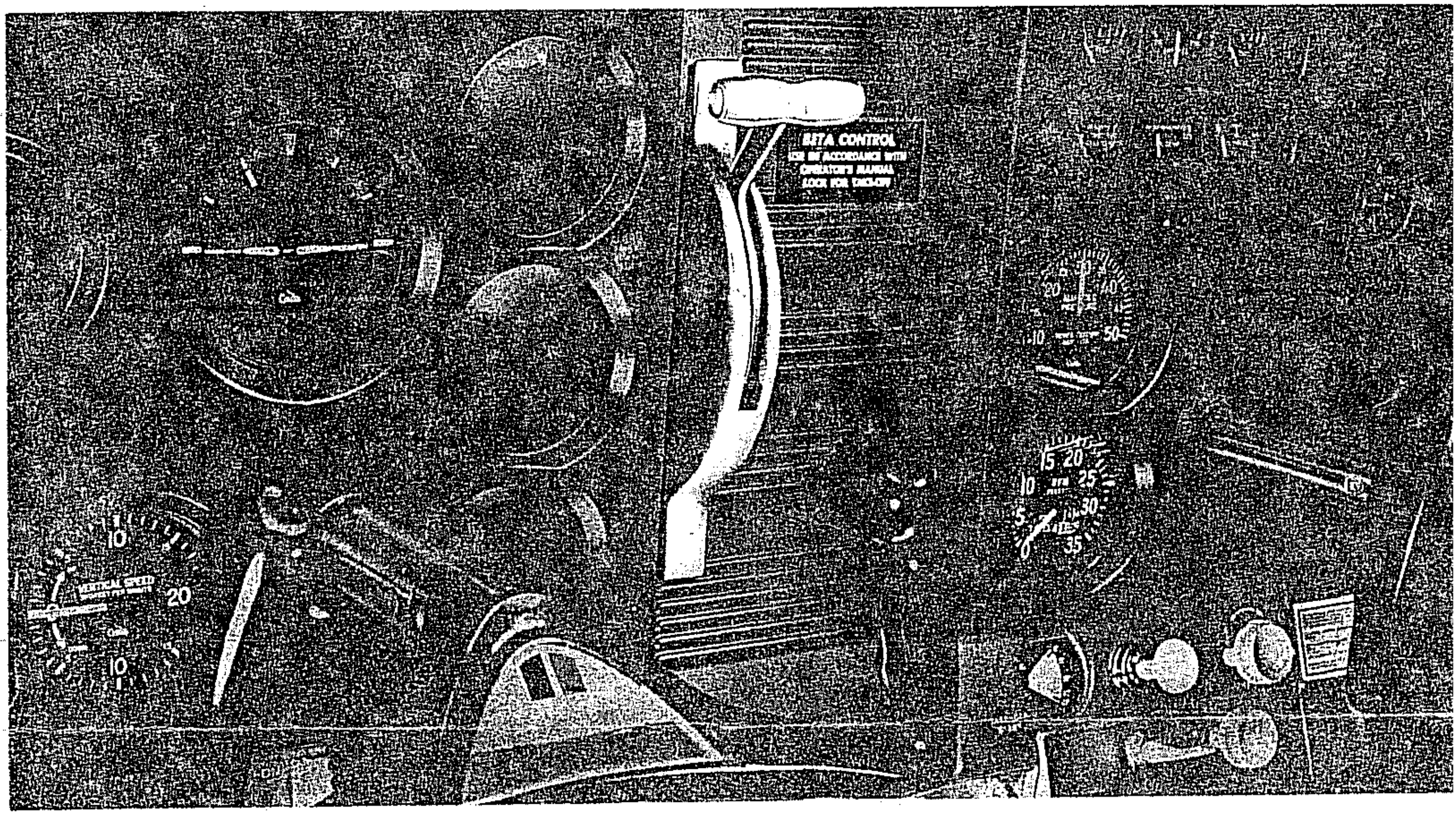
NEED AN "OBSTACLE REMOVER"?

A "RUNWAY STRETCHER"?

A "LANDING SPOT MAGNET"?

A BUILT-IN "LANDING ARRESTER"?

THEN.....



GRAB HOLD OF THIS NEW CONTROL FOR

SAFER LANDING APPROACHES...

MORE ACCURATE TOUCHDOWNS...

AND SHORTER LANDING ROLLS.

IT'S THE WREN BETA-CONTROL SYSTEM REVERSIBLE PROPELLER FOR MANY MODELS OF SINGLE-ENGINE AIRCRAFT.

WREN AIRCRAFT CORPORATION
P. O. BOX 4115 MEACHAM FIELD
FORT WORTH, TEXAS 76106
(817) MA 6-3739

MANUFACTURERS OF
THE REMARKABLE
STOL WREN 460

What it is . . .

A new control system for aircraft for use during approaches and landings to increase safety and accuracy of touchdown and shorten landing roll.

An extra bonus benefit is its use during taxiing to reduce wear on tires and brakes, for backing in or out of a parking space, for float-planes maneuvering on the water, and to provide a brake for ski-equipped planes.

How it developed . . .

For nearly five years Wren Aircraft Corporation has been developing and improving features that increase STOL capabilities — with safety.

Logically, our thoughts turned toward reverse pitch propellers to shorten landing roll — the "L" of STOL (Short Take Off & Landing). By the numbers, this seems unnecessary, for many planes both STOL and ordinary airplanes are already capable of shorter landings than take-offs. The problem, though, is that few pilots can consistently touch down on a pre-selected spot, or at the perfect speed for a short landing, and none can do it every time. Thus, when getting into a really tight strip is essential, there's a certain amount of "sweat" on each landing. A reverse pitch prop would give an extra margin of safety.

Wren began experimenting with a reverse-pitch prop in the fall of 1965. Working closely with Hartzell Propeller Co., these experiments evolved gradually into the fully certificated Hartzell/Wren Beta-System reversible pitch unit of today — a unit that is not only a reverse pitch prop, but is really a new *control system* to use along with ailerons, rudder, and elevators during approaches and landings.

Why it is needed . . .

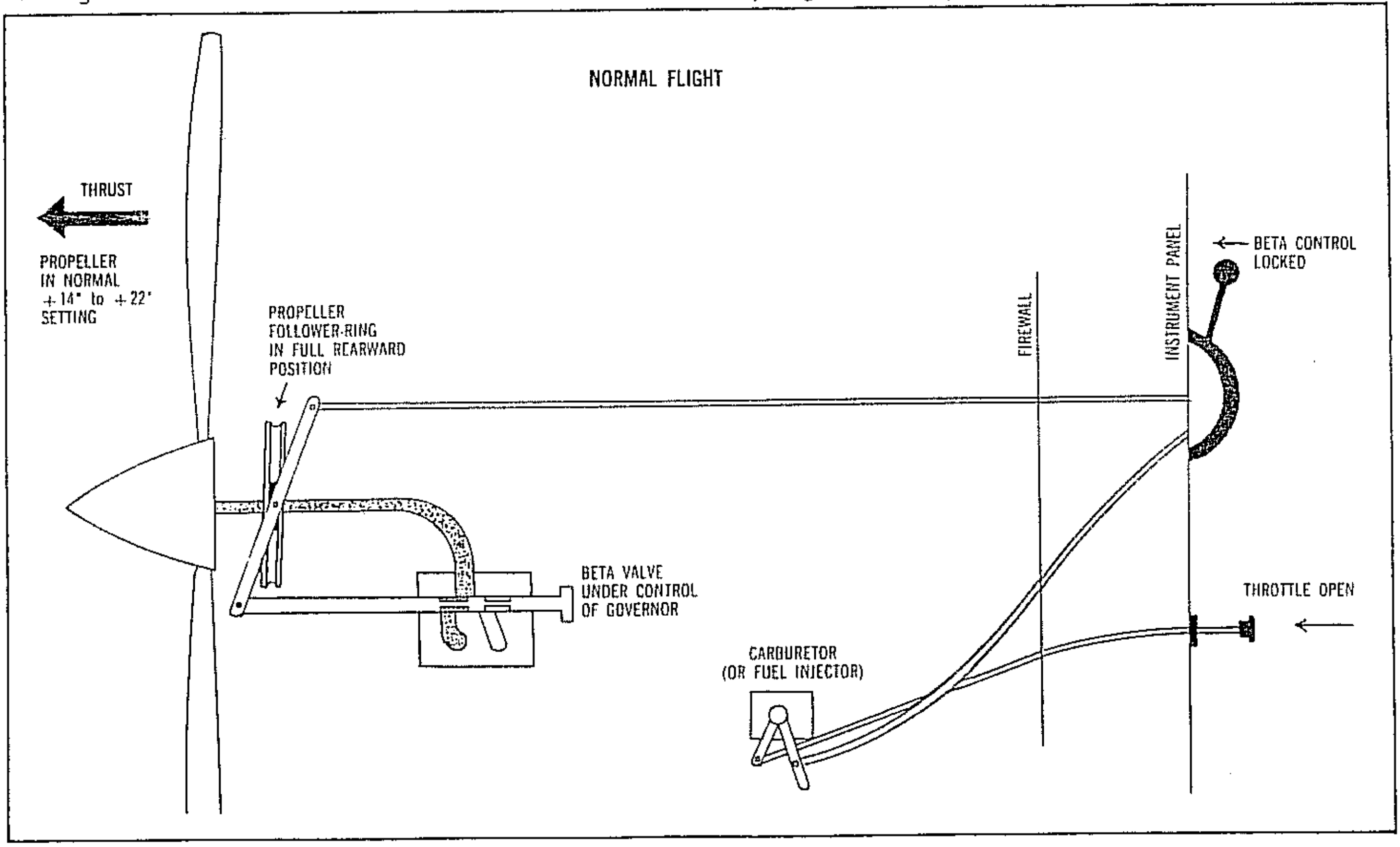
Records of general aviation accidents taken from Flight Safety Foundation reports for the most recent year (1965) show that *61% occurred during the landing phase* of aircraft operation. Half of these occurred in the approach to landing and consisted mainly of stalls (in trying to stretch a glide?); striking trees, power lines, or other obstructions (too low an approach path?); or touching down short of the runway. The other half came after touchdown and represented loss of control on the runway or overshooting the runway.

The Hartzell/Wren Beta-System reversible pitch propeller becomes a safety aid that gives a desirable extra margin in each of these situations that cause the majority of general aviation accidents.

First, the approach to a landing can be started from a higher altitude closer to the touchdown spot. The use of Beta control as an instantly responsive variable drag control automatically results in a steeper approach-angle to avoid obstacles, with an approach speed well above the stall point, with increased accuracy of touching down on a selected spot on the runway with a very minimum of "floating." Once ground contact is made, the use of reverse pitch can reduce landing roll 40% on dry surfaces and even greater reductions, as much as 80%, on wet or icy surfaces when normal braking becomes less effective.

What planes can use it . . .

The system is presently approved for use with single-engine airplanes using Continental 0-470 or 0-520 series engines. Aircraft equipped with these engines include the Wren 460; Cessna 180, 182/Skylane, 205, 206 Super Skywagon and Super Skylane, 210 Centurion; Beech



Bonanza and Debonair; Aero Commander 200; and Bellanca 260 and Viking.

Eventually the system may be expanded to include some Lycoming and Franklin engine installations, in which case the majority of single engine airplanes equipped with constant speed propellers can utilize the Beta system propellers.

Eventually, further development of the system may make it available for some light twins as well.

How it is used . . .

On approach to any landing area, procedures are as ordinarily used, i.e. reduce power and speed and lower flaps as desired (lower gear on retractable gear airplanes). Adjust trim as usual. When turning onto final approach, maintain altitude until much closer to desired touchdown point than is ordinarily done. Push propeller control full forward for maximum rpm and retard throttle into closed position. Adjust trim as usual. From this point on, the Beta control, rather than the throttle, will be used to control glide path.

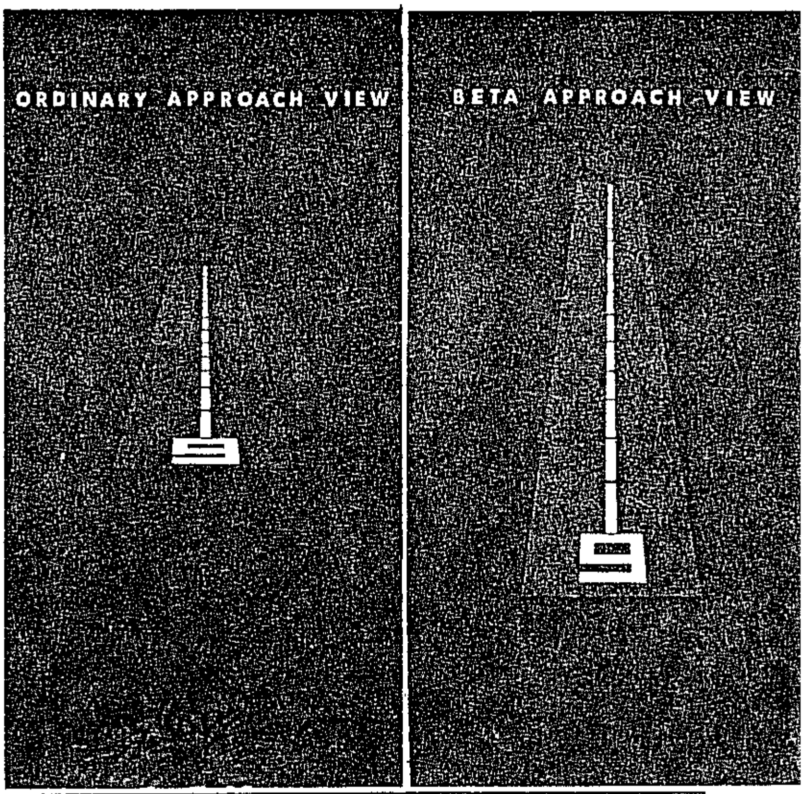
Maintain a *comfortable* approach speed, say 10 to 15 mph above the ordinarily recommended "best speed" for short landings.

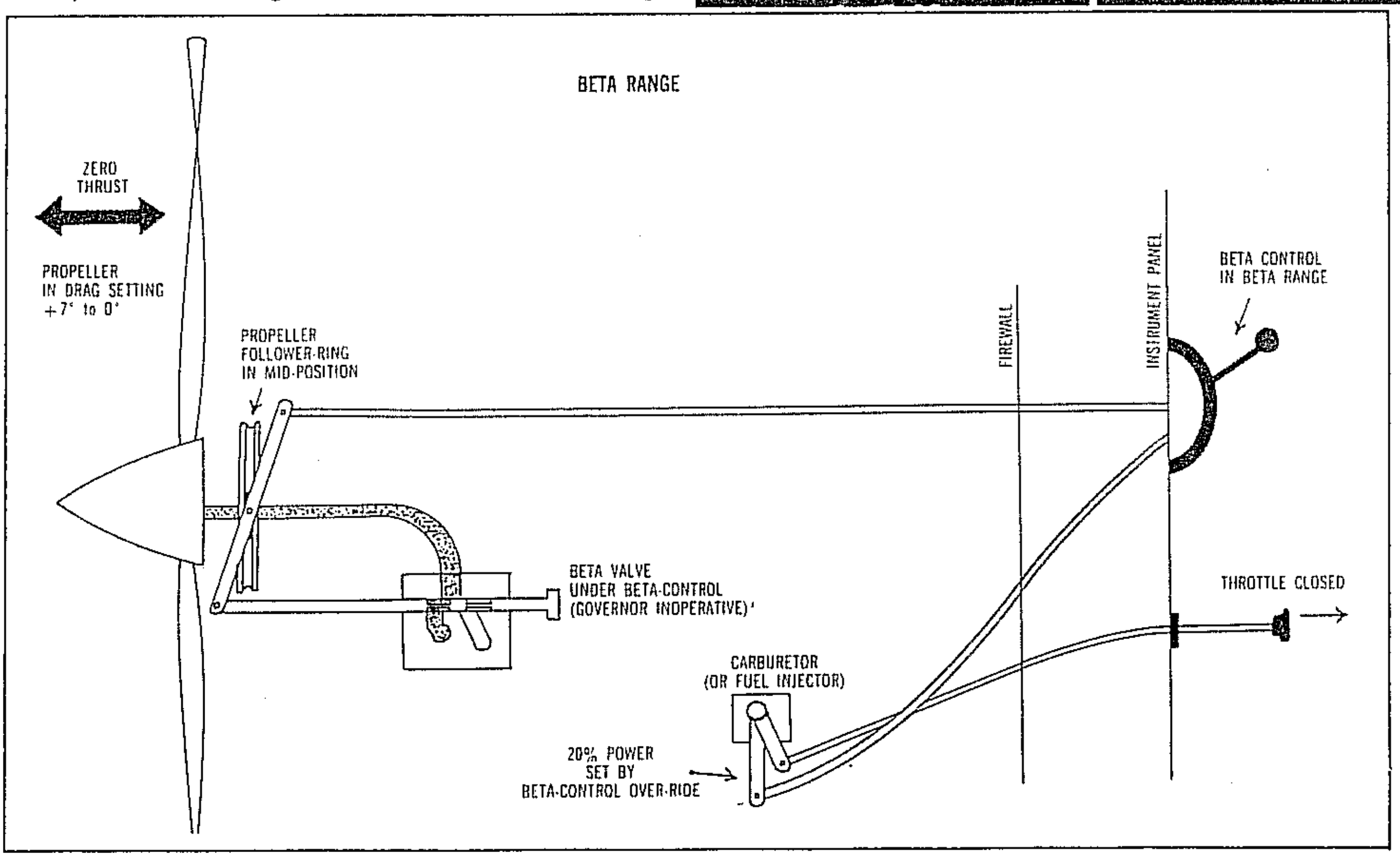
Keep a visual reference to the desired touchdown point and add drag to steepen descent by moving the Beta control rearward (toward flat pitch) or reduce drag to extend glide by moving Beta control forward. Effect of control is instantaneous.

A Beta-controlled descent is usually more than twice as steep as an ordinary approach. This minimizes the possibility of encountering obstacles such as trees or high

THE ORDINARY VIEW vs THE BETA VIEW

These two perspective drawings of an airport graphically show the difference between the ordinary approach (left) and a Beta approach (right) in the same airplane. The desired touchdown point (and stay down) is on the first dashed line past the runway number in each case. Beta approaches are accurate enough to touch down on that point every time, and stay down. Obviously, the same can not be said of ordinary approaches.



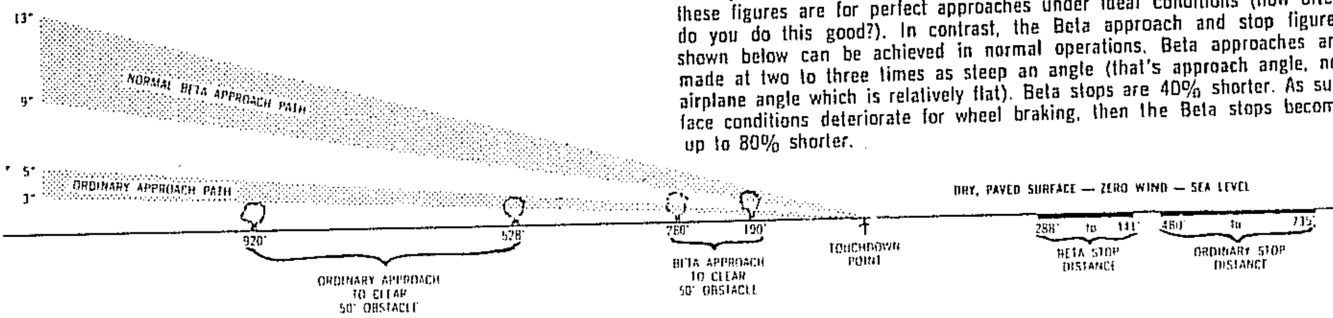


BETA APPROACH AND STOP vs ORDINARY APPROACH AND STOP

Don't let approach angles fool you. The Cessna and Beech factory figures for best approach angles to clear a 50 ft. obstacle are from 3° to 5° as follows:

Model	Distance from 50 ft. obstacle to touchdown	Computed approach angle	Distance from touchdown to stop	Overall distances
Cessna 185	920'	3°	480'	1400'
Cessna 180	885'	3°	480'	1365'
Cessna 182	760'	3°	590'	1350'
Cessna 206	660'	4°	735'	1395'
Beech Debonair 33	655'	4°	643'	1298'
Cessna 210	605'	4°	735'	1340'
Beech Bonanza	530'	5°	647'	1177'
Beech Debonair 33A	528'	5°	632'	1160'

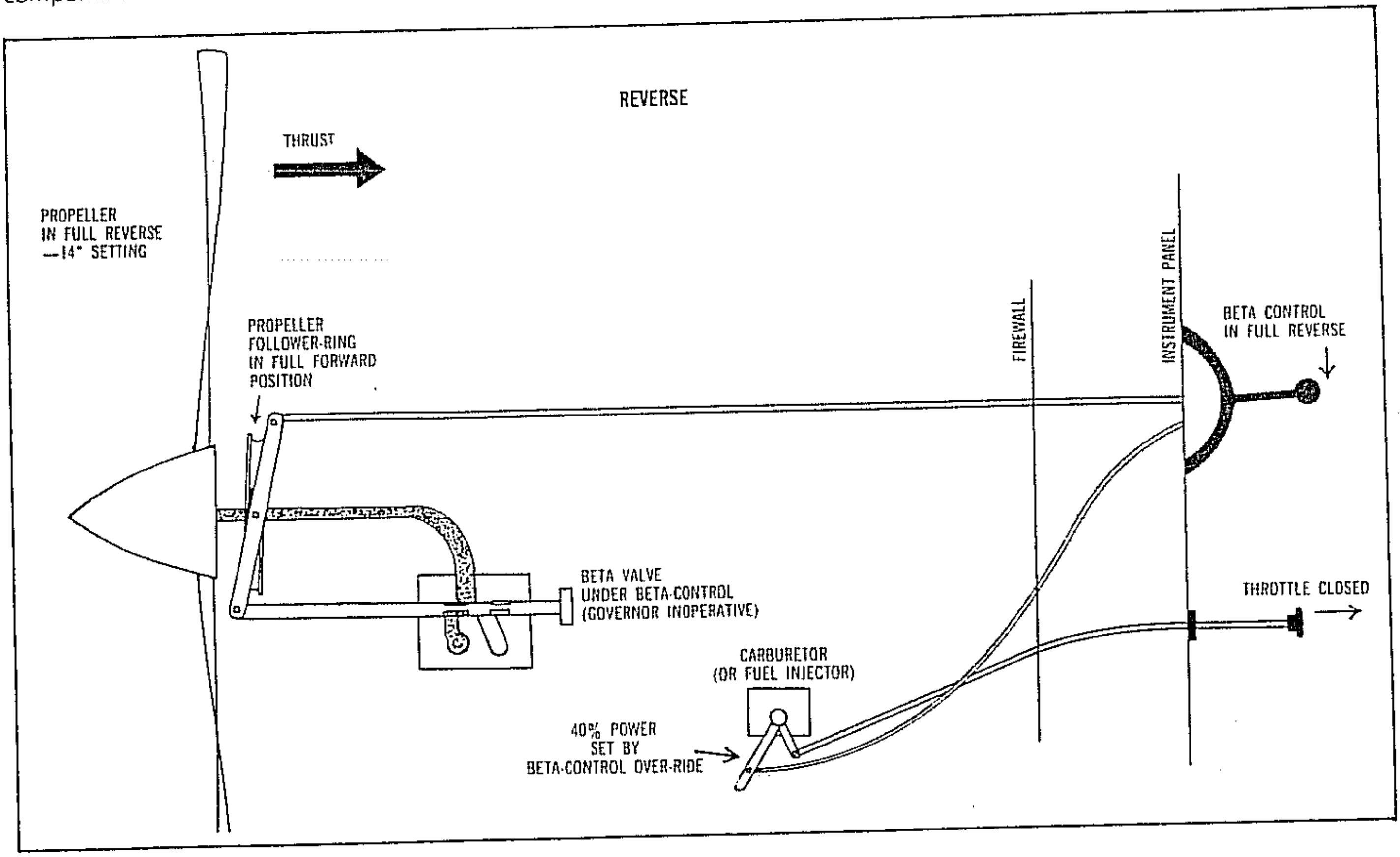
Although the factory specifications do not so state, it can be assumed that these figures are for perfect approaches under ideal conditions (how often do you do this good?). In contrast, the Beta approach and stop figures shown below can be achieved in normal operations. Beta approaches are made at two to three times as steep an angle (that's approach angle, not airplane angle which is relatively flat). Beta stops are 40% shorter. As surface conditions deteriorate for wheel braking, then the Beta stops become up to 80% shorter.



lines that can present a hazard in a long, flat approach. The attitude of the aircraft will be *slightly nose down* and rate of descent will vary from 500 to 1000 ft/min depending upon amount of Beta control being used. If control is moved past flat pitch position into reverse pitch, nose down attitude will increase somewhat and rate of descent can reach 2500 ft/min.

When drag is added by use of the Beta control, air speed remains relatively constant, with the horizontal speed component decreasing while the vertical speed component increases. Thus it is not necessary to keep a close watch on air speed; instead, keep the touchdown point in sight and vary drag as needed to maintain an approach path that will exactly reach the desired point.

Rounding out for touchdown is made much closer to the ground than in ordinary procedures. It is actually made *in ground* effect (ground cushion). The Beta control is placed in full reverse pitch at the instant of contact (or a second before if the airplane shows a tendency to 'float' a foot or two above the ground) and is kept in reverse until stopped or until it is desired to taxi onward. As the speed drops off, normal braking can



be applied to shorten the roll. Beta landings, after a few practices, will be found to be enjoyably second nature and can be likened to *landing on a pillow*.

Taxiing can be conducted by use of the Beta control and should result in doubling or tripling the life of tires and brake linings.

Parking in tight spots can be accomplished by backing the airplane (if tricycle geared) into position. Care should be used to avoid application of brakes while backing up — the tail could be bounced against the ground.

What makes it work . . .

The Wren Beta control handle adjusts the pitch of the propeller from its normal low pitch position (usually about +14°) through flat pitch (0°) and into reverse pitch (−14°). It can only be used when power is reduced to a point where the propeller reaches its low pitch stop and is thus no longer being controlled by the propeller governor (about 25% power or less).

This changing of pitch — instantaneously — at the will of the pilot, adds or subtracts drag. It becomes, then, an instantly variable drag control. Adding drag "trades off" horizontal speed of the airplane for vertical speed. In this way, the aircraft can approach a landing area from a safely high position to amply clear all obstacles, giving the pilot a bird's eye view of his selected touchdown spot and permitting him to adjust his approach path to the spot by a simple movement of only one control — the Beta handle — moving it forward and upward in its quadrant to "catch up" with the spot, or rearward and downward to avoid "overshooting" the spot. A few practice runs and the system becomes the preferred way of making *all* landings, even on a mile-long runway.

Reverse pitch propellers are not new. They have been used on multi-engined transports for many years. They have been installed on several single-engined amphibians for water handling. They are also available on a few single-engined turbo-prop aircraft. Where the Hartzell/Wren Beta-System reversible pitch propeller differs from most previous reverse pitch propellers on reciprocating engine airplanes, is that it moves into reverse position through *flat pitch* rather than through *feathering* position. Moving through feather position requires complete removal of power, then moving of the prop control into reverse, then re-application of power. Moving the propeller into reverse through flat pitch permits the pilot to use his Beta-System prop as a *control system* by varying pitch angle to suit his needs.

Mechanically, the Hartzell/Wren Beta-System provides an adjustable low-pitch-stop setting for the propeller beyond the low pitch stop normally provided. This is accomplished by opening or closing the hydraulic valves leading to and from the propeller hub — either permitting more oil to be pumped to the hub to decrease pitch or allowing it to be dumped to increase pitch in the Beta range.

Propeller angle of attack is measured at a point on the propeller blades about ¾ths out (30" on an 82" prop) from the centerline of the hub. The following table indicates the approximate propeller angles as an approach is conducted:

Condition	*Position of Beta Control*	*Blade Angle*
a. Turning final	Full forward & locked	+14°
b. Begin approach	Full forward	+14°
c. Beta approach	Partially rearward	+ 5° to +13°
d. To increase descent	Flat pitch	0°
e. Touchdown	Full rearward	−14°

In addition to controlling the pitch of the propeller, the Wren-developed Beta control system also controls the throttle by an ingenious linkage that keeps power at the proper settings to match any blade position below +14° to −14°. This throttle control linkage overrides the closed master throttle when the Beta control is activated. It adds approximately 20% power in the Beta range and when placed in reverse, increases the engine power to 40% for maximum reverse thrust in stopping.

How it operates in turbulent air conditions . . .

An unusual, but very useful, effect of the Beta System will be noticed during approach in turbulent air when strong up-and-down drafts and/or gusty crosswinds are encountered. The propeller blade, turning without load at speeds from 2000 rpm to 2400 rpm in flat pitch, acts as a giant gyroscope to substantially dampen pitching and yawing movement. The effect is one of being "locked on" to a steady desired angle of descent.

What about overheating the engine . . .

It was noted above, that the blade angle of the propeller is measured at a point approximately ¾ths of the way from the hub to the prop tip. There is actually a twist to the propeller blade that is great enough that even with the measuring point at −14° (maximum reverse pitch position) the inner ⅓rd of the blade is still in a slight positive pitch condition and is blowing cooling air into the engine. This condition keeps the engine from overheating during reverse pitch operation and hence there is no time limit on extended use of reverse pitch.

What's different about the propeller itself . . .

Very little. Basically, the propeller is a standard Hartzell propeller as presently certificated for the airplane involved. There are minor alterations and several additions that permit the propeller to function in the reverse mode. Servicing is no more frequently required nor more involved than with the standard propeller.

What about installation . . .

The propeller and its control system are available in kit form. The first installation that a mechanic makes may take two days. The Wren factory makes the installation in a day because it is familiar with the method. No special tools are required. Kits contain simplified, complete instructions.

Safety features . . .

The Hartzell/Wren Beta-System control is so designed that no failure of any part of the system can cause a hazardous condition. The worst that can happen is for the propeller to lock in high pitch, in which condition the plane would be flown as though it had a fixed-pitch propeller. The same condition can occur whether or not the Beta system is installed, and is not necessarily more likely to occur with the Beta System than without it.

The engine will not over speed during reverse pitch operation while on the ground or airborne, nor can excessive power be added while in Beta control. Any attempt to add excessive power will force the propeller out of Beta and into normally governed operation.

If a landing approach needs to be aborted and a "go around" executed, simply add power with the throttle (as normally done). Adding power automatically overrides the Beta control and once again places the propeller in normally governed operation.

Is it necessary to use it on every approach . . .

For anyone not desiring to use the Beta system for making approaches to landings, it is still quite possible to make an ordinary approach, touch down (with the throttle closed as normal) and then apply reverse pitch to shorten the landing roll. Wren's Beta system will automatically add in power as the control is brought into reverse pitch to assure maximum reverse thrust. Landing roll-outs will be about the same length as when using the Beta control for *both* approach and landing.

How else it can be used . . .

To a float-plane pilot, the Wren's Beta-System provides good control for docking and taxiing. He can taxi in calm air or downwind or approach or back off from a dock or beach and not be at the mercy of the wind. A float plane can even be started in reverse while aimed toward the dock. Potential float and wing damage — many times more costly than the propeller installation — becomes more readily avoidable.

To a ski plane pilot, such a prop means that, for the first time, he has a means of braking after touchdown. No more will he be limited to long clear stretches or uphill landing areas.

To all pilots, the ability to utilize the Beta-System and reverse pitch is, in effect, an "obstacle remover," a "landing spot magnet," a "runway stretcher," a "landing arrester," an extra safeguard against "running out of runway." He can now consistently, safely, and easily land shorter than he can take off.

Other factors . . .

The Hartzell/Wren Beta control system is covered by patent applications to the U. S. Patent Office.

In summary . . .

A new control is now available for easier and safer landing approaches.

Roll outs can be shortened by 40% to 80% for any particular airplane, depending mostly upon runway surface condition and comparative touchdown speed.

Spot landing, so essential to safe use of ultra short strips, is simple and positive.

Float and ski-equipped planes are much more positively controlled on the water or snow.

Taxiing and parking of tricycle geared planes is simpler and saves wear on tires and brakes.

Cost . . .

The Hartzell/Wren Beta-System control is available in kit form ready for installation at your repair station for $1,995.00 with 82" blades. Other blade lengths available at slight price differential. Factory installation available at $100.00 — one-day service by appointment. Factory allowance of $100.00 will be made for your present propeller. The installation adds a net weight increase of 17 lbs. Fully F.A.A. certificated.

OPERATING MANUAL FOR HARTZELL/WREN
BETA-SYSTEM REVERSE PITCH PROPELLER
WREN 460

Introduction

The Hartzell/Wren Beta-system reverse-pitch propeller is a propeller and propeller control system whereby the pilot may select a flatter propeller blade angle during final approach and landing and continue into reverse pitch after landing.

This system gives the pilot a selective drag control without changing the aerodynamic configuration of the plane. It gives the pilot the ability to make steep approaches over obstacles and makes it possible for him to use reverse thrust for braking after landing on wheels, or skis, or floats. Additional benefits include the use of reverse thrust for water handling of float planes and the taxiing and parking of land planes.

This propeller and control system give the pilot an additional control of his plane that he has never had before -- instant on-off drag and reverse thrust.

Operation

1. Beta Approach

In approach configuration, the Wren will have flaps extended 30°, cowl flaps open, air speed trimmed to 60-70 mph IAS, governor selector at high rpm, and throttle at idle. Lock in this setting.

The Beta Control Lever now becomes a rate-of-sink control for final approach and landing. By constant visual reference to the desired touchdown point, use the Beta Control Lever as required to add or reduce drag so that touchdown will be made on a pre-selected spot on the runway, as it can be accomplished every time after a little practice. The reason for improved accuracy in hitting a pre-selected touchdown spot is that the approach is made from a higher altitude in relation to the landing strip with the approach angle being much steeper than normal.

2. <u>Landing Using Beta Control</u>

Landing is accomplished in a normal manner. <u>Flare for landing is begun much later</u> than is normally the custom. Remember, with the drop in flat pitch there is much more drag than normal, hence, after flare, air speed will decrease rapidly. If flare is made too high the plane is apt to "drop in" for a rough landing. One such landing becomes an education.

3. <u>Braking After Landing</u>

Since about 20% power is being used during final approach, the engine will be turning approximately 2,200 rpm and 10" at touchdown. At the instant of touchdown, move the Beta Control on past the detent to full reverse. This reverse thrust will quickly reduce ground speed to about [illegible] mph from which point light application of wheel brakes will bring the plane to a stop in a few feet. After landing, the Beta Control can be used in taxiing to save wear and tear on the brakes and tires and to taxi more smoothly, or the Beta Control can be returned to normal position and taxiing conducted in the usual manner.

4. <u>Taxiing Float Planes</u>

This propeller will reverse rapidly even at idle engine speed. Use the Beta Control to stop, go backwards or forward as required. It is most helpful in approaching beaches, piers, or docks, in calm air or downwind or downstream.

5. Taxiing Land Planes

Set throttle so engine turns 1200 to 1300 rpm and taxi using reverse as required for braking.

6. Parking Land Planes

The tricycle gear of the Wren 460 makes it possible to park by the use of reverse thrust. To taxi backwards set the rpm at about 1800, then, using the Beta Control in Reverse Position, the plane will move backwards. Note! Do not use the brakes when moving backwards. Use forward thrust to stop. Using the brakes may cause the tail to hit the ground. Do not attempt to back up on an upgrade, the power is just not sufficient.

7. Beta Light

The Beta Light is mounted on the radio switching panel. This light is so adjusted as to come on only when the Beta Control is unlocked and moved slightly to the rear. When the Beta Control is in Normal Position and locked the Beta Light will be out. Only when the Beta Control is in use will the Beta Light be on.

8. Abnormal Operations

Through no fault of the Beta-system certain conditions may arise which could affect the operations of the Beta-system. None of these are hazards, but they will negate the possibility of using the Beta-system. All are unlikely to occur, but are listed here for the pilot's knowledge.

A. Propeller goes into high pitch (of its own accord) and will not respond to movement of the prop governor control.

   Reason: loss of oil pressure

Action: (1) Check engine oil pressure. If very low, land at once for engine is not being lubricated.

(2) If oil pressure is normal, continue flight to convenient landing field where servicing is available. The prop governor will not be working because of governor pump failure, but the plane will continue to fly, holding altitude and even climbing at full throttle in high pitch. The Beta Control will not be operable.

B. Propeller sticks in one position and cannot be changed by moving governor control. Reason: oil passage between governor and propeller is plugged.

Action: Fly plane as fixed pitch propeller, continuing flight to available servicing. Beta Control will be inoperable.

C. Propeller goes to reverse (of its own accord) when power is reduced.

Action: Apply power and propeller will return to positive pitch. For landing, place governor selector in high pitch, propeller will remain in high pitch, make normal landing. Beta Control will be inoperative.

9. Note

When using the Beta-system for final approach even if the propeller is placed in full reverse in flight, the plane is still fully controllable and presents no problem, other than a higher rate of sink.

The Hartzell/Wren Beta-system prop will not reverse with more than 20% power. Further, it will go out of reverse if power is added to exceed this level. This is a safety feature that prevents reversal under any condition approaching what would be a hazard.

Conclusion

The Härtzell/Wren Beta-system Reverse Propeller is an additional control to increase the utility and safety of an airplane. Learn to use it well, and fly safely.

Pre-Starting

A. Adjust and check seat	
B. Altimeter and Clock	Set
C. All Electrical	Off
D. Fuel Selector	Both
E. Cowl Flaps	Open
F. Flaps	0°
G. Parking Brake	Set
H. Beta Control	Normal Position (locked)

Starting

A. Mixture Control	Rich
B. Propeller	Hi rpm
C. Beta Control	Normal Position (locked)
D. Carburetor Heat	Cold
E. Throttle	Cracked 1/2 inch
F. Master Switch	On
G. Prime	As needed
H. Propeller	Clear
I. Start	Engage

Taxiing

Parking Brake	Off
A. Oil Pressure	Normal
B. Radio	On
C. Altimeter and Clock	Check
D. Gyros	Set
E. Brake	Check
F. Beta Control	If desired during taxi check prior to leaving chocks

Prior to Take-Off

A. Parking Brakes	Set
B. Flight Controls	Free
C. Trim Tabs	T.O.
D. Oil Pressure and Temperature	Normal
E. Mags Check (1700 rpm)	125 max.
F. Carburetor Heat	Check
G. Propeller	Exercise
H. Beta Control	Exercise, note Beta Light operation, and return to Normal Position (locked)
I. Generator	Check
J. Vacuum	4 inches hg.
K. Flaps	Check----
L. Idle RPM	Check

Landing

A. Parking Brakes	Off
B. Fuel Selector	Both
C. Propeller	Hi RPM
D. Cowl Flaps	Open
E. Flaps	Full 30^o
F. Throttle	12" - 14"
G. Beta Control	As required

After Landing

A. Beta Control	Normal Position (locked)

HARTZELL REVERSIBLE PROPELLER MODEL
HC-92ZF-3

MODEL installed in BHC-A2VF-3 Ser# CU-3

MANUAL 120

HARTZELL PROPELLER, INC.
March 11, 1968

HARTZELL REVERSIBLE PROPELLER
MODEL HC-92ZF-3

OPERATION

The propeller utilizes oil pressure from the governor to move the pitch into low pitch and on into reverse. Counterweights attached to the blade clamps plus springs acting on the hydraulic piston oppose the action of the oil pressure and move the pitch out of reverse to low and on into high, when the governor calls for oil to be drained from the propeller. The governor supplies oil to the propeller when the RPM is below the prescribed value and drains oil from the propeller when the RPM is above the prescribed value.

A hydraulic low pitch stop is provided in the form of a "Beta" valve, which has a valve spool linked to the propeller piston. This "Beta" valve is located between the governor and the propeller and acts to shut off the supply of governor oil when the pitch is moved to the low pitch position. The "Beta" valve is slightly open when the pitch is in the low-to-high pitch range. The pitch is moved into the reverse range by manually readjusting the linkage connecting the "Beta" valve spool to the piston, so that the low stop becomes the reverse pitch stop.

The pitch can <u>only</u> be reversed when the RPM is below the governor setting, because only then does the governor supply oil to the propeller. Thus the propeller cannot be put into reverse pitch during level flight because the governor is not pumping oil to the propeller, except during momentary periods in order to maintain constant RPM. Nor can the propeller be reversed at airspeeds above a certain airspeed because the propeller will windmill at governing speed.

The propeller can be reversed during power-off descent after the airspeed has reduced below the speed where the propeller windmills below the governor speed setting.

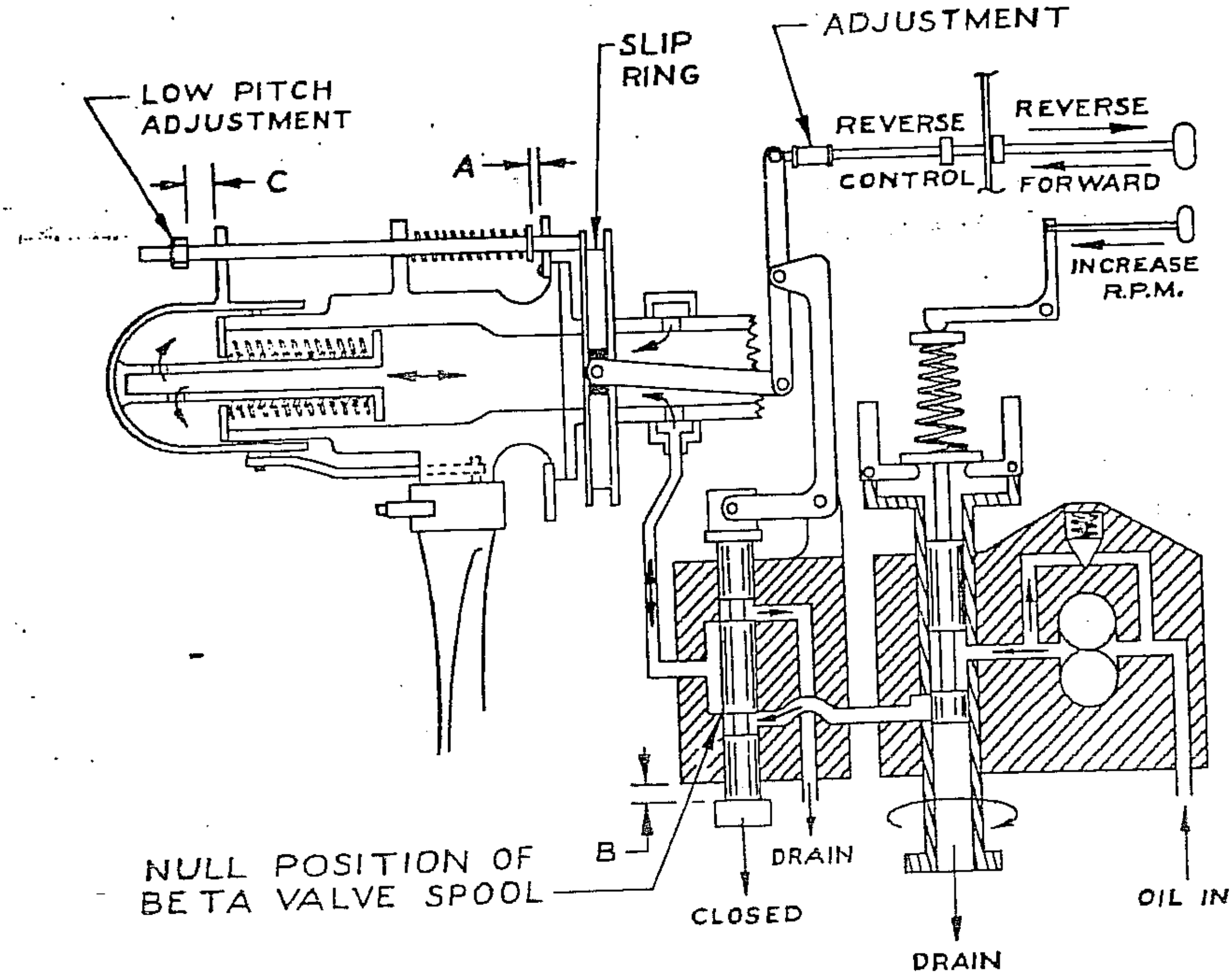
OPERATION (Cont'd)

Engine power can be applied during descent with the pitch set at some low value or reverse value, in order to increase drag. The power must be limited, however, to avoid the RPM reaching the governor setting. If this occurs, the governor will take charge and move the pitch out of the reverse pitch range since it calls for draining oil out of the propeller to correct the overspeed condition.

After the aircraft has touched down, the pitch can be moved to full reverse, after which the power can be applied to increase the braking action of the propeller. Again, it is vitally important that the pitch be in full reverse and the RPM kept below the governor setting, else the governor will take charge and move the pitch out of reverse. This would cause the engine to overspeed when the pitch went through flat pitch, unless the power was reduced very quickly.

The pitch must be moved to the low pitch value before the engine is shut off; otherwise the linkage may be damaged when the springs move the propeller to the high position.

Taxiing the aircraft is facilitated by controlling the thrust with the Beta system, since it is possible to go from positive to negative thrust. The engine power is adjusted for normal taxiing power.



REVERSIBLE PROPELLER CONTROL SYSTEM DIAGRAM
MODEL HC-92ZF-3

INSTALLATION INSTRUCTIONS

Installation of Propeller on Engine

(Reference Installation Drawing of Propeller)

See Manual 106 ( ) for instructions to install the "F" flange propellers onto the engine.

Installation of "Beta" Valve

The "Beta" valve is installed between the governor and the engine pad. In order to provide for this added thickness of the "Beta" valve, longer studs are installed in the engine. The "Beta" valve is installed first, using a gasket between the valve and engine pad.

A drive coupling is installed on the engine governor drive shaft.

The governor is mounted over the "Beta" valve, using another gasket.

Installation of the Reverse Pitch Push-Pull Control

The push-pull control is installed in the aircraft, and the one end is connected to the "Beta" valve linkage as shown in the assembly drawing.

PROCEDURE FOR ADJUSTING PROPELLER CONTROL

(See Diagram)

1. Set reverse control in FORWARD position.
2. Adjust reverse control rod to position "Beta" valve approximately 1/16-3/32 in open position. "B" = approximately 1/16-3/32. "A" = 0.
3. Check travel of push control when in reverse pitch. Use blade bar to move pitch into full reverse. Move push-pull control into reverse. "Beta" valve should be in Null position. "B" = 1/8-5/32.
4. Run up engine to check low pitch RPM. Set governor for maximum RPM. Adjust low pitch adjustment nuts to provide maximum rated RPM less approximately 100. Screw all four nuts one turn counter-clockwise rotation to increase RPM setting by 100, or vice versa.
5. Check reverse pitch RPM. Set pitch in full reverse. Set governor maximum RPM. Run up engine full throttle. Maximum RPM should be at least 100 less than maximum rated RPM to provide a safety factor.
6. If RPM is too high, increase reverse pitch by rotating blades in clamps. Increase reverse pitch blade angle about 1° per 100 RPM, or vice versa.
7. If blade angle is changed under (6), it is then necessary to reset low pitch under (4).
8. Check runout of slip ring. Total runout within .010 static. "A" and "C" must be uniform distances for all four rods within ± .003. Observe wobble of slip ring when engine is running during low pitch and reverse pitch operation. If slip ring does not run true, recheck runout.
9. Flight test.

OPERATING INSTRUCTIONS

1. Reverse pitch ONLY when throttle is CLOSED.

2. Propeller can only be reversed when pitch is in low. This means airspeed must be below a certain value, and throttle is closed. Governor control must always be in maximum RPM position - forward.

3. Be sure pitch is either in LOW or FULL REVERSE before throttle is opened up. Otherwise engine will overspeed. The reverse pitch control provides a means to feel the position of the pitch.

4. Do not shut off engine with pitch in reverse. This would cause damage to control mechanism because propeller spring will return pitch to high after engine is shut down. There is not enough "Beta" valve travel to allow for this change in pitch unless reverse control is moved to low position.

TROUBLESHOOTING

Variations in Low Pitch Static RPM

The linkage may have too much backlash in the joints.

Pitch Goes to Full High During Idle - Governor Ineffective

The "Beta" valve is shut off and drain opened up allowing piston to move full into high.

Correction: Adjust the reverse push-pull to reduce "B", so "Beta" valve is open to governor by at least 1/16 inch. "Beta" valve spool is in Null position when centered approximately between stops.