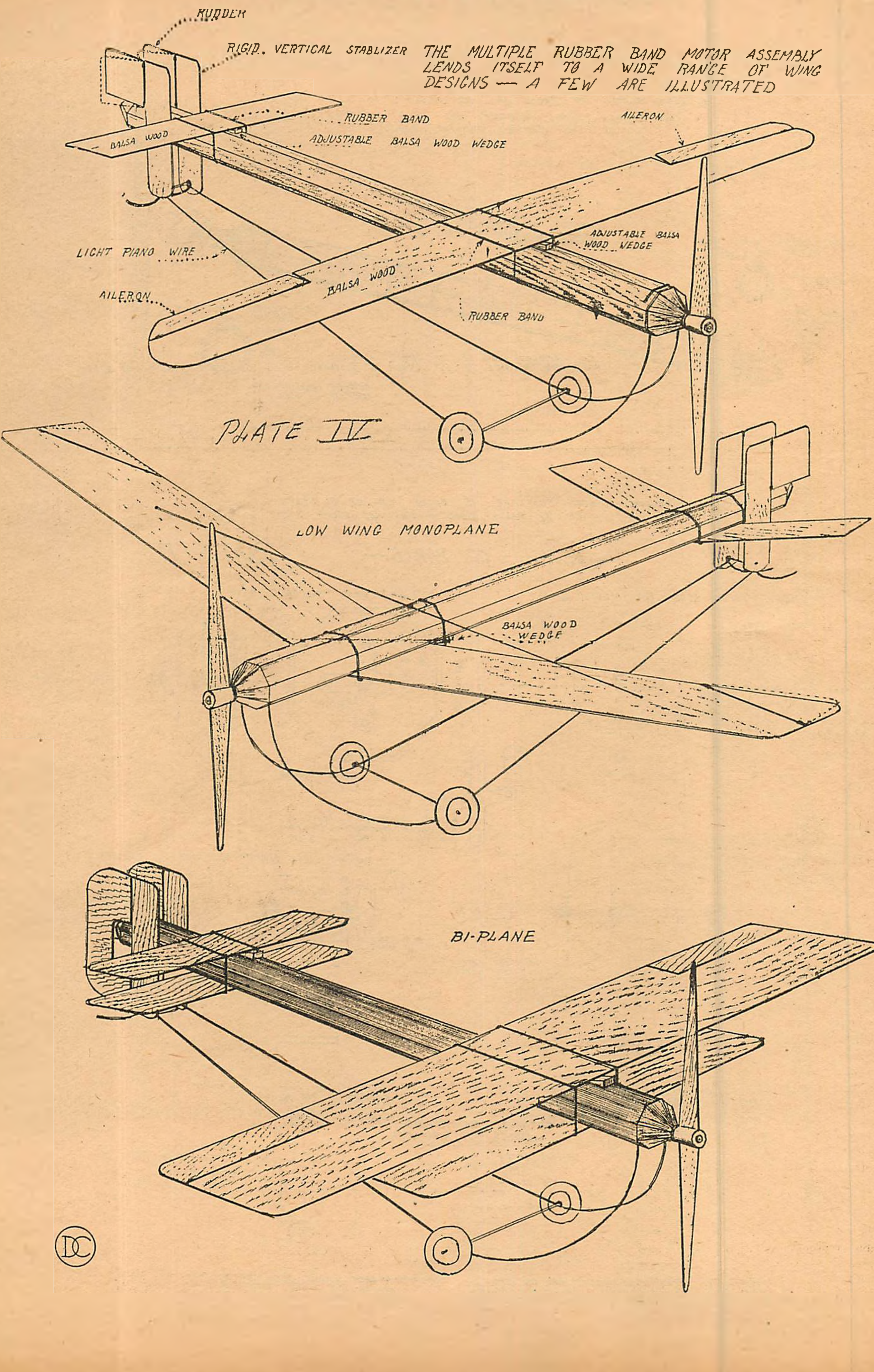
Figure 6 (Plate II) shows a gear combination resulting in a ratio of 7 to 3. If both the driving gears and the pinion stock have a pitch diameter of 9/16", the resultant ratio will be 1 to 1. In other words, four times more power is delivered to the propellershaft. This will permit the using of a much larger propeller with a heavier pitch. However, it must be left to the experimenter to find the most suitable combination for his particular model.

(*Continued on page* 35)

REAR AND SIDE ELEVATIONS OF MULTIPLE RUBBER BAND MOTOR

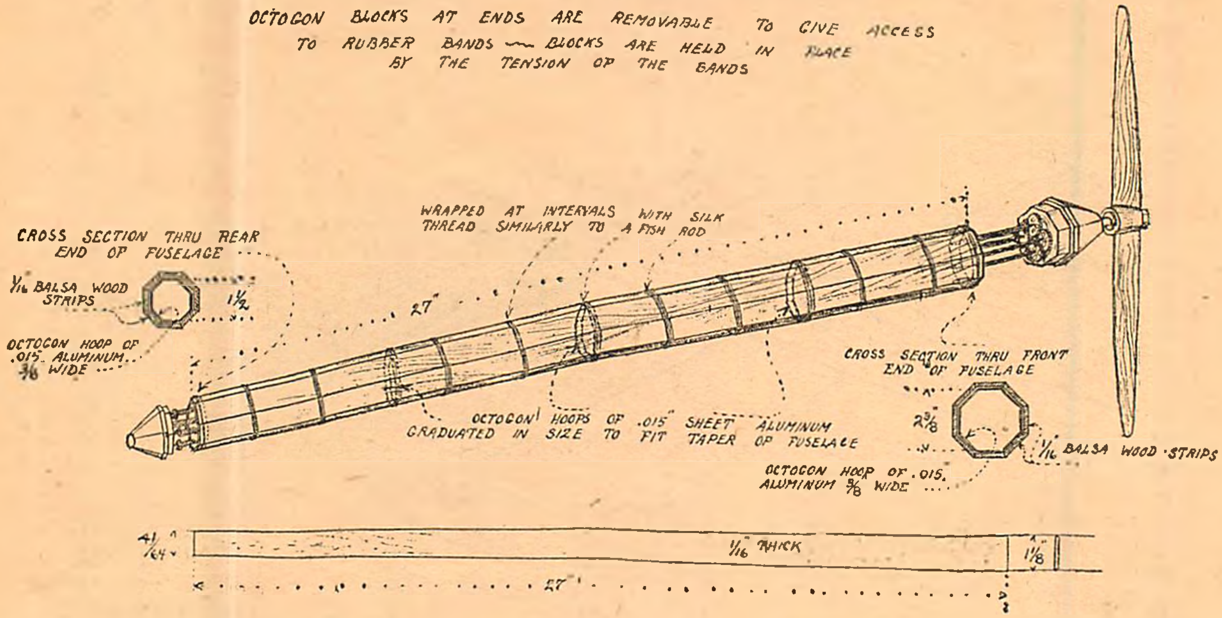
SKETCH I • FOUR TIMES ACTUAL SIZE




RUDDER
RIGID. VERTICAL STABLIZER
THE MULTIPLE RUBBER BAND MOTOR ASSEMBLY LENDS ITSELF TO A WIDE RANGE OF WING DESIGNS — A FEW ARE ILLUSTRATED
RUBBER BAND
ADJUSTABLE BALSA WOOD WEDGE
AILERON
BALSA WOOD
ADJUSTABLE BALSA WOOD WEDGE
LIGHT PIANO WIRE
AILERON
BALSA WOOD
RUBBER BAND
PLATE IV
LOW WING MONOPLANE
BALSA WOOD WEDGE
BI-PLANE
DC

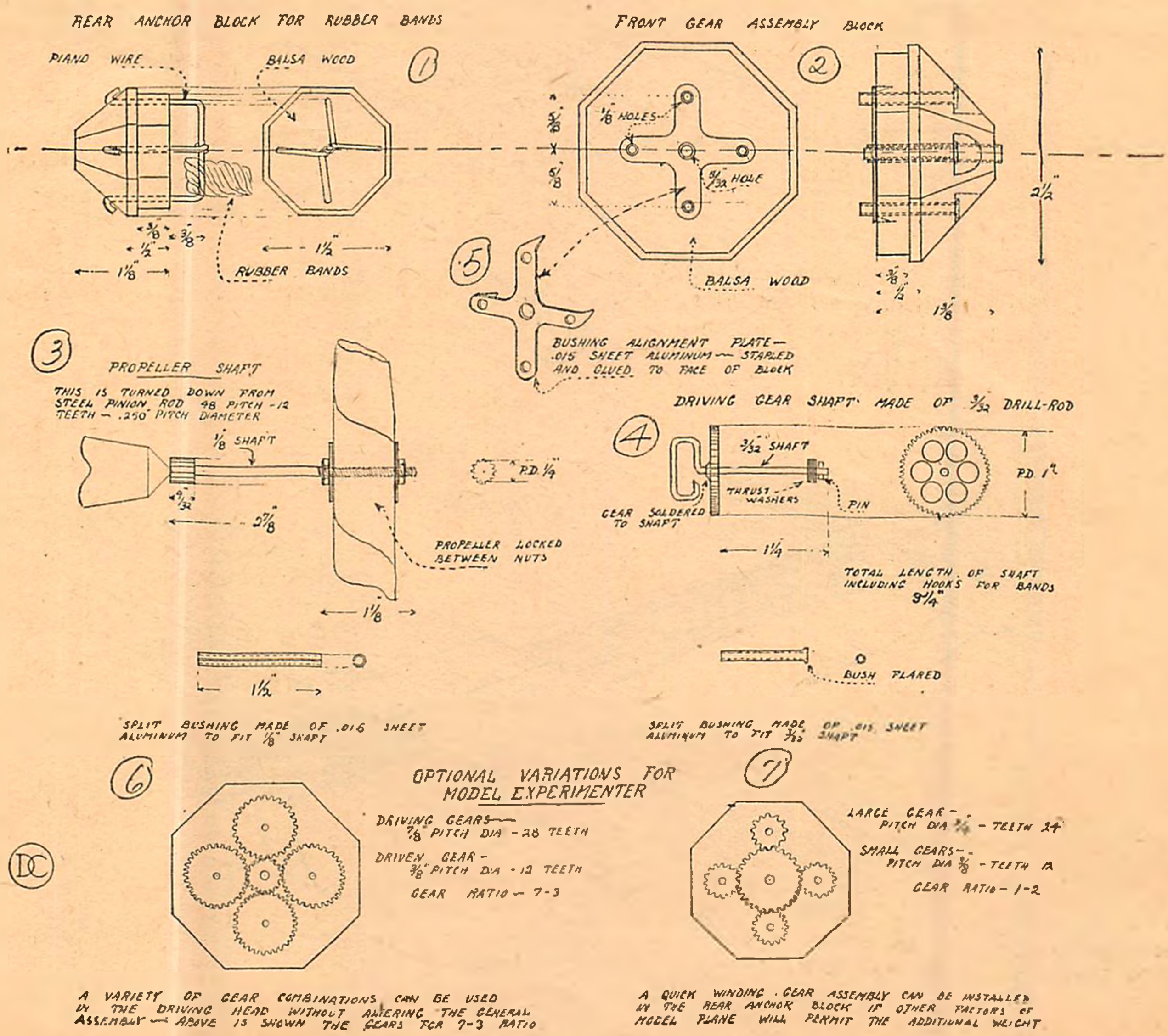
SKETCH III

OCTOGON BLOCKS AT ENDS ARE REMOVABLE TO GIVE ACCESS TO RUBBER BANDS — BLOCKS ARE HELD IN PLACE BY THE TENSION OF THE BANDS



HOLLOW OCTOGON FUSELAGE IS BUILT UP OF 8 STRIPS OF 1/16" BALSA WOOD — JOINS ARE GLUED

~DETAIL OF PARTS~ PLATE II



DC

Automatic Switch for Flying Models

By

Prof. T. N. de Bobrovsky

Increased Performance With the Aid of Alternating Motors

IT is an old problem and the dream of every model builder to find a device which would permit using two rubber motors that would work separately, with the second motor starting only after the first is nearly unwound.

Anyone who has thought of this device, imagined that a flying model, using it, would be capable of flying twice as long and climbing higher, than one model with one motor. In my research work I have used the device for large flying models, but found it too heavy and applicable for models, which have 8 to 10 ft. or more span only.

Working with a gear switch, the device is perfect, the amount of duration and distance being about 50 to 60 per cent more, although the switch in question is impossible to use on a 3 to 4 ft. model. Therefore I have designed the device, shown in drawings, which is a simplified automatic switch, and is not heavy—a most important fact.

I do not recommend the use of this switch for models that have less than 3 ft. span, because this device needs two propellers and two motors, against the one propeller—one motor device. If the model has two propellers and motors, there is dead weight, which makes it necessary that special attention be given to the design of the model.

It is but natural that the model with this device does not fly twice as long as the one with one motor, but it is possible to obtain 25 to 40 per cent better results.

The construction of this device is simple, and does not need special material, work or tools. In Fig. I we see the device in general view. (The reader's attention is called to the fact that not one of the drawings are to scale.) We can see that a motorstick, which is sufficient for holding two rubber motors, is mounted at both ends with bearings. In the drawing, the left one is a normal bearing, with one propeller mounted on a shaft. At the right end the bearings are combined with the automatic switch, which is shown in Fig. II (side view); Fig. III (section) and Fig. IV (perspective).

There are two double bearings on the motorstick, one at the upper and one on the lower end. We can see, that the upper bearing has a shaft (1), which is curved as shown in the drawing. Number 2 is a conical metal ring, which is soldered to the shaft. Number 3 is a spring. This is a metal spring for pressure, and can be obtained from a cigarette lighter, in which it is used for pressing the flint. This spring presses the shaft in the direction of Number 4. It is also natural that the completely wound rubber motor will pull the shaft in the direction of Number 5.

It is clear, therefore, that if the motor is not wound the shaft will creep to the right side of the bearings. If we wind the propeller (I), the rubber motor overcomes the spring force, and pulls the shaft against (5). It is obvious then, that a piece of the sheet metal soldered to the bearing, and the curved shaft cannot make more than one revolution under the torque of the motor.

There is a brass eyelet (8) soldered to the lower bearing of the shaft (6), which is against the pulling power of the rubber motor (II). Soldered to the shaft (6) is a brass wheel (7), which has a small cut, shown in Figs. III and IV. We can also see in which direction the rubber motor (II) is driving the wheel.

In the side of the motor stick, but soldered to the bearings are two triangular holders (10) and (11) for the axle.

This axle holds a metal switch (12), which is clearly shown in the drawings. The device is now ready for the test.

Wind up motor (I), then motor (II). Hang the lower part of the switch (12) in the cut of the wheel (7) as shown in Fig. III. Placed in this position motor (II) and propeller (II), will not work. Now free the propeller (I), which is either held in the hand or fastened with a hanger. Then the motor and propeller (I) will start revolving. The instant that the force of the spring subdues the force of motor (I), shaft (1) moves back and the conical ring (2), soldered to the shaft, moves the switch in position (12a), shown in Fig. III. At this moment wheel (7) becomes free and the motor and propeller (II) start working.

To obtain good results, see that the spring has enough power to move back the shaft, after motor (I) has made 60 to 80 per cent of the total revolutions.

If the spring does not work properly it is not strong enough to push the switch out and the second motor will not function. Equally important is that the cut in wheel must be small.

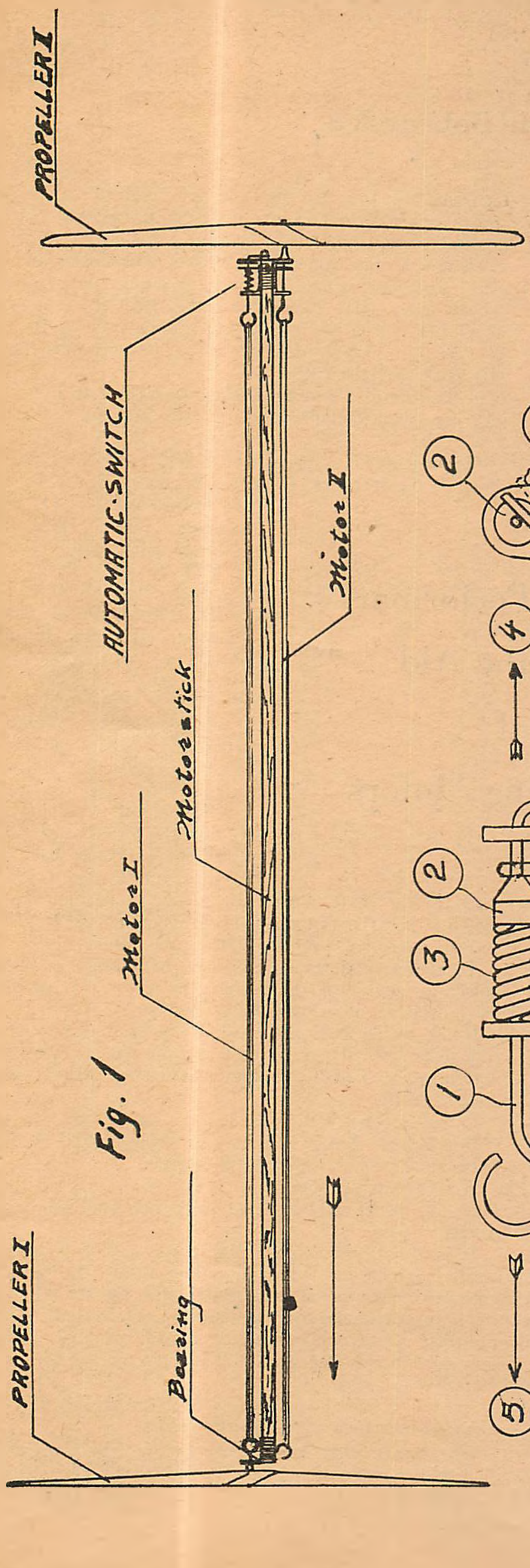
Propeller (I) is best, when it has a small pitch, and (II) with a larger. Motor (I) must be stronger than (II), because more power is needed for starting.

A small pitch propeller (I) is necessary for good climbing. The model will then have flying speed and will be able to climb easily.

It is a well known fact, that the model, in normal weather conditions, will lose ceiling before the motor is exhausted, therefore it is necessary that the second motor starts functioning before this happens. When the second propeller starts, while the first is still working, a new, but smaller climbing period takes place, and the speed increases somewhat.

Even in a well constructed model the second propeller alone will not give more climb or speed.

The best models for this device are, the Canard (or "Duck") type and the biplane, which normally have *pusher* propellers.


PROPELLER II
AUTOMATIC-SWITCH
Motor II
Motorstick
Motor I
Fig. 1
Bearing
PROPELLER I

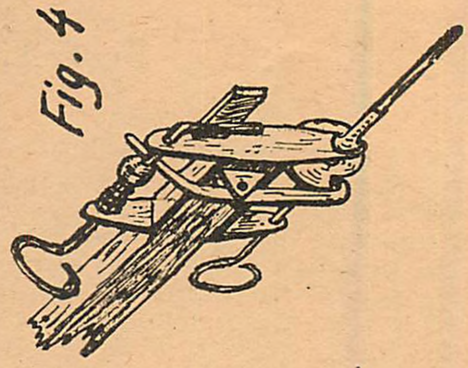
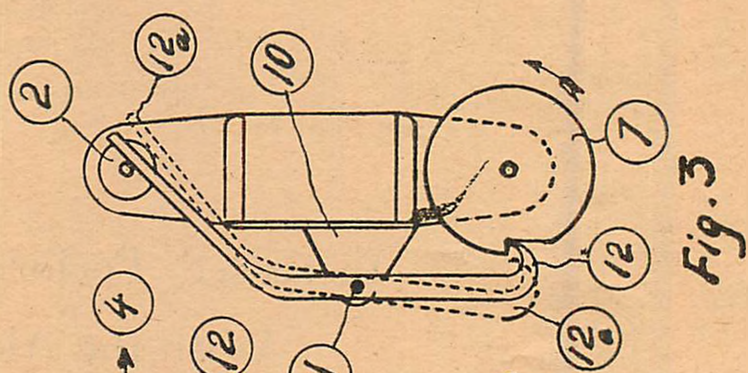
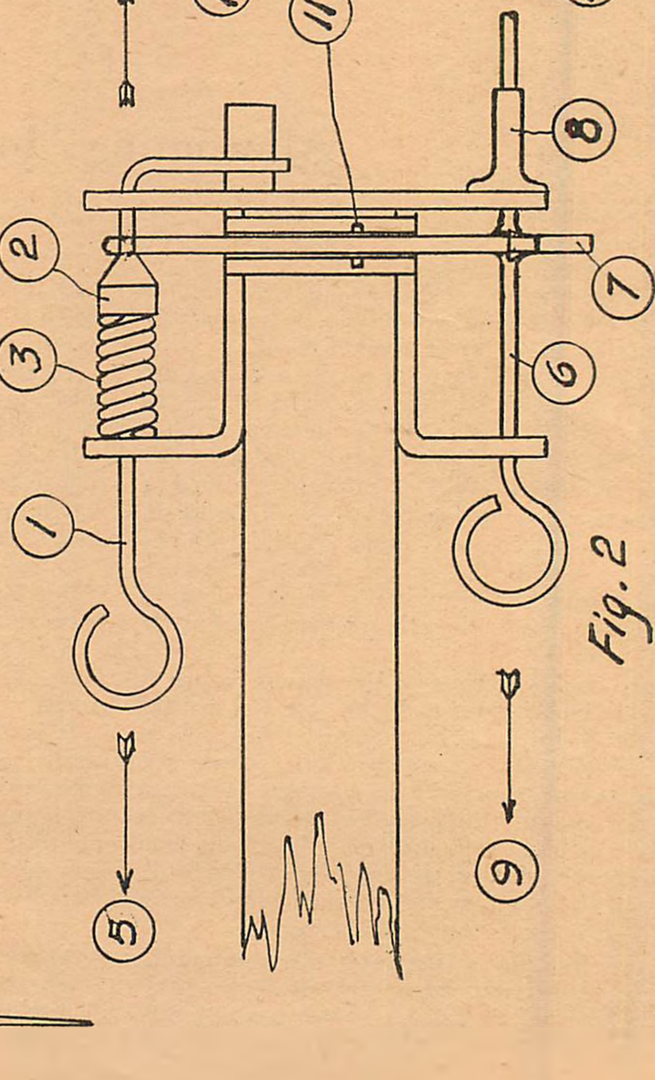


Fig. 4


2
12a
10
7
12
12a
4
12
11
Fig. 3


2
3
1
8
7
6
5
9
Fig. 2

Conducted by Capt. H. J. Loftus-Price

AVIATION ADVISORY BOARD

CONTINUING our recently adopted scheme of letting our readers know as much as possible about wartime planes, we are publishing below some interesting data concerning machines designed and built by the famous Sopwith Company; of which the "Camel," and "Dolphin," and "Triplane" wrought such havoc on the enemy air corps during the war.

The history of this famous aviation firm starts with:

The Sopwith "Tabloid": In its original form the Sopwith "Tabloid" was built as a side-by-side two-seater, with an 80 h.p. Gnome engine. It was built in 1913 for Mr. Hawker, the famous Sopwith pilot, to be taken out to Australia in 1914, but very soon after its appearance a number of single-seaters of similar type were ordered by and built for the British Army. This machine had a skid type undercarriage and a balanced rudder, while there was no fixed vertical fin. The pilot and passenger sat side by side, the pilot on the left. Lateral control was by means of wing warping.

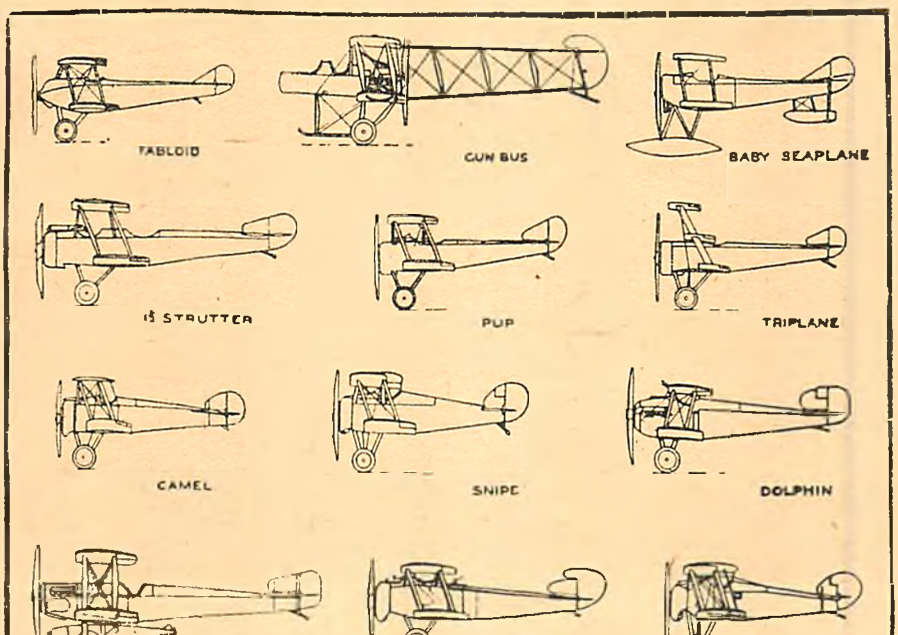
When this machine paid its first visit to Hendon Aerodrome, England, it left everyone agape, as such speed as it developed had certainly never been seen, nor probably been believed possible, with a biplane type of machine. In those days the general opinion was that for speed one must have a monoplane, and it was not until the advent of the "Tabloid" that this fallacy was effectively cleared up.

After that the small, fast single-seater biplane received a great impetus, and the type began to become general all over the world. It will, therefore, be seen that the world at large, and British aviation in particular, owes a debt of gratitude to the Sopwith firm for having demonstrated the possibilities of the small biplane. In addition to its great maximum speed—92 m.p.h.—the "Tabloid" was remarkable in those days for its great speed range, as it would fly as slowly as 36 m.p.h. This was a range of speeds which none of the contemporary monoplanes were capable of.

In its single-seater form the "Tabloid" underwent various minor alterations, one type having skid undercarriage, but with the front struts slightly more raked than they were in the original machine. Another slight alteration was the addition of a vertical fin in front of the rudder, which latter was not balanced. The next step in the evolution of the "Tabloid" was seen when the late Mr. Harold Barnwell flew a "Tabloid" in the aerial Derby. This machine, although similar to its prototype, was fitted with a Vee-type undercarriage. Finally, the "Tabloid" entered the last stage of its development by being fitted with ailerons instead of warping wings, and in this form it was a most successful single-seater scout.

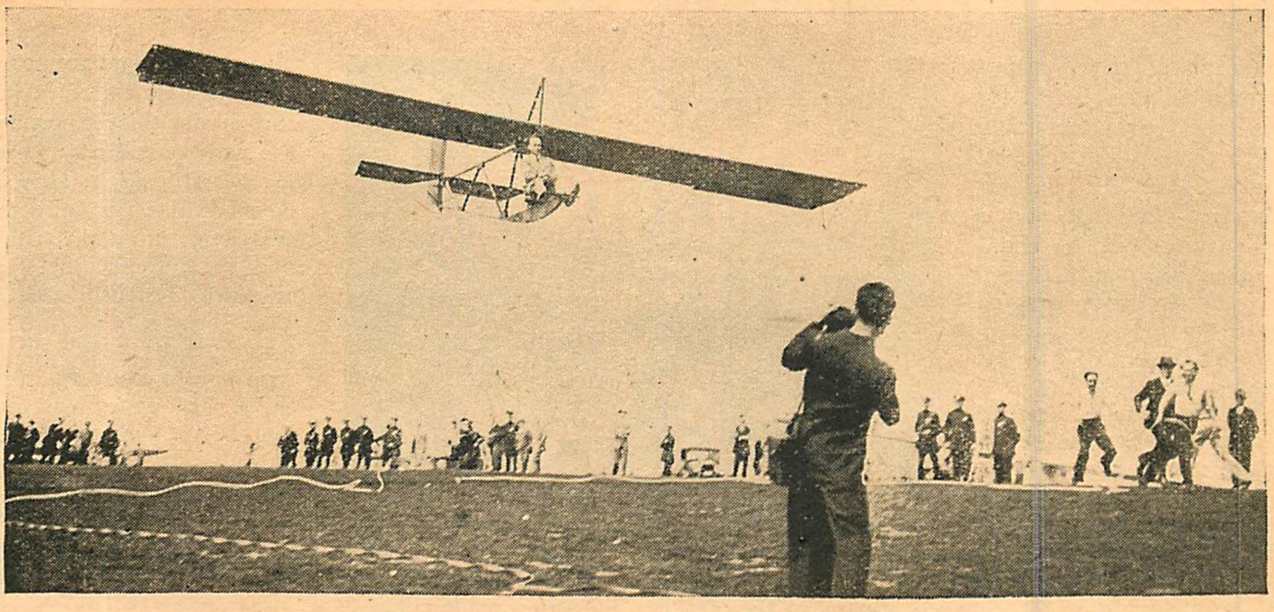
The Gun 'Bus (1914): As a result of their experience with Sopwith school pushers, the Sopwith firm were given an order by the Greek Government for a number of somewhat similar machines, carrying a pilot and gunner, but not fitted with dual controls. A gun was mounted in the nose of the nacelle. This order was nearing completion when the World War broke out, and the machines were commandeered by the Admiralty. From August, 1914, they were immediately put into service, being among the first aeroplanes to be armed, and were equipped with land undercarriages instead of the original float chassis. The earlier batches were

(*Continued on page* 46)



Side elevations of the Sopwith machines

HOVERING a few feet above the French liner *Ile de France* in an autogyro, James Ray, of the Pitcairn Company, successfully passed a package of films from the plane to the liner. *Courtesy of Paramount News*



A Primary Glider in Flight

Gliding AND Soaring

The Construction and Maintenance of a Glider

By Percival and Mat White

THE following chapter will not show you the detailed, step-by-step, engineering process of designing or building a glider. Such careful instruction involves a separate book devoted to the subject, and all that can be done here is to sketch the genuine procedure and to acquaint you with the process.

It is essential that the construction be accurate and airworthy. If possible, you should submit your work frequently to the inspection of a qualified builder to be sure each step in the building is satisfactory before you go on to the next one. He should be, if possible, an aeronautical engineer who has made a hobby of gliders, an experienced airplane rigger, or a high school manual-training teacher with special training. During the construction work, you should also keep in touch with the nearest Department of Commerce inspector.

Once you have chosen trustworthy plans, you should follow their directions implicitly. The general instructions given here are merely to make the plans more intelligible.

To avoid waste, the different parts should be laid out on the lumber before cutting it. The working dimensions for all parts should be given on the blue prints; but if not given, you must compute the dimensions according to the scale by which the plans are to be enlarged.

As has been stated, you will need a large clear space to lay out the work. Although the profile of the wing can be laid out on a bench, the wing itself must be set up flatwise; usually on horses or on a specially built form, and must be built either on a firm floor or on trestles, so that it can be lined up with great accuracy. This is also true of the framework for the fuselage.

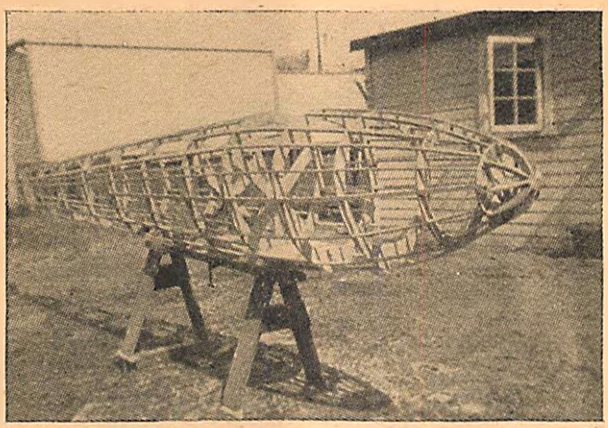
Wing Construction. Essentially, wing construction consists of a series of ribs strung onto a framework of spars. Spars are pieces of wood which run the entire length of the wing. Ribs are sections built up of thin strips of wood bent to conform to the proper profile. This structure is put together by setting up the spars, lining them up carefully, and slipping the ribs over them. The ribs are glued, and sometimes nailed, in place. The whole framework is then strengthened by wooden diagonals and cross pieces, running in different directions. Diagonal wires are also used for bracing the wing structure.

Externally Braced and Cantilever Wings. There are three types of wings: externally braced wings, semi-cantilever wings, and full cantilever wings. A cantilever wing is one in which the construction within the wing itself transmits all of the strain and stress of flight and landing from the wings to the fuselage, and *vice versa.* Cantilever wings are used on soarers and must be extremely well built. An externally braced wing is one where the struts and wires, running from the wing to other parts of the ship, transmit most of the strains. A semi-cantilever wing is one with comparatively few struts and wires, where the strains are divided between the construction inside and that outside of the wing.

THE externally braced wing is the one used almost entirely in primary gliders. Many water gliders are biplanes and have the other form of external bracing. Usually the externally braced wing differs from the cantilever wing in that it has solid spars instead of lattice work, web work, or box spars. The strutted wing usually has two spars, and the cantilever a varying number. The cantilever wing must be very firmly braced internally in order to resist torsion. The externally braced wing is much the most common, and is the one which will be described here.

Ribs. The strips of wood used for a rib are bent into shape over a jig, or form. This jig consists of a board, somewhat larger than the cross-section of the wing, on which has been drawn the full-size outline of the profile of the airfoil. Blocks of wood are nailed to this board to hold the various strips of wood accurately in position until they have been fastened together. The strips of wood should then be steamed and forced into place between the blocks of wood.

While the rib is held by the jig, the various posts and braces must be glued in place. The Wrights used solid pieces of wood for braces, which ran vertically between the top and the bottom of the rib. This block rib is still used somewhat, and is satisfactory for primary training gliders; although it is very heavy and is hence adapted only to very thin wing sections. These braces are put in with glue. They are usually fastened by nails, also, for the additional strength. If nails are not used, the whole rib must be allowed to remain on the jig for at least a day, until the glue is dry.



The Framework of a Fuselage

The usual method of building the internal rib braces for primary or secondary training gliders is to join strips of wood, anywhere from 3/16" to 1/4" square, to the outside rib strip by means of junction gussets. These gussets are small pieces of plywood glued, or glued and nailed, to the joints to reinforce them. The gussets may be fastened to the joints on one side of the rib only, or an additional set may be glued on the reverse side after the rib has been taken from the jig.

OFTEN, when the wing covering is stretched over the wooden structure, the sections of the rib rim between the posts become bent or flattened out. This is the great disadvantage of this type of rib. It may be overcome if the rib is carefully built, and if the braces are numerous.

The rim of the braced rib with junction gussets is often made in two pieces. In this case, the strip of wood at the top of the rib is joined to the strip at the bottom by means of a piece of plywood at the leading edge. This plywood runs along the entire leading edge of the wing. It is joined to the ribs by nails and glue, and serves to hold the cloth covering taut over the wing.

There are many other types of rib construction. The most rigid rib is one in which the entire profile of the wing is cut from a single piece of plywood. Slots are then cut in the plywood to reduce the weight and to give room for the spars to pass through. A less expensive, but highly useful, rib is made by cutting the rim alone from plywood. This rim is braced by diagonals. All plywood rims should be reinforced by cap strips around the outer edges of the rims. However, ribs of this sort are both expensive and difficult to build, and are usually used only in soarers.

Spars. Solid spars are used in most training gliders, since they are the simplest to build. When solid spars are used, they are usually placed fairly near the leading edges of the wings, so that they will not need to be too thick, and thus add excessive weight. Solid spars are not usually much larger than 3 or 4 inches by 1/2 inch.

If you are building a high performance glider, solid spars are not suitable. Spars made to run through the thicker portions of the wing profile may be made in several ways. They may be made like iron girders, of two long thin strips running parallel, and joined by diagonal braces fastened with gussets. They may be of I-beam section; that is, made of a flat strip of plywood, stiffened by cap strips, or they may be hollow boxes built of plywood. However, these spars are used especially to resist torsion, or to give additional strength, and are commonly used only in soarers.

Beside the regular spars, additional lengthwise reinforcing strips, made either of wood or thin strips of metal, are often used along the leading and trailing edges of the wing, and along that part of the wing to which the ailerons are to be hinged. These are not used if the leading edge is covered with plywood, as it often is, and the trailing edge also may have plywood or a thin strip of metal, probably aluminum.

The wings of primary training gliders are usually made in two units so that they may be easily taken apart, to be repaired, stored, or transported. The fittings for joining the spars in this case should be attached to the spars before the wings are assembled. They are designed so as to allow the spars to be joined by easily removable pins.

Assembling the Wings. The usual method of assembling the wings is to set up the spars on trestles or on the floor in perfect alignment. The spars may be lined up by the use of a string. You should mark out with a pencil the point on the spars where each rib is to be located. The ribs are then fastened into place on the spars. Ribs are usually set about 1 foot to 18 inches apart. If they are farther apart than this, they will not serve to hold the wing covering in shape, especially over the nosing, and false ribs, extending forward from the front spar, should be inserted between the true ribs.

SEVERAL ribs at the wing tips are occasionally made heavier than the others to withhold the strain of the taut wing covering; in this case, you should be sure to put these ribs in the proper positions. Glue and, if necessary, nail the ribs firmly to the spars. It is essential that the assembling should be done with great accuracy.

Wire Bracing. After the ribs are fastened in place, the whole structure must be braced with wires. The wires used to brace wings internally are called the "drift" and "anti-drift" wires, or cross bracing. These wires run diagonally from the rear to the front spar. The drift wires serve

(*Continued on page* 39)

Rigging and Assembling a Secondary Training Glider

Special Course in

Air Navigation

By

Capt. Leslie S. Potter

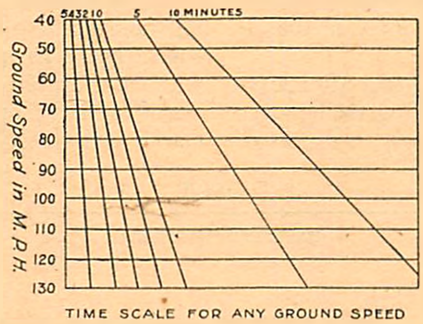
IN this final article of the series I will try to co-ordinate some of the lessons learned in earlier issues into a practical illustration (so far as a ground illustration of aerial matters can be practical) of their application in flight. The whole object of this series has been to supply the navigator with information that will enable him to cope with various problems that may arise during the process of navigating a plane on a cross-country flight.

We will first deal with the preparations that should be made before starting, and then follow the course of a hypothetical flight through all its stages, including in it some of the problems that most commonly arise. In the first instance we will consider the case of a plane where a second pilot or navigator is carried.

The first thing to do on receiving instructions for a cross-country flight is to obtain all the weather information on the route available at the Meteorological Office. A report of the winds at various heights along the proposed course and the visibility and conditions at your destination should be noted. A careful study of the synoptic chart will give valuable indications as to the possibility of weather disturbances being encountered en route. The next point is to secure the necessary map or maps covering the area to be flown over.

FIGURE III

For use with 8 miles to an inch scale map



In connection with this it is always advisable to carry your maps in a map case of convenient size with a celluloid face. The size most convenient you will determine for yourself. Too large, they may be difficult to handle in the air owing to limited space; too small, and an insufficient portion of the route will be exposed. There are some map or chart boards which have an adjustable protractor attached to movable arms at the side. These are an advantage but not essential.

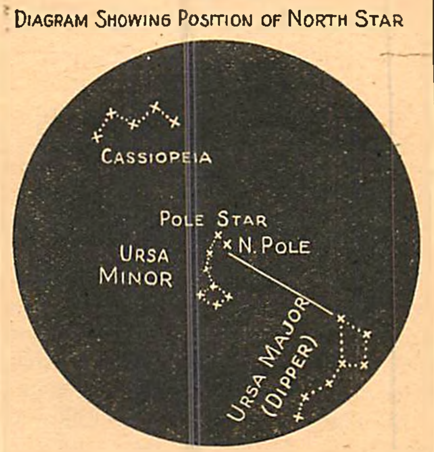
Having placed your maps in the case in their proper sequence, you lay down your track. When more than one map is being used, see that they are folded in such a manner that a good overlap is left. That is to say, see that at least five or ten miles of the track on one map is repeated on the track at the beginning of the second map.

DRAW a line between your places of departure and arrival on the face of the celluloid cover. Measure the length of this line by reference to the map scale and ascertain your distance. With the aid of a protractor next find your true bearing. Place the center of the protractor over the point of departure and align it so that its north and south line runs exactly parallel to the nearest meridian. You can then read off the angle made with the line representing your track.

These figures should all be entered in a pilot's log book. Two books for navigation purposes should be carried on a long cross-country flight. Different navigators will probably prefer to set out their calculations in different manners, and they will no doubt all be excellent, but the books shown in Figures I and II are the ones I have personally found most satisfactory and are the ones which I always use. It is essential to keep a record of your calculations in the air, as even if no record of the flight is required afterwards, you may, in the case of difficulties have to refer back to earlier figures to see where any mistake may have been made.

FIGURE IV

DIAGRAM SHOWING POSITION OF NORTH STAR



The apparent position of these stars in relation to the North Star will change about 15° every hour. A line drawn from the two points of Ursa Major will always point toward the North Star

Figure I represents a rough note book with rubber bands securing the pages together. On the top page all rough calculations could be made, and on the lower page the data and results brought neatly together with notes explaining their relevance. Figure II shows the log book to be kept during flight. The information on the top is all set in prior to starting. Where it is not desired to carry two books, the portion headed "space for calculations" may be used instead of the rough note book. Some may prefer it that way, though personally I have found the space insufficient for calculations on a flight of any distance.

NO irrelevant matter should be included and the notes should all be sufficiently clear and concise as to make them understandable by a third person. Letters should always be placed after degrees indicating whether they are True, Magnetic or Compass courses, and abbreviations should be used where possible. Such abbreviations as A/S (airspeed), G/S (ground speed) E. T. A. (estimated time of arrival) will always be readily understood.

We will now consider a flight from New York to Quebec. Our track line drawn over the map tells us that the bearing is 16°T. and the distance 450 miles. Of all the windspeeds and directions given us by the weather bureau we find that the wind is most favorable at a height of 6,000 feet. Here it is from 145°T. at 25 m.p.h. This height is particularly suitable as it leaves a good margin for the hills over the route.

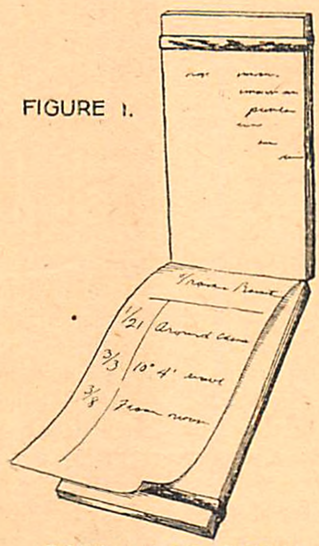
The map tells us that our variation is 10°W. at the start, though by the time Barre is reached it increases to 15°W., while at Quebec it becomes 20°W. The deviation card gives us a deviation of 1°E. at 45°, and no deviation on north. We may, therefore, assume no deviation exists on our course. Our cruising speed is 90 m.p.h. and our calculations tell us that assuming the wind to be correct, we must steer a course of 30°T. to maintain a track of 16°T., and that our groundspeed will be 106 m.p.h

We enter these particulars in the log book and add, also, a list of the prominent places over which our course is going to take us. The following places might be selected: New York-Carmel Reservoir; Carmel Reservoir-Pittsfield; Pittsfield-Barre; Barre-Derby; Derby-Sherbrooke; Sherbrooke-Quebec. We can then work out our estimated times of arrival at each. If the line representing the track is now divided in sections representing 20 or 30 miles, it will save a lot of measuring in the air and facilitate easy reference.

Now study the map carefully for a short distance on either side of the track and note any particular features of the route. For example, it will be seen that most of the journey lies over hilly country; the Connecticut hills first followed by the White Mountains later, but the height of 6,000 feet allows a safe margin for these. The Connecticut river lies on our east for a large part of the flight, and between Pittsfield and Barre a stretch of the course runs almost parallel to a railway running nearly north and south.

Before we reach Derby, Lake Memphramagog will be clearly visible, while Sherbrooke is a railway junction there will be no difficulty in recognizing, and from here to Quebec a railway runs west of but almost parallel to the course. Between Barre and Derby the ground rises considerably, culminating in Mount Mansfield with a height of nearly 4,500 feet, but after Sherbrooke the hilly country is gradually left on the east.

FIGURE 1.



ROUGH LOG BOOK

WE have now entered all the particulars in the log book prior to departure, and assuming a start is made at 11 o'clock, the E.T.A. at Carmel Reservoir will be 11.34. We must not forget to gradually increase the allowance for variation along the route.

We climb as rapidly as possible to 6,000 feet after leaving and assume our first course of 40°C., glancing over the side to see that our drift is approximately as expected. At the end of 33 minutes we find ourselves about 4 miles to the east of Carmel Reservoir instead of slightly to the west. We immediately pin-point this position and the drawing of a line between here and New York will show us that our track has been 12° T. instead of 16° T., and that our groundspeed has increased to 112 m.p.h. This looks as though the wind had veered to a direction further abeam. Calculations will show that it is now from 138°T and has increased slightly to 28 m.p.h. Our new track to Pittsfield will, therefore, be 19°T and our course 35°T. The groundspeed will be 100 m.p.h., as we are now steering more into wind.

Accordingly we steer a course of 48°M. (the variation is gradually increasing to 15 W. at Pittsfield), and find that our new E.T.A. is 12.13 p.m. This proves to be correct as we arrive over Pittsfield at exactly this time. A brief check of the wind here with our drift indicator will be an advantage before we set the new course for Barre. The wind proves to be the same and our new course is set, 32°T. or 47°M. Just before Barre, clouds appear ahead at a low altitude. Owing to the hilly nature of the country it is not safe to attempt to fly beneath them.

A glance at the watch tells us the time that has elapsed since leaving Pittsfield, and from this we calculate the distance flown and so pin-point our position on the map before passing above the clouds. After 20 minutes flying the clouds cease and we again pin-point our position before attempting to identify objects on the ground. We are now somewhere between Barre and Derby, and a further wind check here shows that no change has occurred in its speed and direction.

THE presence of hills on either side agrees with the map and we continue our previous course, allowing, however, a further 2° for variation. The appearance of a hill larger than the rest directly ahead, which we judge to be Mount Mansfield, and later the sight of Lake Memphramagog on our left, confirms the correctness of our deductions.

Beyond watching objects below and checking them on our map, it should not be necessary to do anything further before arriving at Sherbrooke. If we are still on a correct course here, we continue without another check on the wind, remembering that we edge away to the left of the hills and keep to the right of the railway. Providing our course keeps us in this direction, Quebec will be reached without the need for further calculations.

All of these: our changes of course and noting of landmarks, will have been entered in the log book together with the times. The method found easiest in calculating windspeed and direction may be used; tail bearings may be taken if preferred but it is immaterial which method is adopted. There can be no doubt about reaching the desired destination so long as it is possible to check, and when necessary, modify the course.

In the case of a pilot who has to do his own navigating while at the controls, it is a mistake to assume that he is not concerned with the methods of air navigation because he is unable to use many of the navigational instruments and because most of the calculations will be beyond his ability to perform while at the controls. His examination of the map of the route should

(*Continued on page* 34)

FIGURE II

SPACE FOR CALCULATIONS

NAVIGATOR'S LOG SHEET

DATE .... AIRPLANE .... PILOT ....

FLIGHT INSTRUCTIONS ....

WIND AT .... FEET .... M.P.H. .... FROM .... TRUE ....

FROM	TO	AIR SPEED	TRACK TRUE	DISTANCE	COURSE TRUE	VARIATION	COURSE MAG	GROUND SPEED	TIME	ETA

LOG TO BE KEPT IN THE AIR

TIME	TRACK REQUIRED	COURSE STEERED	OBSERVATIONS

SPECIMEN NAVIGATOR'S LOG SHEET

A Course in Airplane Designing

By Ken Sinclair

IN presenting this course, MODEL AIRPLANE NEWS *wishes to stress the fact that model building is more than a mere sport. If the builder of model airplanes learns the fundamental principles underlying airplane flight and designing, he prepares himself for a future career in the most profitable phase of aviation.*

The policy of MODEL AIRPLANE NEWS *is not to encourage or teach its readers to become pilots, but rather to become aeronautical engineers, designers, salesmen, manufacturers, or equip themselves for any other positions which require the training of the specialist or executive. Study this course from month to month, master it in every detail and you will gain a fundamental knowledge of the how and why of airplane design which will be second to none.*

THE EDITOR.

THE motor, though, is not responsible for all of the noise made by a plane. Quite a good measure of the racket is due to the propeller, as has been proven in cases where mufflers have actually been fitted.

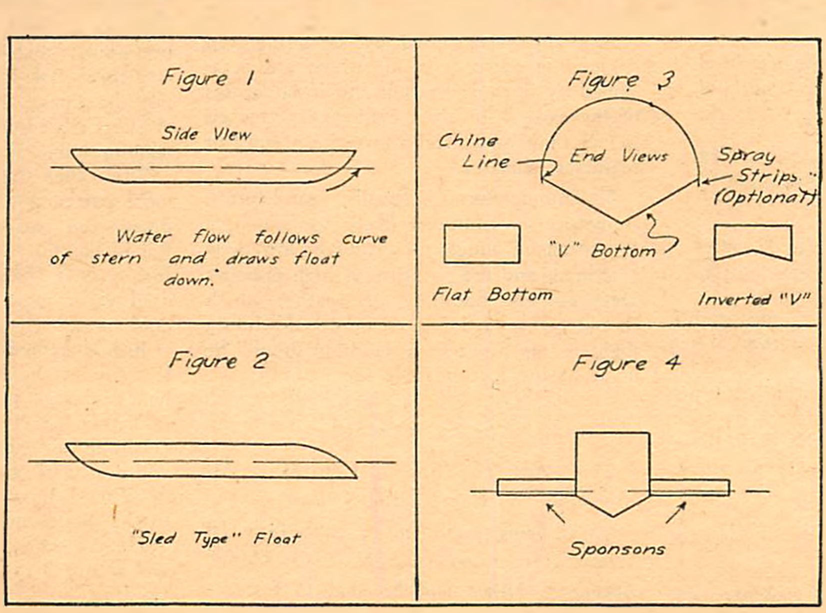
Just how the propeller comes to be so noisy is not precisely understood, but it is thought that the air breaks away from the curve of the blade near the tip, just as it breaks away from a wing beyond the burble point, and sets up violent eddies.

At the terrific rotational velocity of a propeller (about 511 miles per hour for the tip of an eight-foot prop turning over 1800 R.P.M.) these eddies of air behind the blade strike each other with great force, and it is believed that they are the cause of the peculiar noise made by the prop. No remedy for this is known at present, other than the reduction of the propeller tip speed.

This latter can be brought about by gearing down the propeller, so that the motor turns up to a sufficient speed to operate efficiently in the production of power, while the propeller turns over more slowly; thus reducing the tip speed and hence the noise.

On full-size ships, the propeller is sometimes subjected to stresses from external causes. For example, when flying through a heavy rainstorm the propeller undergoes some little punishment from the raindrops. At the tip, which is traveling, say, at five hundred miles per hour in its circular path and a hundred miles per hour forward, a large drop of rain would strike with terrific force.

Some idea of that force may be gained by sticking one's hand out of the cockpit when flying through the rain. Even at the speed of the ship, about a hundred miles an hour, the rain drops strike the hand with such force that they feel like tiny pellets of lead. Think, then, of the force with which they must strike the propeller tips, which are traveling at more than five times the speed of the ship!



Most wooden propellers on the larger ships are metal tipped to protect the tip of the propeller. This brings another danger. Were the metal tip to be sealed, the water from a rainstorm might gather under it, and cause a dangerous vibration as well as a strain on the propeller. Metal tips, therefore, are provided with small holes at the end, through which the water may be thrown by centrifugal force if any should gather under the metal.

Hail, too, brings its dangers to the propeller. Hailstones frequently attain large sizes, and one of these striking a rotating prop will be sure to cause quite a shock. I have seen propellers that had flown through hail for but a few minutes, with the leading edges all chewed up by the hailstones as if a beaver had been at work on them!

Thus we see that a propeller must be designed for more than level flying. It must be designed for the abnormal stresses of rapid maneuvering, for the effects of rain, and, to a reasonable extent, for the effects of hail and ice. The propeller must be tough, strong, resilent and light.

As to materials for propellers, we have only found three or four that have been practical. The ancient and honorable wooden propeller, still in widest use, has truly carved a place for itself in the air. Wood is resilient, tough, and strong for its weight.

OF greater importance, perhaps, is the ease with which it may be worked. Wood is very often used in the laminated form, in which alternate layers of different woods, such as mahogany and spruce, are glued together and the propeller cut from the block. Contrary to general opinion, a properly glued joint is actually stronger than the wood around it.

The laminated propeller is satisfactory for the reason that it does not split easily and the layers of different woods keep it from warping.

Duralumin, an alloy of aluminum and other metals, has been used to quite a large extent, but of later years has been replaced largely by the steel propeller. The steel prop has the tremendous advantage of easy manufacture. That is a big point. Airplanes are costly enough as it is, due to the expense involved in building them, and every effort is being made to standardize production and cut down cost.

A propeller that is hard to manufacture is an expensive one. The expense will naturally cut down the sales, which in turn will

(Continued on page 43)

Navigation

(Continued from page 32)

be even closer than that given it by one who is simply concerned with the navigation and who is able to use the instruments.

Landmarks and their positions with relation to the track should be memorized, tracks and distances carefully tabulated in a form that can easily be referred to in the air, and the actual times of passing prominent objects should be noted en route. Frequent use should be made of drift lines on the wings and drift checked wherever possible.

By noting actual times of arrival at various places and comparing them with the estimated times worked out before departure, and considering these in conjunction with any variations of drift noted, a rough idea may be gained of windspeed and direction, though this, of course, can be accurately ascertained by flying upwind and across it in the method already explained.

A simple ground speed scale such as shown in Figure III could be prepared. The one in the diagram has been drawn for use with an eight-miles-to-the-inch map, but one can easily be drawn to suit the scale of the map being used. Knowing the time taken to fly between two points on a map, you place the scale so that the lines representing the correct interval of minutes pass through the two places and the ground speed is read off from the side. Scales are best prepared in celluloid.

When a doubt arises as to a pilot's position he should know from his map or his record of times, his approximate position, and should endeavor to locate some distinctive landmark. If he decides he is definitely lost, he should keep some conspicuous landmark in sight while he tries to find any reason for being off his proper track, and here it is that his log book proves invaluable. Glancing through his notes he should try to decide whether:

1. There is any reason to believe the wind has changed, and if so, what effect it is likely to have had on his course.

2. His airspeed or altitude has been changed for any appreciable time, and how this is likely to influence his track.

3. The drift differs materially now from that observed at the beginning of the flight.

4. The course has been altered materially at any time to avoid storms, etc.

Answers to these queries should enable him to decide on which side of the correct track he is, but if these do not help him to locate his position he must either continue until he recognizes some landmark, or else land and inquire, but neither of these courses should ever be necessary normally. Try and eliminate any uncomfortable feeling of uncertainty that may come when no recognized landmark is in sight. Your compass, used intelligently, is far safer to follow than any railroad. Bad visibility may obscure the latter; your compass is always with you!

Navigation by night should not be attempted until one has become proficient by day. The use of instruments by night and the reading of maps by artificial light is always more difficult. Towns, railroad stations, etc., show up well by night, but do not forget that at certain times many of the lights are extinguished and the same objects will present entirely different appearances at different hours. It is easier to steer a steady course at night as the air is generally less bumpy.

The ability to recognize the principal stars and to locate the North Star will be a useful accessory to the compass, but remember that stars appear to revolve round the North star through an angle of about 15° every hour (see Figure IV). It may be a help to "set" a star globe or chart before starting and adjust it hourly. The position of the stars at certain times will then be apparent.

In conclusion it is pointed out that two or three courses successfully steered by purely navigational methods will be so convincing as to their efficacy, that the average pilot will never again return to the old "hit or miss" or "hope to goodness the weather keeps clear" methods.

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ANSWERS TO LAST MONTH'S QUESTIONS

1. The wind flows from high to low pressure areas in clockwise rotation on leaving the high, and anti-clockwise rotation on entering the low.

2. The general direction of travel of highs and lows across the United States is from west to east.

3. Aneroid and mercury barometer. A falling barometer indicates a falling of the atmospheric pressure which allows the mercury to fall in the mercurial barometer and the metal box to distend in the aneroid barometer. It always precedes a change in weather. Cloudiness accompanied by rain and winds will frequently follow. The latter need not necessarily be of gale force but will be stronger than in an area of high pressure.

4. Bumps are caused by ascending and descending currents of air which are occasioned by unequal heating and irregularities of the earth's surface. Seldom experienced higher than 3,000 feet above the ground in temperate climates.

5. Thunderstorms, squalls, sandstorms, snowstorms, conditions likely to cause ice formation on wings, the center of low pressure areas and the outskirts of high pressure areas are all conditions of weather which should be avoided. If encountered while a flight is in progress a landing should be made at the first possible opportunity.

This ends The Special Course in Air Navigation by Capt. Leslie S. Potter. The series is being published in book form by Messrs. Harper and Bros., N. Y. C. MODEL AIRPLANE NEWS will be glad to forward any inquiries for you.

The Editor.

Bishop!

(Continued from page 12)

wounded. The only injury in his whole war career was a damaged knee while he was an observer. At that time his pilot made a bad landing and Bishop was laid up for several months.

Bishop holds numerous records for all air fighters on both sides. On April 30, 1917, he had nine fights in one hour and three-quarters. "This very pleasant fighting day," as he called it, was marked in the afternoon by a battle between Bishop's patrol and four of Baron von Richthofen's fighting circus, which included the famous German ace himself.

"I opened fire on the Baron," reported Bishop in his "Winged Warfare," "and in another half-moment found myself in the midst of what seemed to be a stampede of bloodthirsty animals. Everywhere I turned smoking bullets were jumping at me, and although I got in two or three good bursts at the Baron's 'red devil,' I was rather bewildered for two or three minutes.

"Around we went in a cyclonic circle. I was glad the Germans were scarlet and we were silver. It was a lightning fight and I have never been in anything just like it. During one minute you would have to concentrate all your mind and muscle in doing a quick turn to avoid a collision. Once my gun jammed, and while maneuvering to the utmost of my ability to escape the direct fire of the ravenous Germans, I had to 'fuss' with the weapon until I got it right again. I had just got it right again when von Richthofen flashed by me and I let him have a short burst."

Four more machines suddenly dove in. Both sides pulled out to see whether they were friends or enemies. They were British naval triplanes, and the Germans vanished in a swift dive. Honors were even. Bishop's machine was riddled, one burst having passed within an inch of him!

He had forty-seven planes to his credit when he went home to organize and train fighters of the air, but in twelve more flying days in May, 1918, he had added twenty-five more to his score. On his last day before returning to his training work, he made the record for a single flight of less than two hours. Behind Ypres, on this flight, he saw three fast Pfalz scouts just after crossing the lines. He dived for the nearest. A short close burst and the enemy fell in a flaming spin.

The other two dived at him, then two more roared out of a cloud above. Bishop dived, and two of the enemy collided and fell in flames. The remaining two climbed, Bishop gave chase, opened fire at two hundred yards, and sent one into a spin that crashed it. The other escaped.

Bishop kept on cruising, for this was his last day at the front. Near Neuve Eglise he attacked a two-seater and sent it down in flames. Following it down to watch it crash, he spotted a column of German troops and scattered them with his gun.

"Then," he reported later, "I climbed into the clouds and went home."

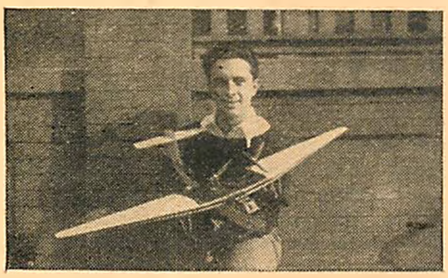
He had set out with a score of sixty-seven, and returned to lunch with seventy-two! In addition to destroying all these enemy planes, he was victor in at least a hundred other combats high in the air.

American Sky Cadets

(*Continued from page 20*)

for each fifty square inches of wing area; they may drop no parts in flight; they must be built entirely by their owners, except for propellers, wing ribs, propeller bearings and propeller shafts; they must derive their power from rubber motors; they must be hand-launched; they must be flown by their owners. A contestant may have three models for use in the contest.

Scale Model Contest: Models to be eligible in this contest must have a wing span of exactly 24 inches, and must have all other parts in exact proportion; they must be exact replicas of man-carrying airplanes; they must



William Petrosio, student at the Aeronautical Research Laboratory, Secaucus, N. J.

be built entirely by their owners; if a model is made from drawings not previously checked by the A.M.L.A. Contest Committee it must be accompanied by a drawing approved by the manufacturer of the plane giving all dimensions and details necessary in judging the model. A contestant may enter one model. It must reach contest headquarters not later than June 14th.

Stout Outdoor Fuselage Contest: Models to be eligible in this contest must "conform to good engineering practice"—that is, they must have built-up fuselages and resemble real airplanes: they must have main supporting surfaces (wings) of at least 125 square inches in area; wings must be double-surfaced; the fuselages must be completely covered, except for an opening of not more than two square inches to permit access to the motor; they may drop no parts in flight; they must be built entirely by their owners, except for propellers, wing ribs, propeller bearings and propeller shafts; they must derive their power from rubber motors; they must rise from the ground; they must be flown by their owners; they must have a maximum fuselage cross section at least equal in square inches to one-tenth of the length of the fuselage squared. A contestant may have three models for use in the contest. To be eligible for N.A.A. records, a model of 125-inch to 150-inch wing area must have wheels of at least 1½-inch diameter; a model of more than 150-inch wing area must have wheels of at least 1¾-inch diameter.

Wakefield International Contest: All models must rise from the ground from a standstill; only one model may be used; each contestant will be given three trials; fuselages must be entirely covered including rubber motor, fuel tanks or air container; power is optional; models must not weigh more than eleven pounds; the minimum value of the largest cross section of the fuselage must be not less than 1/10 of the length of the fuselage squared.

Note: Examples of fuselage formulae used in both Stout Outdoor and Wakefield Contests:

required cross section area $= \dfrac{(\text{length of fuselage})^2}{10}$

If fuselage equals 30″

$$\text{required area} = \frac{30}{10} = 9 \text{ square inches}$$

If fuselage equals 33″

$$\text{required area} = \left(\frac{33}{10}\right)^2 = 10.89 \text{ square in.}$$

Under the contest rules at least one part of the fuselage must have a cross section equal to the required area.

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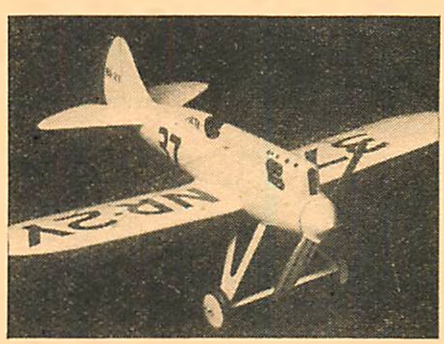
The Junior Aviation League of Denver, Colorado, recently held a scale model con-



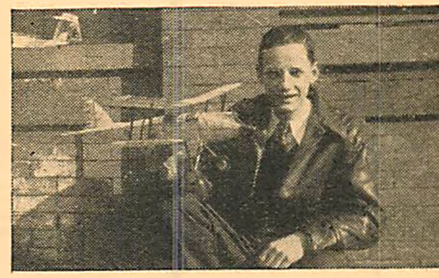
A model Benny Howard Racer built by E.W. Topping, Ashland, Ohio.

test in the boys' department of the Gano Downs Clothing Store. The store sponsors the club which now boasts of a membership of more than six hundred boys.

More than fifty boys entered scale model planes. Parents and friends crowded around the planes as they were placed on the show cases for exhibition before the judging commenced.

Mr. Thomas Shelton, an Aeronautical Engineer who is a Ground School Instructor at the Curtiss-Wright Flying Field in Denver, was chief judge. Models were grouped as to types. Judging was made by elimination. Points observed were detail, neatness, and workmanship. The models entered were replicas of many well known ships. Wing span did not exceed twelve inches.

The first prize was a silver trophy. The



Walter Treger, student at the Aeronautical Research Laboratory, Secaucus, N. J.

second and third prizes were also silver trophies. All three trophies were won by high school boys.

Richard Jones won first with his perfectly constructed scale model Boeing P12-B.

Second prize went to Fred Swink who also entered a Boeing P12-B.

The third prize was awarded to Gerden Henry for his miniature Travel-Air Mystery "S."

There were six other prizes of gold wing insignia for the six next best planes. The awards were as follows:

Fourth—Richard Wade, OA-5 Curtiss Robin.
Fifth—Billy Sparr, Boeing P12-B.
Sixth—Harry Wheeler, Sikorsky.
Seventh—Robert Quick, Eagle Rock.
Eighth—Porter Nelson, Bellanca.
Ninth—Harry Cornish, Curtiss-Robin.

Contests, such as the one here reported are held frequently throughout the year. Interest is keenly alive for the next contest to be held soon in the large City Auditorium. This will be for indoor and commercial models.

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Multiple Motor

(*Continued from page 22*)

If an experimenter wishes to build an over-size, multiple rubber band motor—say increase the dimensions given by one-half—it is then quite practical to install a quick winding gear in the rear anchor block. Figure 7 (Plate II) suggests how this can be done.

Of course, a ratchet pawl, or other provision, must be made to lock the gears after the motor is wound up. The quick winding gear is not advocated for the motor specified in the drawings. The added weight will seriously impede flight of the model.

It is not the intent of this article to deal with the actual plane construction, but Plate IV will suggest the possibilities of incorporating the octogon fuselage into various models. It is well to mention, however, that any model plane using the multiple rubber band motor should have not less than 180 square inches of surface to the main wing.

There are so many factors to be considered when building a flying model plane, and relation between the factors, that it is impossible to lay down a fixed rule except for a fixed model. The experimenter will find, however, that if his wing construction conforms to the established laws of aerostatics, the multiple rubber band motor will provide the power to fly the model.

Plans and Hints

Readers who submit plans and hints for model makers to MODEL AIRPLANE NEWS are requested to see that their manuscripts are addressed to

THE MANUSCRIPT DEPARTMENT
MODEL AIRPLANE NEWS
Room 1901, 570 Seventh Avenue
New York City.

All manuscripts MUST be typewritten on one side of the paper only, and double-spaced. If the manuscript deals with a flying model, a photograph of the finished model *in flight* must be submitted. The plans MUST be drawn to scale, and all measurements on the plans checked against the text matter.

The Airplane Engine

(Continued from page 11)

mechanical work. We find that this is so.

Heat can be measured very accurately. The unit is the British Thermal Unit, commonly called B. T. U's. It is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. Although an approximation, this is close enough for practical purposes.

Work is the expenditure of energy through a distance. Its unit of measurement is the *foot-pound*. That is, if a person lifts a hundred pound weight one foot, he has done one hundred foot-pounds of work. Gravity alone must be considered in this computation. For instance, if a body weighing one hundred pounds is slid ten feet across the floor, only the friction tending to resist that motion would be considered.

Suppose the frictional resistance were ten pounds. Then the person has again done one hundred foot-pounds of work. On the other hand, if a person pushes all day against a building and fails to move it, he has done no work. True, he has labored, but he actually performed no work.

Since in an internal combustion engine heat does result in the movement of a certain force (as in the power stroke of a piston) work is done. It has been found that one B.T.U. is equivalent to 778 foot-pounds of work. That is, with no frictional losses and a 100% efficient engine, the resulting action of one B.T.U. on top of a piston would contribute 778 foot-pounds of work to the crankshaft.

When it is considered that aviation gasoline had a heat value of 20,000 B.T.U.'s per pound, or approximately 150,000 per gallon, it can be realized what an enormous amount of heat is liberated within the cylinder. Unfortunately, a large percentage of the available heat is lost before being put to any useful purpose. Figure 5 gives an approximation of the practical use of heat within an internal combustion engine. The thermal efficiency of such a power-plant is very low, even though it is higher than that of a steam engine.

We have all observed that the speed with which we perform a task affects us physically. The man who runs the hundred yard dash may be nearly exhausted, while a man who walks the same distance will notice no results from his efforts. Yet it may surprise us to learn that both of these men, providing they weigh the same, have done exactly the same amount of work.

However, we find that it takes more *power* to do the same amount of work in a shorter time. In other words, *power* is the *rate* of doing work. It is expressed in *foot-pounds per minute*, although the practical measure is the horsepower which is the equivalent of 33,000 foot-pounds per minute.

The power of an engine can be found by the formula:

$$\text{Horsepower} = \frac{PLAN}{33{,}000}$$

where

"P" is the mean effective pressure in pounds per square inch. That is, it is the average of all pressures within the cylinder which tend to contribute to the power.

"L" is the length of the piston stroke in feet.

"A" is the piston area in square inch.

"N" is the number of power strokes per minute for the complete engine. It is equal to the product of the engine revolution and one-half the number of cylinders.

The power given by this formula is called the *Indicated Horsepower* and is the power that the engine can theoretically produce. However, a certain amount of power is dissipated by friction. That which is left is termed the *Brake Horsepower* and is the amount of power that is available to turn the propeller in order to provide forward speed to the airplane.

Mechanical Efficiency then becomes the ratio of Brake Horsepower to Indicated Horsepower as shown by the formula:

$$\text{Mech. Eff.} = \frac{\text{Brake Horsepower}}{\text{Indicated Horsepower}}$$

Anything that will increase the Brake Horsepower will increase the Mechanical Efficiency of the engine. An increase, for instance, of engine temperatures will increase the Brake Horsepower, for it will decrease the thickness or the viscosity of the lubricating oil and hence will reduce the frictional losses.

The remaining factor which affects the efficiency of the engine is the *Volumetric Efficiency*. When the piston is at bottom dead center of its travel, the space within the cylinder above the piston is the total Cylinder Volume. See Figure 6. This is the volume that could be filled with a fresh charge of fuel, if the engine were operating ideally. This condition is never actually reached, unfortunately.

As the piston drives upward to scavenge the cylinder of exhaust gases it is unable to force them all out. Thus, the incoming charge is unable to completely fill the complete volume, for some of the space is already occupied by the burnt gases. Further, as the in-rushing gases strike the hot cylinder walls they expand and occupy an increased amount of space. Consequently, a lesser weight of fuel can find its way into the cylinder.

Many other factors prevent a full charge from flowing into the combustion chamber. The *Volumetric Efficiency* is the ratio of the weight of the fuel charge actually drawn in to the weight of the charge that would fill the space under normal atmospheric pressure and temperatures.

It is well known that if one compresses a gas before igniting it, much greater power will result. This is because under compression the particles of the fuel and air are in closer contact. Consequently when combustion takes place less energy is absorbed by the particles themselves in order to complete their chemical mixture. As a result more heat is available for useful work; that is, to expand the gases and hence force the piston downward to its work of revolving the crankshaft. This expansion force acting on the piston will be about four times the compression pressure.

The *Clearance Volume* of a cylinder is the volume above the piston when it is at its top dead center. See Figure 7. We have already seen the total cylinder volume in Figure 6. The *Compression Ratio* is then the ratio between the volume of the cylinder above the piston when it is at its extreme depth and the volume above the piston when it is at its extreme height. According to the sketches, it is:

$$\text{Compression Ratio} = \frac{V_1}{V_2}$$

In actual practice we can expect the power of any engine to increase as we increase its compression ratio, for it increases the efficiency of combustion. This is true up to a certain point. The limit is set by the kind of fuel used. If compressed too much, most fuels will detonate or "knock," This point of limiting compression can be raised if properly blended fuels are used in the engine.

For instance, if benzol or ethyl-lead is mixed with the normal gasoline, a higher compression ratio is permissible. Fuels for racing airplanes are always specially blended. The compression ratio for this type of engine will often approach eight, but for ordinary uses it remains between five and six.

Under average conditions one may safely say that the faster an engine is operated the greater is the power developed. This can be seen by observing the power curves in Figure 8. The power continues to increase as the revolutions increase. However, a point is reached when the output begins to drop in spite of increased engine revolutions. This is mostly because of reduced volumetric efficiency. The piston is traveling so fast that a full volume of fuel can not be drawn into the cylinder. Hence, a smaller charge of fuel is burned and, consequently, less heat and power is developed.

The speed of the engine is also limited by other factors. One is the stresses set up by the inertia of the reciprocating parts of the mechanism. The strength of the materials must not be exceeded if reliability is desired. As rated the maximum horsepower of an aviation engine is somewhat below the actual maximum output that is possible.

However, at these high speeds many revolutions increase in engine speed is necessary for a small power increase, and it is not worth while, considering the strain on the engine. Thus even as far back as the drawing board, the designer must prevent the careless operator from getting into trouble.

* * *

The second article, "The Mechanical System of an Airplane Engine," will explain in detail the action of all moving parts of the engine. Instead of the simple one-cylinder engine we will consider a multiple cylinder job. After this article the student should have a good general idea of what is taking place within an engine. Succeeding articles will take up individual subjects in detail such as: Lubrication, Ignition, Fuels, Accessories, etc. Upon the completion of this course the student should have an intimate knowledge of every detail of the airplane engine.

Radio Course

(*Continued from page 7*)

and dissolved in the solution.

These particles contain positive electrons, and the solution becomes positively charged, leaving the zinc plate negatively charged. The escaping hydrogen gathers on the copper plate in the form of bubbles and produces a positive charge there before rising to the surface.

There now exists a difference of potential between the two plates which will last as long as the chemical process continues. As soon as a path is made along which the electrons can flow; or in other words, as soon as a connection is made between the two terminals, a current is set up.

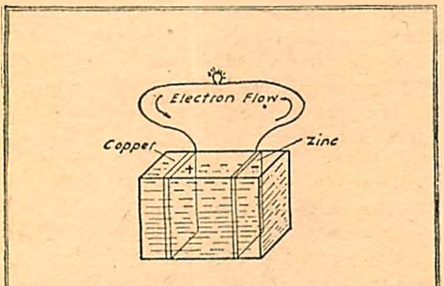

FIG. 7 - SIMPLE WET CELL

The metal plates are named electrodes and the solution electrolyte. The battery just described is of a simple type. In the batteries made today another element is introduced to combat the tendency of the hydrogen bubbles to move back to the zinc plate and so reverse the polarity of the battery.

During these explanations it will have been noticed that no flow of electrons and, therefore, no flow of current has occurred until a connection has been made. There must be an uninterruptd path of flow from one terminal back to the other; that is to say there must be a complete circuit. Break the circuit and the current ceases.

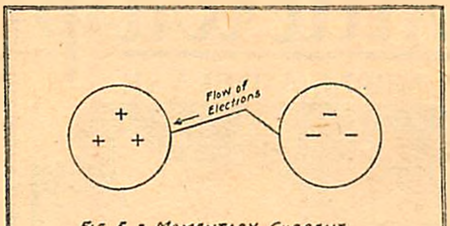

FIG. 5 - MOMENTARY CURRENT

In the case of a transmitting key the circuit is completed by pressing down the key and a buzz results. In the case of a pocket flash light the circuit is completed by pressing the button when a light follows.

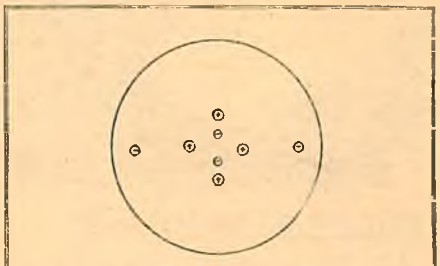

FIG 3 - NEUTRAL ATOM

A greater voltage may be gained by placing the electrodes closer together. The closer together they are the more operative they become. It may also be gained by wiring together the alternative negative and positive terminals of a number of cells, as shown in Figure 8.

This is called a series connection and the voltage will be the total voltage of all the cells. The amount of current will not be increased. If this is required the positive and negative plates must be connected to opposite sides of a circuit, as shown in Figure 9. The voltage will not be increased, but the quantity will be represented by the total amperage of the cells connected. This is called a parallel connection.

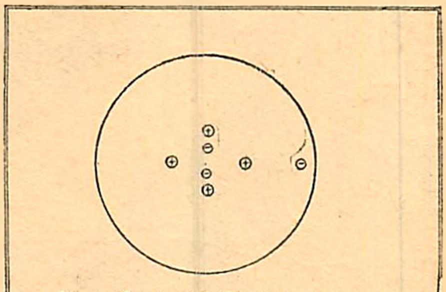

FIG. 4 - POSITIVELY CHARGED ATOM

Next month we will deal with the different types of generators.

Tractor Model

(*Continued from page 14*)

drawing, as is the mounting of the hangar.

The same drawing shows the outer dimensions of the propeller, which is made of medium balsa. The propeller-hook is made of steel wire, and is inserted through the propeller hub. Drop a little ambroid on the hub to hold the fitting in place after the end has been bent over and pushed into the hub.

Experiments can be made much more interesting and instructive if you purchase from a model supply store a ready-made 10-inch diameter variable pitch, propeller, aluminum for preference.

For motive power, eight strands of 1/4-inch flat rubber can be used.

LANDING GEAR

The parts and mounting for the landing gear are shown in drawing number 5. You will need two pieces each of "p" and "r," made of hard balsa. The piece "s," shown in the assembly drawing, can be made of 3/32 inch bamboo, sandpapered to streamline shape. Use steel wire for the axles, and 2 inch celluloid wheels.

TAIL

The tail is our last job. As shown in drawing 2, make from hard balsa one of piece "n" and two of "o." Ambroid these together to form the triangle tail piece as shown in drawing 5. Now mount the wings on the motor-stick, using a couple of strong rubber bands to fasten them. Next fashion the motor-stick to the "l" struts. Ambroid the tail to the motor-stick and cover the upper side. Don't cover the sides of the wing structure—you will see the reason for this later.

TEST FLIGHTS

Put one drop of oil on the propeller and wheel axles and start your tests.

Now, as an incentive for various tests, my Aeronautical Research Laboratory will award a compressed air motor to the boy who builds this model, tests it and makes the most interesting and successful reports.

Try the following experiments:

1. First glide your model in the usual way.

2. Try to make a hand start when your motor is turning at about 100 revolutions a minute. Is it really necessary to move your motor-stick to obtain good balance?

3. Wind up your motor as tightly as possible. How is your lateral stability, longitudinal stability, and does your model keep a straight course?

4. Try launching your model into a side wind.

5. Place pieces of wood between the motor-stick and wing to change the angle and height of wing with respect to the motor-stick, and try flying your model that way.

6. Does your model make a three-point landing?

7. NOW—cover the sides of the wings as shown in the photograph and make the experiments outlined above, write down the results and let me know what happens. Write to me, care of Capt. H. J. Loftus-Price, editor of Model Airplane News, 570 Seventh Ave., New York City.

Gliding and Soaring

(*Continued from page* 30)

to offset the tendency of drift to sweep back the wings; the anti-drift wires simply equalize the strain exerted by the drift wires on the wings. The wires are attached to the spars by means of metal fittings.

The Fuselage and Landing Gear. The fuselage of a primary training glider is comparatively simple to build, but there is at present a great deal of dissatisfaction with the type usually seen, which is an American adaptation of the German "Zogling." When starting to build you may, however, begin construction with the box skid. This should be made of very strong material, since it must withstand many landing shocks. Put together the top and the side of this skid, and brace them with several diagonal strips of wood. The piece of wood forming the bottom of the skid should then be steamed and fastened to the skid.

The front posts in the fuselage, running from the skid to the wings, should be of strong wood, about 3 inches by 1 inch, and streamlined. The best plan is to run these struts right through to the base of the box skid. The framework of the fuselage which extends backward from the wings to support the tail group may be made of metal or of wood. These must be carefully lined up and the intersections laid out accurately. Fasten the joints firmly by inserting three-cornered blocks into the angles of intersection and by reinforcing with gussets.

Gliders of this type must be flown very carefully. There is little or no lateral strength to the fuselage, making it dangerous in a yaw while towing, and very breakable in a side-slip landing. The main vertical member, being of wood, sometimes shatters in a hard landing, releasing the safety belt and throwing the pilot on his head. Steel tubing corrects this latter weakness but not the lateral, as it would bend where the wood might break. A steel-tube keel with a V-shaped cross-section has been suggested to give lateral strength.

The enclosed fuselages of secondary training gliders and soarers are more difficult to construct. These are built in the manner of boats over a series of bulkheads or forms set thwartwise of the fuselage at stated intervals. It may be intended to remove the bulkheads after the longerons have been put in place. In this case, they may be made of almost any kind or thickness of wood. However, some, if not all of the bulkheads commonly remain, in order to give the structure great rigidity when it is completed. They are then built of plywood or of some other light material. If no bulkheads are allowed to remain in the completed fuselage, cross braces, similar to those used *in rib construction*, may be used to strengthen the fuselage.

The longerons, or lengthwise members of the fuselage structure, must be attached to the bulkheads, and all joints fastened as in the openwork fuselage. Another lengthwise member is often built into the fuselage from one end to the other, like a backbone, to give strength. Do not depend on wires to brace the fuselage, for they will not withstand severe landing shocks.

Steel tubing can be used to advantage and is less dangerous in a bad smash. However, while it will not break, injuring the pilot, it will bend and is difficult for amateurs to repair. For auto towing and aircraft towing, steel should be used. Properly selected, it is no heavier than wood.

An enclosed fuselage is covered with plywood, cloth, or both. Plywood covering is expensive and somewhat difficult to build. A cloth covering, treated with dope, and strengthened in places with plywood, is the most satisfactory material for the amateur to use.

The seat consists of wooden bottom and a curved metal or wooden back.

The Undercarriage. A single skid, or runner, is used on most gliders and soarers. Primary training gliders sometimes have such a runner in addition to the box skid; sometimes springs are put between the base and the runner. You should make this runner of clear, hard wood, ordinarily about 10 or 11 feet by 3 inches. The runner is bent into shape by steaming it; the curve should be sharp at the front and gradually decreasing, so that it is flat at the rear end, somewhat like a toboggan. It is important on a primary training glider that the runner be easily removable, since it may be broken easily and have to be replaced.

A tail skid is used on most gliders. This prevents damage to the tail group in landing. This is similar to the main runner, except that it is smaller and shorter. It is fastened below the tail end of the fuselage, at about the point where the tail controls are fastened. Wheels are used on those gliders which are intended to be towed behind automobiles.

The wheels should be small, hung close to the fuselage, and provided with shock absorbers, if possible. The simplest method is to buy the wheels. Probably the neatest use of the wheels is to have it "buried" in the skid at the normal point of contact with the ground. In a hard landing, the balloon tire lets the ship come down gradually on the skid, acting as a shock absorber. This wheel may have a brake for spot landings.

The Control Surfaces. The control surfaces are, in general, built in the same way as the wings, except that they may be made of lighter material and they have no camber.

You must take care that the ailerons do not spoil the streamlined shape of the wings. The jig for the ailerons should be made from the full-size drawing of the wing profile which you have already made. If the ailerons run the whole length of the wings, the simplest method is to make a separate jig for the ailerons.

If, however, the ailerons only extend along the trailing edge of the wings a short distance from the tips, no new jig need be made for them. After all the ribs have been fastened to the spars, it is possible to saw off those rib tips which are to be used for ailerons. Small spars will previously have been put in position to serve as the leading edges of the ailerons.

The ailerons are hinged directly to the main rear spar, or to a spar set in the wing purposely to carry them.

Training gliders are usually built with triangular stabilizers and stationary fins. The elevators and rudder are hinged directly to these airfoils, much as the ailerons are hinged to the wing. Soarers, on the other hand, often have elevators and rudder which are pivoted at the center of pressure.

Cloth Covering. The wings, the control surfaces, and often the fuselage must be covered with cloth. The wing covering can in some cases be made up in the form of a properly shaped bag, to be pulled over the ribs and spars and nailed, glued, or sewed in place. This method of covering is not so satisfactory for most purposes as that by which the cloth is glued or sewed to all the ribs, and tacked along the edges of the wing. In this case, the cloth need not be made into a bag, but can be drawn over the wing in strips. A wing covering which is fastened securely to the wood structure greatly strengthens and stiffens the entire wing.

The strips of cloth used for the covering should be sewed together firmly, wherever necessary, with strong thread. It is well to cover the seams with tape. The tape may be made to adhere by means of glue or dope. When the cloth covering has been applied, it should be given several coats of dope. The dope will cause it to shrink until it fits tightly over the framework. There is some danger of stretching the cloth too much: the right degree of tautness may be determined by experiment.

Control Mechanism. The stick and rudder bar should be set into the floor of the fuselage at a comfortable distance from the seat. The stick is usually of wood covered with a metal tube, so that bolts may be put through it without crushing the sides of the tube. The rudder bar is a piece of wood shaped like the rudder bar on a bob sled. It is pivoted at the center to a short post projecting from the floor. From holes in each end of it, wires run to horns affixed to the rudder.

The control surfaces themselves are fitted with horns, *i.e.*, small blocks of wood, with holes bored through them, projecting from the control surfaces. Through these holes in the horns, the other ends of the control wires are run. The method of lining up these wires is described in the following chapter.

Struts and Wires. The primary training glider has a considerable amount of trussing which is open to the air. The struts, *i.e.*, the pieces of wood or metal which brace the wings, are usually streamlined. It is customary to put ferrules, or other metal fittings, at each end, so that they may be held in place strongly and be easily detachable.

A great many wires are used to brace the whole construction of a primary training glider. The most important of these are the landing and the flying wires. Numerous other guy wires are used, such as those stretched from the tips of the stabilizer to the rudder post. The wooden framework of the wings, fuselage, and control surfaces is reinforced by gussets at the points where wires or struts are attached.

Wires used for trussing are fitted with turnbuckles so that their tension may be adjusted. It is necessary that the wires should be tight enough to serve their purpose, but loose enough to give slightly.

Secondary training gliders have fewer struts and wires, and are often semi-cantilever. Soarers are designed on the cantilever principle, so that they do not have any outside trussing of the wings.

Water-glider Construction. The construction of water gliders is in some respects different from that of land gliders. The float is covered either with duralumin or wood, or sometimes with wood covered with cloth. A metal float is difficult to shape and requires special tools. The wood used for floats is usually cedar or mahogany. Wide, clear, and amply long pieces of white or western red-cedar can be obtained. Brass or copper tacks and nails should be used in the float to prevent rusting.

A float is built in much the same way as the enclosed fuselage of a land glider. The wood covering must usually be steamed and bent in place around the bulkheads; the boards or "streaks" should be fastened as close together as possible. The cracks between them may be filled with glue or heavy varnish; but if the joints are accurate the water will swell the wood enough to close the crevices. If you should cover the float with cloth, more coats of dope should be given to it than to the fuselage covering of a land glider, since it is important that the float soak up as little water as possible.

The wing floats of a water glider are built in the same way as an entirely enclosed float. They must be large enough to have sufficient buoyancy, but small enough to increase parasite resistance as little as possible. The amphibian glider is one which will take off on land but land on the water. The National Glider Association states that the development of this type glider will make available three times the soaring terrain in America.

Conclusion. Although a number of primary training gliders have been designed and the designs well treated, comparatively little experimenting as yet has been done in this country with gliders of a higher performance. When building your first gliders you will do well to work with these already tested designs. It will rarely happen that you start your building with an advanced ship, but it is particularly necessary that great care be given to the choice of design and the building of anything but a primary ship.

It has been impossible here even to suggest the extent of such designs. The more construction work there is carried on, however, the greater will be the advance in the science of glider design. When the amateur has built two or three planes, he will no longer be an amateur, but will, perhaps, be prepared to draw original plans and to test out new types of motorless planes.

MAINTENANCE

A knowledge of glider maintenance is of importance to any one who is either building or flying one. There are certain means for transporting the glider from the factory, and from one glider field to another. You should not only be able to effect some minor repairs, in case of accident, but you must also know the nearest place where the repairs can be made and new parts purchased.

Devices for Transporting the Glider. When gliders are sent out by rail from factories, they are usually crated or boxed, with the wings and the fuselage packed in different units. There are, however, methods by which the glider can be transported after it has been assembled. The commonest of these is a trailer, i.e., a frame mounted on wheels which can be fastened behind an automobile. The wings are removed and placed on this endways.

Moreover, gliders are sometimes transported by a carriage, or frame, onto which the fuselage can be set, so that the wings protrude at either side. This carriage can be put onto a truck, allowing the glider to be moved without being jarred; or wheels may be attached to the carriage so that it can be towed for short distances behind an automobile (not practical—still too wide for the highway).

Attaching the Wings. On most gliders, the wings are set at zero incidence. You can find the correct position for the wings by calculating, from the plans, actual distances between definite points on the wings and on the fuselage.

When you have set the wings in place, the struts must be attached. These will already be the correct lengths, if they have been made exactly in accordance with the plans. They are fastened in place by means of metal fittings at either end.

Fastening the Guy Wires. In all planes except those with cantilever wings, the wires have to be lined up. This is a very delicate piece of work, and must be done with great precision. After the wires are attached to the rest of the structure by means of special fittings, they must be tightened by turnbuckles until they have the proper tension. It is important that the tension of all the wires be practically equal, especially that of the flying and landing wires. If these wires have too much tension on one side of the wing, they will pull that side out of shape, and out of line; if they have too little tension, they will allow the wires on the other side of the wing to distort that side.

You can judge this necessary equality of tension pretty nearly by plucking the wires to feel whether they all have the same tautness, and to hear whether they all have the same pitch. When you have completed the adjustment of the wires, you should fasten the turnbuckles by passing another wire through the hole in the center member of the turnbuckle and twisting its ends through the holes in its ends. All fittings should be safetied.

Attaching the Control Surfaces and Wires. When the wings have been joined to the fuselage, the glider is practically complete except for the control system. The stabilizer and stationary vertical fin must be put into place. Fasten the stabilizer at zero angle of incidence, and the vertical fin perpendicular to it. (Use a carpenter's square to obtain exact right angles.) Then, hinge the ailerons, rudder, and elevators in their respective positions.

In the system of control wires, the rudder wires run directly from the holes in each end of the rudder bar to the holes in the horns at either side of the rudder. The wires may be fastened by doubling the ends back and twisting them around the main wire where they should be firmly bound, or by twisting the ends around bolts fixed on the horns for this purpose. This is an important operation and should be done with great care.

There are two general methods of operating the ailerons. The simpler of these is that by which a spring is attached at one end to the underside of the wing and at the other end to the underside of the aileron. This spring tends constantly to pull down the aileron. When the wire, which runs from the horn on the upper side of the aileron to the stick, is not pulling the aileron up or holding it in normal position, the spring pulls the aileron down.

This system may be reversed and the spring attached to the upper side, thus pulling the aileron up. This type of aileron control may be used on a primary training glider although its use is questioned by many authorities, but it will not do for a more highly sensitive type of ship, since the spring is always apt to get caught or weakened.

The other and better method of operating the ailerons is to run two wires to each aileron from the torque tube, over pulleys, or "sheaves," fastened to the main part of the wing just in front of the aileron horns, and through the horns which project, one from the top, and one from the underside of the aileron.

To each elevator, two wires run from the stick, over pulleys, and through the horns on the upper and lower sides of the elevator; these wires are crossed once between the pulleys and the horns. Be sure that you do not confuse the different cables.

The control wires are fitted with turnbuckles, as are the guy wires, and these should be carefully adjusted. You must make sure that, when the stick and rudder bar are in neutral position, the ailerons and elevators are exactly in line with the wings and stabilizers, and that the rudder is in line with the vertical stationary fin.

(*To be continued*)

von Richthofen!

(*Continued from page 8*)

Baron and his brother next went after two artillery-observing planes. The great ace finally got into his favorite position under his enemy's tail and the British plane caught fire.

Fifteen minutes later Richthofen fought a speedy Nieuport flown by Captain Frederick Leycester Barwell. They fought half an hour as the German squadron hovered on the "side-lines." Barwell was getting away when Richthofen started firing, though out of range. Barwell, thinking himself attacked again, began zigzagging, lost his superior speed and Richthofen overhauled him, sending the British plane down in flames. This was his fourth that day and his fifty-second victory.

In July, 1917, after a leave, von Richthofen lost his first battle. Leading eight in a patrol, he met six British planes. In a hard fight four Germans were shot down. Lieut. Albert Edward Woodbridge, observer with Pilot Captain D. C. Cunnell, poured a stream of lead in Richthofen's plane as it attacked head-on. When only twenty yards apart the German ace received a bullet in the head. Though scarcely able to see, he managed to land safely.

He recovered and brought down over a score more of Allied planes. However, he never flew with the same ease and confidence after this. On his final battle he led his squadron into a dog-fight between four Australian photographic planes, escorted by combat planes under Captain A. Roy Brown. Four Fokker triplanes attacked, followed by

Richthofen's fighters, who dived furiously in, while Captain Brown led his seven Sopwith Camels into the melee. There were twenty-two Germans, all told.

Richthofen attacked Lieut. W. R. May, a young flyer who had been ordered to stay out of a dog-fight until he had had more experience. However, May had brought down a German when Richthofen dived on him. The German was within thirty yards of the deadly tail position, with May dodging and stunting to get away, when Captain Brown dived to his aid.

At the bottom of his screaming dive Brown swerved to the right and slightly above the German ace of aces. Brown's tracer bullets struck Richthofen's tail; Brown elevated his Camel's nose, and the bullets raced along the Fokker's body.

Brown saw the pilot waver. He did not know who it was, but saw the riddled machine glide to earth, where it lost a wheel and landed in a shell-hole close to the British lines. Australians dragged it in from No Man's Land, and found the pilot still sitting erect, the control stick between his knees. They were amazed to find that it was Richthofen—The Red Devil of Germany. He had fought his last battle and lost.

Airplane Designing Course

(*Continued from page* 33)

prevent the manufacturer from lowering his price because of the production savings afforded by quantity manufacture.

It all goes in a vicious circle, and it is easy to see that the part, in this case a propeller, must be easy to manufacture in the first place. The steel prop fulfills this requirement. Modern methods of steel production are so highly developed that a very high grade of steel, *of uniform quality*, is obtainable at low cost. Moreover, steel is easily worked, and it is strong and resistant to changes of temperature and inclement weather.

Still another material that is used in propellers is Micarta. This is a composition material, used also in certain gears and other parts, that has proven itself quite satisfactory.

Research is continually going on in connection with the airplane propeller. Various freak designs are always cropping up, being lauded to the skies by the newspapers, and then proving themselves totally worthless in practical "flight" tests. In the majority of these cases the inventor is a man with very little knowledge of aerodynamics, and usually he has overlooked some important point that has spelled the failure of his invention.

If these inventors would get expert advice from someone who knows the game before they spend thousands of dollars on their worthless inventions they would be saved an infinite amount of labor and worry, to say nothing of the money loss involved, and the heartbreaking disappointment that is usually the only result of years of patient effort.

It is possible, of course, that someone may discover a new principle that will revolutionize aviation. In that case the inventor should stick to his guns, but first he should make sure that his invention does not run afoul of any of the long-proven laws that have been worked out by years of practical experience and study.

THE seaplane is not a new development. It is nearly as old as flight itself. The Voisin brothers were experimenting with seaplane gliders, towed behind speedboats on the Seine, long before they built their first successful airplane. The late Glenn Curtiss turned to the seaplane after he had built successful airplanes, and he is credited with the first take-off from the water in this country.

These pioneers realized that the water, whether it is a river, a lake, or an ocean, offers a natural landing field. The water is nearly always quite level, and there are no curious spectators to get in the way. Moreover, the landing and take-off areas offered by the water are usually much larger than those on land. For the plane with properly constructed floats, the water offers a shock-absorbing medium. For naval operations and for the carrying of passengers over lakes or oceans, the seaplane is the logical thing.

An important advantage of the seaplane is that its runways are not usually restricted, as they are for a landplane. The pilot of the landplane has to get off the ground quickly and climb rapidly because, in case of motor failure, he is in grave danger. The natural thing to do with the landplane in case of engine failure is to try to turn back into the field, rather than crash into obstructions outside. This turning back almost invariably ends up in a spin.

With the seaplane, however, the pilot can take off and climb in a more leisurely manner and, in case of motor trouble, he has merely to nose down and land again, because his field is not limited in extent. Usually he has several miles of "runway," whereas the landplane pilot has less than a mile in most cases.

This matter of long runways is valuable also in the building of racing planes. Ships that fly at three or four hundred miles an hour need very long runways for take-offs and landings. Long runways—and very smooth ones—are scarce indeed on land. The water offers, again, the logical answer.

Taking it further, there are no clouds of dust to blind the seaplane pilot. He does not have to make cross-wind landings, because he is usually able to land in any direction he chooses and can easily head into the wind.

There are, roughly speaking, three types of seaplanes, or planes capable of operating from the surface of the water. The seaplane, which is nothing more than an ordinary airplane with floats attached in place of the wheels; the flying boat, in which the fuselage itself forms the float; and the amphibian which is a combination of the landplane with either the float seaplane or the flying boat. The latter is capable of using either land or water as a base.

In this article we will speak of all three of the types as one, for the function of the float is really the same in all three cases. In the first the float is a separate part, in the second it is integral with the fuselage, and in the third we have wheels attached on retractable struts. The float action is precisely the same in all three cases.

To the designer the seaplane float presents many requirements and some little difficulty. First of all, the float must be a good *boat.* That is to say, it must have sufficient buoyancy to sustain the weight of the airplane, and it must move through the water easily, throwing as little spray as possible. There are numerous other requirements, but we will deal with these general ones first.

The float must support the weight of the airplane. How does it do this? By its displacement. Any boat rides on the top of the water by virtue of displacing a certain amount of that water. We see a scow, loaded with gravel. It rides low in the water. When the gravel is taken off the scow rises until most of the hull is above the water line. Why does it sink lower when loaded? Because it can gain buoyancy only by displacing more water. If the load is too heavy, and the scow had not enough displacement, the whole thing will sink.

Water weighs, roughly, sixty-two pounds per cubic foot. To lift a load of sixty-two pounds, then, a scow or a float must displace one cubic foot of water. For an airplane float, which is to be used on a two thousand pound airplane, we will have to use a float that will displace—*at the very least*—about thirty-two cubic feet of water. That float will sustain the weight of the plane at rest, but only that much and not a pound more. Hence we need a margin of safety, and we design our floats with excess buoyancy, as we will see a little later.

Now we have our float, with a volume sufficient to displace thirty-two cubic feet of water, or more, and this is sufficient to keep our plane afloat on the surface of the water. However, we have only started. What shape shall be used? Shall the float be double-ended, like a scow? Or shall it be shaped like a streamline to cut down air resistance, having a round cross-section when viewed from the bow or stern? No. Either of these would be hopeless as floats.

Our float must run easily through the water at high speeds. That single requirement eliminates both the double-ended scow shape and the streamline shape, and introduces us to a new matter; that of "suction effect."

Suction effect is very important in float design, and must be understood thoroughly. The best way to learn what it is, is to perform a little experiment. Take a curved piece of metal, or even the back of a spoon, if nothing else is handy, and hold it under a running stream of water from a tap. Hold it in such a way that the water strikes the outside curve, and does not run down the other side. Note that the water, instead of flowing downward in its original direction, follows the curve of the metal, clinging to its surface instead of breaking away. That is the suction effect.

What has this to do with airplane design? A lot, most unfortunately. Suppose we design a float like that shown in Figure 1, having an up-curved stern. Excellent for a scow, perhaps, and one that will run easily at low speeds. However, the moment the plane gets up a bit of speed, as it must do to leave the water, what happens? Our arch-enemy, suction effect, comes into play, and the water tries to follow that up-curve at the stern, instead of breaking away. The float wallows lower and lower as the plane speeds up, being drawn down at the stern by the suction effect, and the plane cannot be pried loose with anything less than a crane.

With the streamline float suction effect raises similar havoc. Thus we see that this effect ruins the chances of any float having an up-curved, rounded bottom at the stern.

On the other hand, the first successful seaplane float was something like that shown in side view in Figure 2. The bottom was flat, and the float had a rectangular cross-section when viewed from the bow or stern. This shape is comparatively satisfactory for small ships, since the suction effect is done away with by the straight lines of the bottom.

Before going into the matter of the various float forms we will take a float through the successive stages of a take-off, in order that we may understand what is needed.

As has been said, the float lifts the weight of the plane when at rest by displacing enough water to obtain that buoyancy. When the plane starts to move forward, under the pull of the propeller, what happens? For some time, while the ship is gaining speed, the float moves through the water, still supporting the entire weight by displacement. The wings of the plane, as yet, have no appreciable lift. During this stage the float must run smoothly, so that the plane may gain headway.

As speed is picked up the float begins to rise out of the water, and, to hasten this action, we usually incorporate a *step* in the bottom of the float hull. The purpose of the step is to break the flow of the water. The step, at low speeds, causes a miniature waterfall, inverted, just behind the break. As the speed increases the step enables the water to clear the stern portion of the bottom altogether, and the float is said to be "planing." This cuts down the drag and enables the float to run along the surface of the water.

At this stage the weight is supported by the planing action, but the ship picks up speed rapidly, and the wings begin to gain lifting force. If the motor of the plane has sufficient power to pass this stage the plane will gain speed until the wings support it. Then it will rise free from the surface of the water.

Sounds complicated, doesn't it? It isn't at all bad, however. We must remember that the water is a fluid, and that it is not solid like the earth.

Having analyzed the take-off, we may now take a look at the requirements for a float with respect to what shape to use. The float must run smoothly at low speeds, and easily at all speeds. It must climb to planing quickly.

Moreover, it must not "pound," as it strikes the waves in the take-off, or in landing. Water, when struck with some speed, is not at all a fluid medium in effect. Strike the surface of some water smartly with the open palm, or with a flat board. The shock will be surprising. It is this same shock that is called pounding in seaplane practice.

Obviously it is a bad thing to have a float that pounds excessively, bouncing along from wave to wave, because this causes severe jars to the airplane and its occupants.

The flat-bottomed float mentioned earlier in this article is subject to pounding. All flat-bottomed floats are. On landing, they are likely to come down with a terrific "bang" unless the plane is handled with skill. In the take-off they have a tendency to pound in the waves. Hence the development of the "V" bottom float. The flat-bottom float is still used, however, on some very small, light ships, but it is considered poor for larger and faster planes.

On the other hand, the "V" bottom float has come into general use. The "V" bottom, as shown in Figure 3, is built with two angular sides. This enables the shocks of landing and waves to be eased by the form of the bottom. If the angle of the "V" is overdone, however, the float will not rise to planing easily; and hence it is usually built with a shallow "V."

As stated before, a step, or sometimes two or three steps, is used to help the float rise to planing and to cut down the water drag during the take-off. In America we usually see single-step floats, but in other countries two or more steps are often used.

In fact, every nation seems to have its own distinctive type of float, and the engineers of each seem to adhere pretty generally to their own particular style of design. The basic idea, however, is the same in all cases. The step or steps serve to break the flow of the water away from the rear portion of the float bottom, which is usually inclined upward, toward the stern.

The "V" bottom float is by far the best in landing. The flat bottom type tends to come down with some little shock, particularly if the ship is allowed to drop from a height of a foot or so. The "V" bottom type, however, as may easily be seen, tends to ease the shock by pushing the water aside instead of coming down flat. The point of the float enters the water first and then the rest settles, pushing the water to both sides as it does so.

This pushing-aside, however, causes the float to "spray," or to throw out sheets of water on either side. That tendency must be cut down as much as possible for several reasons. The pilot must have good vision in taking off and in landing, and a float that throws spray all over the ship is bad from this standpoint. Then, too, it is not at all beneficial for the plane to have water, particularly salt water, continually splattered about. Hence we design our floats to keep down the spray as much as possible.

That is done, usually, by the lines of the float, and sometimes by the addition of strips of metal along the chine lines. The chine line, by the way, is the line between the bottom and the side of a float. The curved "V" bottom is good from the spray standpoint, since it holds the spray down instead of shooting it more or less upward. This type, however, has a high water drag just before the take-off, because of its peculiar form, and it is rather hard to build this hollow "V" bottom.

Other forms of bottom have been tried. The inverted "V" runs "clean." That is, it does not throw much spray, but it pounds badly, as may easily be seen. The round bottom does not pound badly and it runs well. It throws a lot of spray, however, and has more water drag than the ordinary "V" bottom. The hollow bottom does not throw spray, but has a tendency toward vicious pounding.

Floats have been built in the form of a half-circle—in cross-section, of course—and have been tried. The idea it seems, is that the flat top will make good footing for the passengers, while the round bottom will reduce pounding. Unfortunately, this type of float is utterly hopeless. Suction effect comes into play, and instead of rising out of the water at high speeds, the float sinks

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State of New York }
County of New York } ss.

Before me, a Notary Public in and for the State and County aforesaid, personally appeared Herbert S. Clark who, having been duly sworn according to law, deposes and says that he is the Business Manager of the MODEL AIRPLANE NEWS AND JUNIOR MECHANICS, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Good Story Magazine Company, Inc., 570 Seventh Ave., New York City; Editor, Capt. H. J. Loftus-Price, Hotel President, New York City; Managing Editor, Harold Hersey, 570 Seventh Ave., New York City; Business Manager, Herbert S. Clark, 570 Seventh Ave., New York City.

2. That the owner is: Model Airplane News Publishing Co., 1926 Broadway, New York City. Stockholder: Macfadden Publications, Inc., 1926 Broadway, New York City. Stockholders in Macfadden Publications, Inc., Bernarr Macfadden, Englewood, N. J.; O. J. Elder, 276 Harrison St., East Orange, N. J.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are (if there are none, so state). None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) HERBERT S. CLARK, Business Manager.

Sworn to and subscribed before me this 3rd day of April, 1931. K. L. SULLIVAN,
(SEAL) (My commission expires March 30, 1933)

lower and lower, drawn down by the suction effect, and throws spray badly.

The circular cross-section float has been tried in conjunction with the streamline longitudinal form. It is even worse than the half-circle, which is saying a lot.

The circular float, however, has been used with some success in other countries. They break the suction effect by using a false bottom, with chines and steps to break the water flow.

On the whole, the ordinary straight "V" bottom seems to be the most satisfactory in general use. As to the form of the top, it is usually rounded. Sometimes the floats are built with a flat top, the idea being to afford a walkway for the passengers. The rounded-top float, when wet, is easy to slip in, and a ducking in cold water is likely to dampen any passenger's enthusiasm for air travel. The flat-topped float does away with that danger.

How about the lateral stability of the ship when it is at rest upon the water? By that I mean, how are we to keep the plane from tipping over to one side?

If we have a single float system it is plain that the ship will tip. So we often use small floats at the tips of the wings. Wing tip floats, however, are not intended to do any lifting. The central float attends to that. Indeed, the wing tip floats do not, ordinarily, touch the surface of the water when the plane is at rest and level.

They are usually about six inches to a foot—in full-size practice—above the surface of the water when the wings are level, and come into use only when the plane is tipped. In taking off the pilot can control the lateral balance with the ailerons, and the wing tip floats are needed only when the ship is at rest.

In the twin-float system no wing tip floats are needed. The twin floats are usually quite widely spaced, and the ship cannot be tipped to the side by any ordinary force. For commercial planes the twin float system has come into general use because the twin floats can be attached readily in place of the wheeled landing gear.

They also offer an easy access to the cabin or the cockpits, and are ideal for aerial photography, since vertical photographs may be taken from the cabin looking down between the floats. Single-float systems are used by the Navy for training planes, but for torpedo-carrying ships the twin-float system is used because the torpedo is slung between the pontoons.

In the single-float system it is not always necessary to use wing tip floats for lateral balance when at rest. The sponson is also used. As shown in Figure 4, the sponson is a stub float placed at the side of the main float. A notable example of this type is seen in the Dornier planes, of which the DO-X is the most well-known.

These sponsons are often made in the form of a wing section, and do their share of the lifting when the plane is in the air. They also enable the structure of the plane to be built up more easily, and they have not the air resistance of the wing-tip floats.

It is obvious that wing tip floats cannot be used on high-wing monoplanes for the reason that the floats would have to be attached by very long struts, and the drag of these, to say nothing of the weight, would be prohibitive. Hence the twin-float system is usually used for high-wing jobs, and sometimes the single-float with sponsons is seen.

Next month we will go on with our discussion of seaplane floats.

QUESTIONAIRE

1. What are some of the advantages of the seaplane?
2. What are the three general types of plane capable of operating from the water?
3. What is the most satisfactory bottom for a float? Why?
4. What are two methods of gaining lateral balance for single-float seaplanes when at rest?

Advisory Board

(Continued from page 27)

equipped with 100 h.p. Gnomes, but later water-cooled Sunbeams were fitted. A similar machine was a very familiar sight at Hendon Airdrome in the earlier days of the War.

The Torpedo Seaplane (1914): In 1915 The Sopwith Co. built for the British Admiralty a torpedo-carrying airplane. This machine was of an experimental character, but is notable as having been the forerunner of the famous Sopwith "Cuckoo." It was fitted with a 200 h.p. Canton-Unne engine.

The Tractor Seaplane (1914): In the matter of tractor seaplanes the Sopwith Co. had already done good work in connection with, for instance, the circuit of Britain, and they were therefore in a position to undertake the design and construction of machines of this type when, early in the War, the Admiralty ordered some seaplanes. One type was designed for reconnaissance work and was unarmed. The engine fitted was a 100 h.p. Gnome monosoupape, and the machine was fitted with folding wings. A somewhat similar machine of the land type was built also. The land machine differed, however, in several respects from the seaplane, apart from the difference in undercarriage. Thus the span of the two planes was equal. On several occasions machines of this type were seen at Hendon Airdome, where they caused curiosity chiefly on account of the bomb racks fitted on the struts of the undercarriage, a feature that was somewhat unusual in those days.

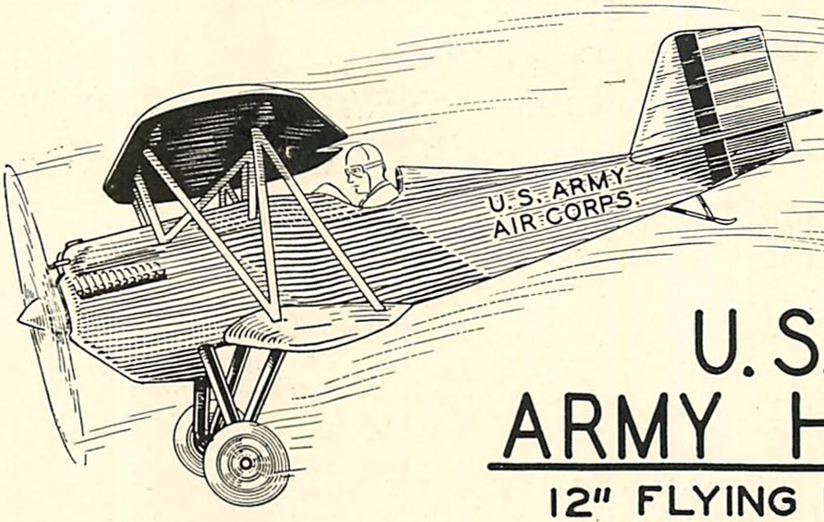
The Sopwith Bat Boat (1914): The Sopwith Bat Boat merits brief mention here on account of the good work done by this type of machine before the War. Thus it may be remembered that the Sopwith Bat Boat, which was first exhibited at the Olympia Aero Show of 1913, and which had a 100 h.p. Green engine, won the Mortimer Singer Trophy by starting off the sea, coming down on land, and starting from the land alighting on the sea again. This was accomplished by fitting it, in addition to the boat, with a collapsible wheel undercarriage. We are not quite certain but what this was the first flying boat to be built in Great Britain.

A later type of Bat Boat was fitted with a 200 h.p. Salmson engine and differed from the previous type in various details. Thus, for instance, it had a straight top plane, while the bottom plane had a pronounced dihedral. Also it had a single rudder instead of the twin rudders of the previous model. Also the tail booms were so arranged as to form a "V" when seen in plain view.

The Baby Seaplane (September, 1915): The Baby Seaplane was an immediate development of the "Tabloid," from which it differed principally in the fitting of floats instead of wheels. One of these machines made history by winning the Schneider Trophy at Monaco, and the Baby Seaplane was very similar to the famous Sopwith "Schneider." In this machine wing warping had given way to ailerons. The floats were of the plain, non-stepped type, and a tail float of considerable size was fitted under the stern. The engine originally fitted was a 100 h.p. Gnome monosoupape, but later on, 110 and 130 h.p. Clergets were used.

It is of interest to note that, although this seaplane performed highly successfully at its first appearance, it was more or less put on one side at the outbreak of War, and it was not until November, 1914, that the demand arose for a fast single-seater seaplane. It was then immediately put into production, and from that distant date until the signing of the Armistice the Sopwith Baby Seaplane was continually in-service.

(To be continued)



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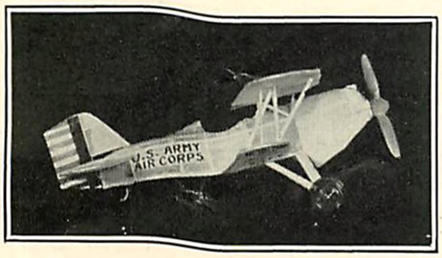

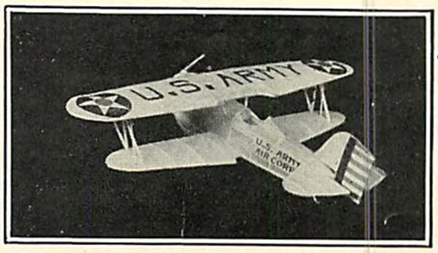

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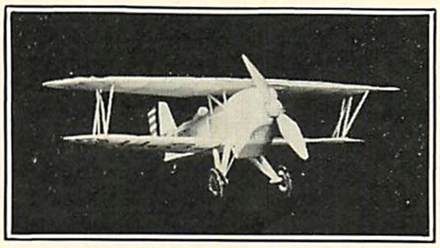

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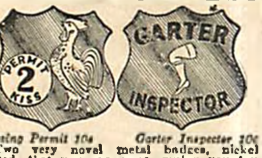

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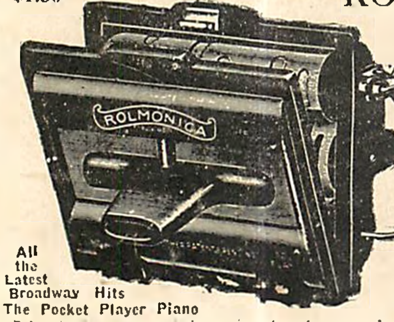

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