PARALLEL DEVELOPMENT WITH PBY

By HARVEY H. LIPPINCOTT

From the earliest concept of the PBY flying boat the employment of the then new R-1830 engine was contemplated. The engine design was new, for when Consolidated's I.M. Laddon was considering use of the R-1830 in March of 1932, the first production R-1830 had not yet been delivered to Grumman for the XJF-1, which took place on November 9, 1932.

Pratt & Whitney Aircraft's first twin row engine was the 14-cylinder R-2270 which first ran on May 14, 1930, and was later test flown in the company's Boeing 40B-4. However, experience indicated that a smaller engine would have a better market. Studies at P&WA settled on a 14-cylinder two-row type with a displacement of 1830 cubic inches. It was named the Twin Wasp. Design was undertaken and the first engine ran on April 16, 1931. Later that year it made its first flight in a Vought V-50 Corsair. However, it was not the first P&WA twin-row engine to go into production. The Navy insisted upon a still smaller engine. From this requirement resulted the Twin Wasp Jr. R-1535 which was in production nine months ahead of the R-1830. It soon became evident, however, that the R-1830 was the right size as the R-1535 had a short production life. More R-1830's were manufactured than any other P&WA recirpocating engine, a total of 173,618.

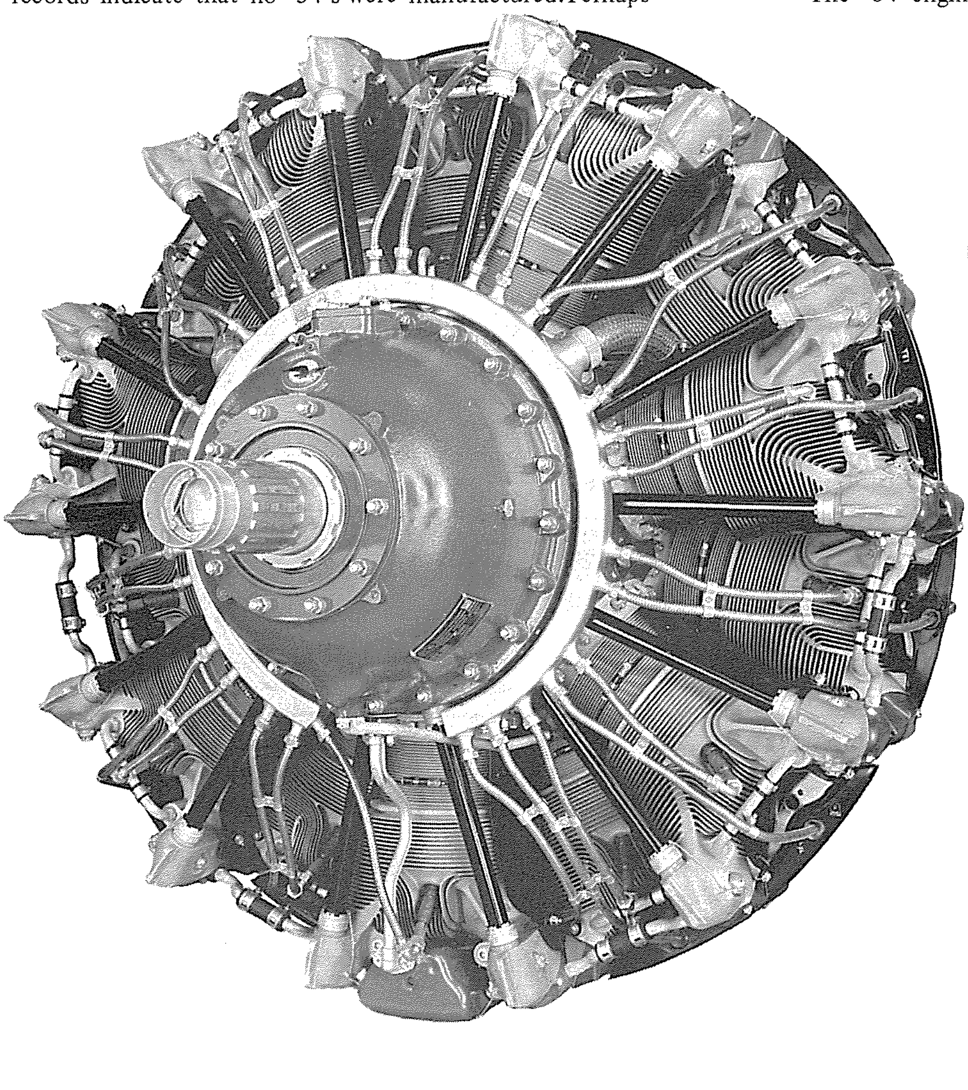
There are various reports of the R-1830-54 engine of 825 horsepower installed in the XP3Y-1. However, production records indicate that no -54's were manufactured. Perhaps this was a paper engine that was originally considered for the XP3Y-1 and which shows up on early paperwork of the airplane.

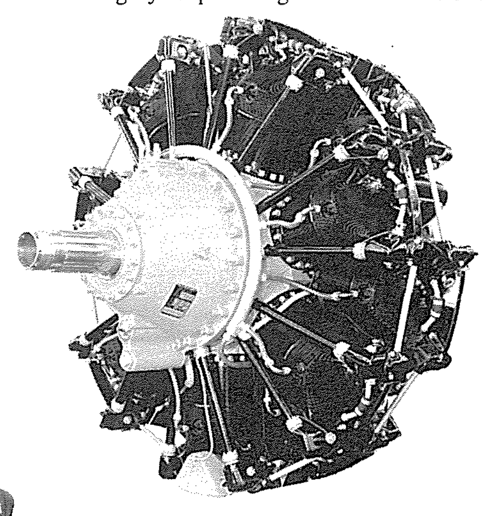
Both engines for the XP3Y-1 were R-1830-58's and No. 29 was shipped to Consolidated on 22 March 1934 while No. 42 went on July 31st. The Installation Report indicates the installation of R-1830-58 with a normal rating of 800 horsepower at 2400 rpm at sea level. As only seven -58's in all were manufactured, the type was, therefore, essentially a prototype engine. It was designated by P&WA as a T1A1-G. The "A" in the designation signifying the first series of basic design. The engine had a compression ratio of 6.5:1, supercharger ratio of 8:1, and a propeller reduction ratio of 3:2.

Meanwhile, a redesigned and improved version of the R-1830 called the "B" Series was forthcoming. The mechanical parts of this engine were strengthened, cooling was improved and power increased. A version called the Twin Wasp SB-G was selected for the production PBY and went into production for the Navy as the R-1830-64. This engine was similar in general appearance to the -58 with the same up-draft carburetor and conical nose case.

With the "B" Series engine the grease gun was thrown away, as the cylinder valves were now fully lubricated with engine oil. Also, the propeller governor was moved to the nose case where the hydraulic operating system of the propeller could more easily be integrated with the engine oil system.

The -64 engine was highly supercharged with a ratio of





Above: The smaller views above here and opposite are of the first "production" version of the R-1830 Twin Wasp used in PBY's, the Dash 64, Series "B", of 850 HP. The continuing refinement of both airplane and engine brought the final version, used in the PBY-5 and subsequent models, to the Dash 92 shown in the larger views.

THE R-1830 TWIN WASP ENGINE

12:1. Normal Rating was 850 horsepower to 8,000 feet altitude. Take-off rating was 900 horsepower and later this was increased to a 1,000 horsepower when heavier connecting rods and pistons were incorporated on a retrofit program.

In October, 1935, the XP3Y-1 was returned to the factory where various improvements were made including the replacement of the -58 engines with -64's, and the production nacelle. At this time the aircraft was redesignated XPBY-1.

There were many detail differences between the power plant installations of the XP3Y-1 and the production PBY. Specifically some of these differences were in the XP3Y-1 three-piece engine cowling with integral short span cooling flaps (what a nasty job to unhook that cowling), a fully rounded after-cowling, no fire-wall, carburetor air scoop differences, as well as more cluttered instalation details.

On the production PBY-1's an engine cowling was employed to ease maintenance which incorporated a fixed-ring nose cowl, a two-piece cylinder cowl, and a fixed rear ring cowl with long span cooling flaps. Nacelle contours were reshaped and a fire-wall incorporated. The entire installation was cleaned-up and simplified. However, the complex engine mount was still attached directly to the front wing spar.

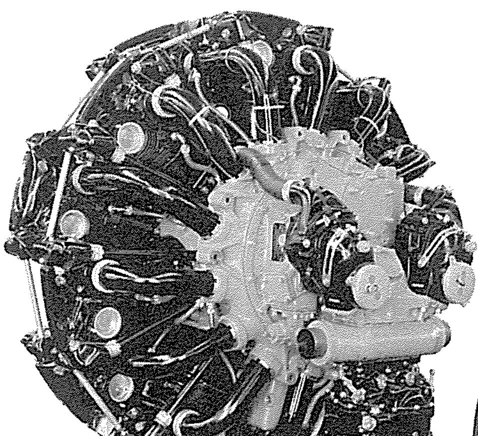
On the PBY-2's further improvements were made to incorporate a semi-monocoque nacelle structure built integral with the wing center section, terminating with an effective fire-wall to which was bolted a simple tubular engine mount.

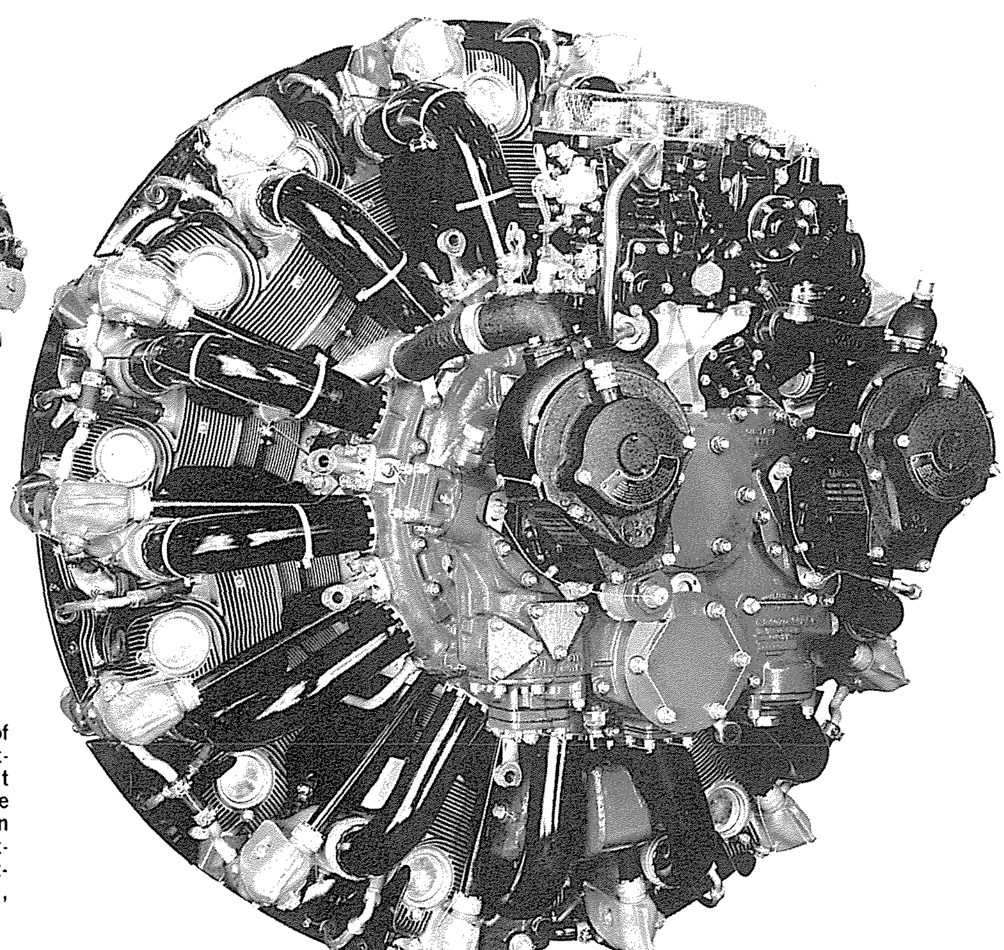
Propellers were Hamilton Standard 3E50 constant speed counter weight type on all PBY's through PBY-4. However, Curtiss Electric C-532-DEA type were used on the first twelve PBY-2's and on numbers 44 and 45 PBY-2's.

The -64 engine was employed in all production PBY-1 and PBY-2 aircraft, but for the PBY-3, once again, the Twin Wasp underwent major redesign to obtain more reliability and better performance. A new improved supercharger using a down-draft carburetor was incorporated. A hemispherically-shaped propeller reduction gear case became a distinguishing feature of the "C" Series engine. The first of these engines to be used was the R-1830-66 in the PBY-3. Normal rating was 900 horsepower to 10,000 feet and take-off rating was at 1,050 horsepower. To accommodate the "C" Series engine the carburetor air scoop in the PBY had to be moved to the top of the nacelle and various plumbing and electrical lines had to be reshuffled.

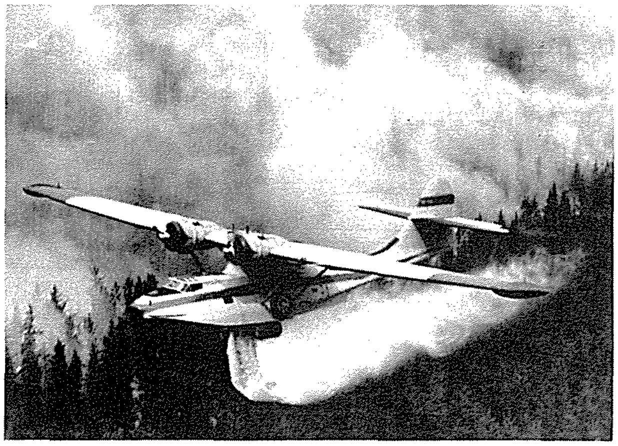
For the PBY-4 the R-1830-72 was employed. This engine was the same as the -66 except for two principle features: a new crankshaft incorporating a harmonic balancer and a propeller reduction gearing of 16:9 ratio instead of the former 3:2. Both the -66 and -72 were Twin Wasp SC-G versions.

Meanwhile, continued improvements were introduced into the "C" Series engines until the S1C3-G version came forth. As the R-1830-82 the version was incorporated into the early PBY-5 and PBY-5A aircraft. Use of 100 octane gasoline enabled the normal rating to be increased to 1,050 horsepower to 7,500 feet altitude with take-off at 1,200

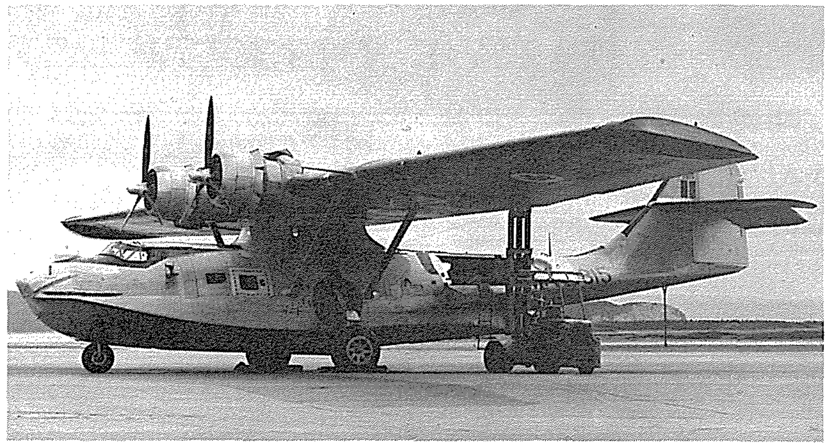




The lower, larger views shown here of the Dash 92, Series "C" engine outwardly indicate increased strength, but major improvements came with the use of 100 octane fuel and the Hamilton Standard Hydramatic Propeller. Hp output was 1,050. (Photos—Pratt & Whitney No. D-5054, -644, -646, and -5058, courtesy of H. H. Lippincott)



Widely used in Canada as a fire-bomber, the PBY-5A is shown at work in typical forestry control. An 800 gallon water load is picked up "on the fly" at about 85 knots in 14 seconds, can be dropped in 0.8 seconds. (Photo—Canadian Archives, via Bradford)



RCAF converted this Canso, No. 9815, to a cargo version, removing the forward turret and blisters, and installing large cargo doors, an astrodome forward of pilot's compartment and minor refinements. Harmon Field, Newf. 1956. (Photo—W. B. Carmody)

PARALLEL DEVELOPMENT (Cont'd)

horsepower. Better fuel distribution and metering was obtained with the introduction of the Stromberg pressure carburetor in place of the former float type. Incorporation of provisions within the engine enabled the use of the Hamilton Standard Hydromatic propeller, which was employed on all subsequent PBY aircraft.

However, a serious problem came to light with the -82 engine swinging the Hydromatic propeller through a bevel type 16:9 reduction gear – a propeller "whorl" developed. The tail of the engine propeller shaft rode inside a bearing in the front of the crankshaft. The impluses from the pistons caused the crankshaft to run slightly out of concentricity because of the crankshaft roller bearing clearances. This urgent problem was corrected by cutting off the tail of the propeller shaft and connecting it to the crankshaft by a series of steel couplings which could absorb the crankshaft whorl. Interestingly, the whorl in the 3:2 gear ratio of the earlier engines was not critical because of the spur gearing involved.

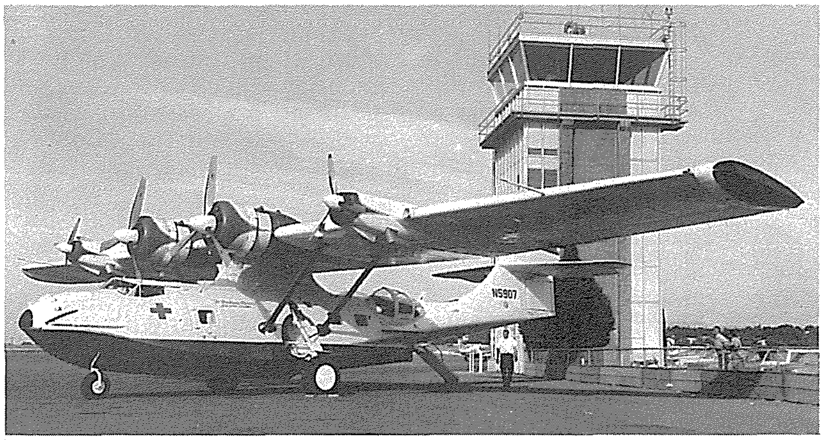
The Navy incorporated this "decoupled nose" change on an overhaul retrofit basis to -82 engines, which when incorporated were redesignated -82A. Production contracts were amended to incorporate the "decoupled nose" and the production engines were redesignated R-1830-92.

Subsequently, the Navy made a field modification to incorporate strengthened nose cases. Nose cases often cracked when whirling propellers hit heavy spray and water on takeoff. These converted engines were designated -92A. From here on, all subsequent production versions of the PBY-5, -5A, -6A, PBN-1, PB2B-1, -2, and OA-10 were powered by R-1830-92 and -92A engines.

After the war, many PBY-5 and more PBY-5A and 6A aircraft fell into the hands of civilian operators who used them for airline, cargo, executive, pleasure, fire-fighting and many other operations. As the PBY could use a bit more power, these operators looked around for more powerful engines. Toward the end of World War II a final redesigned Twin Wasp C9-G engine had been produced for the Convair B-24N and PB4Y-2. The C9 had a Normal Rating of 1,100 horsepower to 7,500 feet and a Take-off of 1,350 horsepower. When the B-24N production was cancelled a substantial quantity of R-1830-75 (TSC10-G) engines became available on the surplus market. Many civilian PBY's have been converted to -75 engines. Hence, we can see the concurrent development from beginning to end of both an airplane and an engine.

WWII RCAF SQUADRONS USING CATALINA AND CANSO

Sqdn.	Based at:	Aircraft
4	Ucluelet, Coal Harbor, and Tofino, British Columbia	Catalina IB Catalina IV Canso Canso A
4	Dartmouth, Nova Scotia and Torbay, Newfoundland	Catalina I Canso Canso A
6	Jericho Beach, Ucluelet, Alliford Bay, and Coal Harbor B.C.	Catalina IB Canso Canso A
7	Prince Rupert and Alliford Bay, B.C.	Catalina I Canso Canso A
9	Bella Bella, B.C.	Catalina I Canso A
116	Botwood, Newfoundland (Summer) Shelbourne, Nova Scotia (Winter)	Catalina I Canso A
117	Sydney and Shelbourne, N.S.	Catalina IB Catalina IV Canso
120	Coal Harbour, B.C.	Catalina I Canso A
160	Sea Island, B.C., Yarmouth, N.S., and Torbay, Newf.	Canso A
161	Dartmouth, N.S. and Gaspe, Que. Detachments at: Sept Iles, Que. Summerside, P.E.I. Yarmouth, N.S. Sydney, N.S.	Canso A
162	Yarmouth and Dartmouth, N.S. Reykjavik, Iceland Wick, Scotland	Canso A
413	Stranraer, Scotland Sullam Voe, Shetland Is. Koggola, Ceylon Detachments at: Addu Atoll, Mombasa, Dehrein, Langaban, and Haban, Eden	Catalina I Catalina IB Catalina IV
422	Lough Erne, Scotland Kesh, Ireland Oban and Dowmore, Scotland St. Angelo and Castle Archdale, Ireland	Catalina IB Catalina IV



The Bird Innovator, converted from PBY-5a with addition of Lycoming engines on the outer wing panels, had significantly improved performance to 200 mph cruise speed. Reversible pitch propellers on outer engines aided handling. (Photo–W. T. Larkins)

PAPOOSE, a recently retired PBY-5A of the Royal Dutch Air Force photographed at Narssuak Air Base, Greenland, in 1956. Wings dark red, fuselage and tail medium gray. The last six PBY's in military service retired Nov 1970. (Photo—George W. Miller)

CANADIAN POST-WAR COMMERCIAL USE

When the first Canadian built Consolidated PBY 5A rolled off the assembly line at the Boeing Canada plant in Vancouver on the 26th of July 1942, it is unlikely that anyone could foretell the full extent of the aircraft's post-war usefulness in Canadian Civil Aviation.

Perhaps the company's Chief Test Pilot Pat Howard had some inkling of its future use when he wrote shortly after flying the prototype during the impressive ceremonies at Sea Island, B.C., "some people seem to think that because the PBY was designed and built several years ago it is obsolete and slow, and generally pretty useless, but that is not true. In fact, very much to the contrary, it is the most efficient flying boat of its class in the world today."

It is interesting to note that Pat Howard's comment, made in 1942 would indicate no surprise to see that 42 Consolidated PBY's are still on the 1970 Canadian Civil Registry in 1970. (Another 34 Canadian-registered PBY's have been struck off the registry during the years since World War II)

Model	Reg'n	C/N or Serial	Owner
28 5AC	CF-AAD	1658	Austin Airways Ltd., Toronto, Ontario
PBY 5A	-IEE	1566	Austin Airways Ltd., Toronto, Ontario
PBY 5A	-JCV	CV 357	Austin Airways Ltd., Toronto, Ontario
PBY 5A	-SAT	9757	William Bernard, Edmonton, Alberta
PBY 5A	-PQF	CV 333	Department of Transport & Communications
PBY 5A	-PQK	9830	Department of Transport & Communications
PBY 5A	-PQL	CV 417	Department of Transport & Communications
PBY 5A	-PQM	CV 425	Department of Transport & Communications
PBY 5A	-PQO	CV 427	Department of Transport & Communications
PBY 5A	-PQP	11079	Department of Transport & Communications
PBY 5A	-NJL	11093	David Dorosh, Edmonton, Alberta
PBY 5A	-HHR	300	Field Aviation Co., Ltd., Calgary, Alberta
PBY 5A	-HTN	48275	Field Aviation Co., Ltd., Toronto, Ontario
PBY 5A	-IZZ	64064	Field Aviation Co., Ltd., Malton, Ontario
PBY 5A	-UKR	CV 281	Field Aviation Co., Ltd., Malton, Ontario
PBY 5A	-FFW	46596	Flying Firemen, Ltd., Sidney, B.C.
PBY 5A	-FFZ	46602	Flying Firemen, Ltd., Sidney, B.C.
28-5AC	-IHN	441	Flying Firemen, Ltd., Sidney, B.C.
28-5AC	-CRP	9837	Government of Newfoundland & Labrador
PBY 5A	-IGJ	48429	ditto
PBY 5A	-IZU	46655	ditto
PBY 5A	-NJC	CV 430	Government of Newfoundland & Labrador
PBY 5A	-OFI	CV 343	Government of Newfoundland & Labrador
PBY 5A	-DIL	427	Ilford Riverton Airway, Winnipeg, Manitoba
PBY 5A	-NJB	CV 249	Kenting Aircraft Ltd., Toronto, Ontario
PBY 5A	-NJF	CV 283	Kenting Aircraft Ltd., Toronto, Ontario
PBY 5A	-UAW	CV 201	Kenting Aircraft Ltd., Toronto, Ontario
PBY 5A	-NTL	CV 383	Leaseway Limited, Toronto, Ontario
28-5ACF	-CRR	9767	Mid-West Airlines Ltd., Winnipeg, Manitoba
PBY 5A	-GLX	560	Mid-West Airlines Ltd., Winnipeg, Manitoba
PBY 5A	-NJE	CV 437	Mid-West Airlines Ltd., Winnipeg, Manitoba
28-5AC	-PIU	64092	Mid-West Airlines Ltd., Winnipeg, Manitoba
PBY 5A	-IDS	11629	North Canada Air Ltd., Prince Albert, Sask.
PBY 5A	-IZO	46645	North Canada Air Ltd., Prince Albert, Sask.
28-5AC	-OWE	11074	Ontario Central Airlines, Ltd., Kenora, Ontario
PBY 5A	-JMS	48287	Questor Surveys Ltd., Rexdale, Ontario
28-5ACF	-MIR	46633	Questor Surveys Ltd., Rexdale, Ontario
28-5AC	-VIG	46662	The Great Lakes Paper Co., Ltd., Thunder Bay, Ontario
PBY 5A	-DFB	605	Wheeler Northland Airways, Ltd., St. Jean, P.Q.
PBY 5A	-FVE	11052	ditto
28-5AC	-ILK	464	ditto

PBY ENGINE OPERATION

The Pratt and Whitney R-1830 engine had few problems early in the development of the airplane/engine combination, and enjoyed virtually trouble-free operation in all the later models. The engines were easy to maintain, undemanding with respect to flight procedures, and earned a reputation for dependability that was already legendary long before the demands of WW II combat environment became everyday routine.

Although the term "maintainability" had not yet been coined at the height of the PBY's operational life, the engine installation and the engine would have been rated tops by any maintainence crew.

In the U. S. Navy of the late 1930's and early 1940's, routine preventive maintainence was standard procedure. At thirty flight-hour intervals, inspections were performed on engine and accessories ranging from such minor items as oil and spark plug changes to major inspections of carburetor, valve clearance, timing and so on. Minor checks were most often accomplished on the flight line or at the buoy, but major inspections were done at the squadron operating base or on board the seaplane tender. The flight crews assisted the maintainence crews, and were responsible for the daily inspections as well as for corrections of minor discrepancies reported after flight.

In day to day operations, the R-1830 engine was always easy to start—probably the ultimate compliment, and particularly for a flying boat installation. Starting was, of course, preceeded by a preflight inspection. At forward-area, tender-based operations during wartime, this involved a predawn exercise by flashlight, checking the nacelles and upper wing center-section area. Then—pulling the propeller through to clear the engine of accumulated oil. This was quite a gymnastic feat—in the dark, on wing and hull slippery with dew or spray, and oily from previous flights.

The usual procedure was for one crewman to straddle the engine cowling, seated on the nose section facing forward. Then two or more men stood on the hull below, where they could just reach the blade tips. One blade at a time the propeller was rotated. Twelve or more blade passes were required to clear the engine for starting (sometimes more, depending on local unit rules).

After this was completed, the crew manned stations for starting. The plane captain (crew chief), at the engineer's station in the pylon under the wing, brought fuel pressure up with the hand pump and primed the engines while the pilot engines while the pilot and co-pilot, in the cockpit, set prop' and throttle controls and stood by the ignition switch.

If moored to a buoy, the crew would have "singled-up", ready to cast off the line as soon as the engine started. On signal from the pilot, the plane captain energized the No. 1 starter and engaged it as soon as he judged it to be "at-speed" and ready, then called "contact" on the intercom. At this, the pilot turned the ignition switch and idled the engine at minimum speed to avoid over-running the buoy. Meanwhile, the No. 2 engine was being started and as soon as it was firing, the buoy was let-go and the pilot taxiied out toward the sealane.

Warmup was accomplished during taxi to the sealane, and when oil and cylinder head temperatures were within the normal operating range, a magneto check was performed. The procedure for this was to idle one engine which, with an assist from the rudder, would put the flying boat in a tight circle. Thus we avoided using too much of the usually restricted sealane area. The engine was run up to about 2,000 rpm for the check of each magneto in turn. The procedure was reversed and completed for the other engine. It required good judgement and close cooperation to avoid overheating or "loading them up" (spark plugs) due to prolonged low-speed idling.

On completion of the mag' check, the pilot and plane captain ran through the takeoff checklist, utilizing the intercom and a system of light signals installed in both pilot's cockpit and engineer's station. The crew then took stations for takeoff, each reporting as soon as ready. Then the pilot would call by radio (or signal by Aldis lamp if radio silence was in effect) for takeoff clearance through the sealane.

Full power was always used for takeoff. The run could vary from as little as 18-20 seconds with light load on a windy day to a minute or more for heavy load and a calm, smooth-water day.

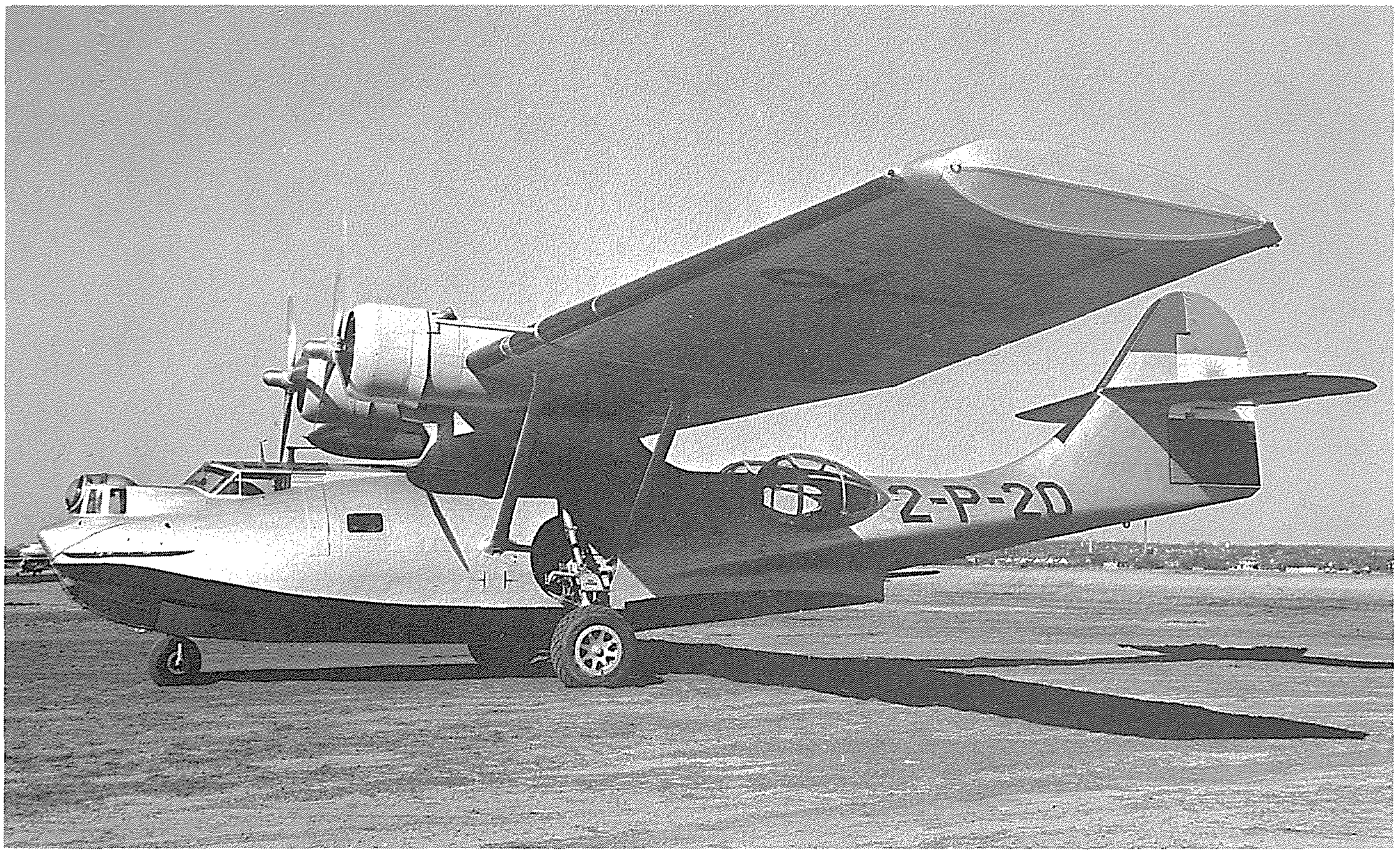
The R-1830 always delivered the performance the crews required, whether under Arctic conditions in the Aleutian Islands or the hot and humid tropics of the South Pacific. During some 1,700 flight hours in PBY models from the -3 to -6A, the author aborted only one flight because of engine trouble, and was never once forced to secure and feather a propeller!

Airplane crews exposed to antiaircraft fire or attacking enemy aircraft frequently reported major damage to engines, but which continued to function until all oil was lost or a fire started. In most cases, the airplane made it back to base, or were able to make successful forced landings at sea.

As dependable as the airplane with which it was evolved, the R-1830 engine ensured its place in aviation history, for at least as long as Catalina pilots and crew are around to remember the feel, the sound, and the smell of two beautiful engines in full synchronous operation. Once experienced, it can never be forgotten.

William E. Scarborough

This second part of Capt. Scarborough's article is from his address before the Northeast Aero Historians Meeting at Chateau Laurier, Ottawa, Canada, in October 1970, entitled "The Consolidated PBY—Catalina to Canso."



PBY-5A of Argentine Navy, at Teterboro Airport, New Jersey, 1946. (Photo—Howard Levy)

PK-AKC was a typical postwar conversion of **PBY-5A**, nose turret and blisters removed. Photographed at Oakland, Calif. in Jan. 1947. Pacific Islands Aviation Society reported, in "Balus Na Niu Gini", that PK-AKC crashed at Bangka in 1947. (Photo—W.T. Larkins)