THE BELLOWS (SYLPHON) FUEL PUMP FOR
LIBERTY “12” AND WRIGHT “H” ENGINES

This report supersedes report of March 30, 1922, with the same title published
in Information Circular No. 369; and report of April 28, 1921, entitled “The
Sylphon Fuel Pump,” published in Information Circular No. 281

(POWER PLANT SECTION REPORT)

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GENERAL.

It was advisable to change the name of this pump from "Sylphon Fuel Pump" to "Bellows Fuel Pump" because of the fact that the term "Sylphon" is a trade name for the first make of copper bellows used. Another make of bellows has also been found by test to be satisfactory for this work.

The Bellows pump was designed to fill the need for an engine-driven fuel pump in order to obviate the use of air pressure where sufficient gravity head is not available. The name is derived from the metallic bellows, which is the characteristic feature of this pump. This type of pump was selected because it requires no packing gland and also because it gives a fixed maximum discharge pressure at high speeds and sufficient fuel at any speed, thus doing away with a relief valve. It is built in duplex form, so that in case one pumping unit fails the other unit will maintain sufficient fuel supply for all engine speeds.

Over two years of service of this type in flight and a 1,400-hour bench test at full capacity have shown this pump to be highly reliable. This performance, however, can be expected only when proper care, which is due any mechanism of this nature, is maintained.

At present this pump is produced for use on the Liberty "12" and Wright Model "H" engines. The only difference between the two models is in the drive shaft and base casting flange. The assembly drawing number of the Liberty "12" pump is 047280 and that of the Wright Model "H" is 047281.

GENERAL DESCRIPTION.

The Liberty "12" pump will be described, but the description for the model "H" is the same, except that the splined drive shaft (045289) and the base casting (045266) on the Liberty are replaced on the Model "H" by parts Nos. 045280 and 045267, respectively. The nut on the end of the magneto-drive shaft of the Model "H" must be removed and replaced by nut (045458) which is furnished with the pump. The Liberty pump is driven directly from the crankshaft. Figure 1 is a photograph of a sectionalized Model "H" Bellows pump.

A four-pitch worm (045305) in Figure 2 meshes with a 32-tooth worm wheel (045291), giving an 8 to 1 reduction. The worm wheel is attached to a camshaft (045284), which actuates cam-follower rollers (045287) attached to cam followers (045286). The cam followers extend into the bellows flange (045289), to which the bellows (045308) is soldered. The upper end of the bellows is soldered to the bellows head plate (045436), which is secured in position by machine screws (SP-2446). The bellows chamber (047277) also contains the inlet and outlet valve assemblies (047282 and 047276), respectively. As the worm rotates the worm on the camshaft, the cams move the plungers down only, admitting fuel from the main tank to the bellows which is returned to its original position by the spring (045282) designed to give a maximum pressure of 150 pounds per square inch with a closed discharge.

The worm-drive shaft (045289) is threaded on to the worm and balls against the ball bearing. The worm-bearing cage (045260) holds the bearing in position. The worm-bearing retainer (045261) is recessed for felt packing to keep oil in the pump, and fits just out-
Fig. 2—Liberty "12" Bellows pump assembly
side of the worm-bearing cage. The worm-bearing retainer cover (060826) holds the felt packing in place. The worm-bearing cage, the worm-bearing retainer, and the retainer cover are attached to the pump by machine screws. The pump base cap (045302) is the bronze bearing on the other end of the worm.

The cam followers (045286) operate in the cam-follower bearings, lower (045304) and upper (045288), which are bronze bushings. The upper bearings are in the camshaft support (045264) and the lower bearings in the pump base (045260). The camshaft operates in aluminum bearings in the camshaft support.

There are two intake and two outlet valves, each a unit, screwed into the valve chamber, which is the upper part of the bellows chamber casting. The valve chamber has a partition, on one side of which are the two intake valves and on the other side the two outlet valves.

A hole, having ¼-inch pipe thread about one-half way down on one side of the pump, is utilized as a drain in case a gasket leaks or a bellows breaks.

Two outlets and two inlets are provided for convenience in installation. Only one of each is necessary. The pipe plugs are inserted to prevent dirt getting in valves in shipping and stock.

The pipe plug in the bottom of the base is permanent and should be removed only to refill the base with lubricant.

**OVERHAUL.**

When an engine, having a pump attached, is received at a repair depot for overhaul, the serial number of the pump should be noted. If the pump is on a Liberty "12" engine, and the serial number is from 1 to 75, inclusive, or if it is on a Wright "H" engine, and the serial number is from 1 to 648, inclusive, the pump must be returned to Fairfield Air Intermediate Depot for overhaul, unless the pump has already been overhauled at that depot, as indicated by the letter "A" stamped after the serial number. These instructions coincide with those of Technical Order No. 02-1-11 issued May 10, 1923.

If the pump is not included in the above, it should undergo the following tests:

**TESTS.**

**Shaft speed.**—For all tests between 1,700 and 1,750 revolutions per minute.

**Priming tests.**—With the suction side of the pump communicating with fuel tank in which the fuel level is between 3 and 3 ¼ feet below the inlet to the pump, the pump must prime itself within 10 seconds, the pump being entirely dry at the start of this test.

**Closed-discharge test.**—With the discharge closed, the pressure shall not exceed 4 ½ pounds per square inch.

**Capacity test.**—With the discharge throttled to give a discharge pressure of 1 pound per square inch measured at the pump outlet, the capacity shall be not less than 70 gallons per hour. With a discharge pressure of 2 pounds per square inch, the capacity shall be not less than 35 gallons per hour.

If the pump passes these tests it may be replaced without overhaul, after lubrication. To lubricate, remove pipe plug at bottom of base and inject 3 ounces of vaseline. In case the pump does not pass these tests, follow the directions below under "Disassembly." The following are a few aids in locating the trouble.

If the pump leaks at the small side opening, either a bellows is broken or else a gasket (045429) between the bellows and the chamber is defective.

If there is a leak around the top screws, it is probably due to a defective gasket (045429) between the bellows and the chamber, or to a scratched or warped surface of the bellows head.

If the pump will not prime, or if it is under capacity, it may be due to a number of things: One or more of the four valves may be held open by foreign matter; a plunger may not be free in its guides, or an actuating spring may be weak. (See precautions.)

**DISASSEMBLY.**

To disassemble the pump, first loosen but do not remove screws (SP-2446) on the top of the bellows chamber.

Remove screws which join bellows chamber, camshaft support (045264) and pump base (045266).

Tap lightly on upper screws (SP-2446) until bond between gasket (045429) and bellows chamber is broken. (This prevents bellows from being stretched.)

Lift off bellows chamber (045277).

Carefully lift off camshaft support (045264). This part carries the worm wheel and is dowelled onto pump base (045260), giving correct alignment with worm (045305).

The worm wheel may be removed by unscrewing machine screws (SV-2533).

The worm (045305) may be removed by withdrawing cotter on engine shaft (045289), unscrewing same, pulling worm bearing cage retainer (045261), worm-bearing cage (045260), and ball bearing, then removing worm (045305).

The cam-follower bearings, upper (045288) and lower (045304), the pump-base cap (045302), and worm-bearing cage (045260) are of bronze, pressed in.

The four valve assemblies are in units. These can be removed by means of a broad screw driver or socket wrench.

**REPAIR.**

If bellows have serious dents or cracks, replace them. Bellows assemblies (045433) may be purchased from The Fulton Co., of Knoxville, Tenn.

Corrosion should be removed from bellows as follows:

(a) Immerse bellows in benzol for about 10 minutes to remove grease and to allow for the action of the acid treatment later on.

(b) Wash in cold running water to remove excess benzol.

(c) Immerse in 10% by volume solution of commercial nitric acid in water for about five minutes.

(d) Wash in cold running water to remove excess acid.

(e) To insure neutralization of remaining acid, dip bellows in 5 per cent sodium hydroxide solution in water.

(f) Remove alkali by washing in cold running water.
(g) Completely dry by air blast.

(h) Dip in transformer oil. This oil is neutral and highly refined, and will protect bellows from further corrosion while awaiting installation.

If gaskets need to be replaced, use only "Wisold" made by the Consolidated Packing & Supply Co. of New York, or equivalent.

If any of the castings are cracked, welding may be done where practicable.

**ASSEMBLY.**

Carefully clean all parts of pump.

Fill base two-thirds full of vaseline, after carefully cleaning out old lubricant.

After assembling bearing plate or base casting, test mesh of worm and wheel, and freedom of plungers in their bearings.

![Diagram of Height Gage for Setting Bellows on Actuating Rod](image)

*Fig. 3.*

Test springs before assembling bellows on plungers. Springs must be loaded to between 12 and 12½ pounds when spring is compressed to 1½ inches.

Check free height of bellows after assembling on plungers. Compress or stretch evenly to a free length of 1½ inches.

Check height of lower bellows flange after assembling bellows on plunger by means of gauge shown in Figure 3. With the outer legs of this gauge on the bearing plate, straddling one of the bellows, the middle leg should just touch the inside of the lower bellows flange, with the cam at the top of its stroke, or there should be a space between the gauge and the flange not to exceed 1/16 inch.

Before assembling the top casting, test valves by sucking on one "in" opening, closing the other "in" with a finger; and blowing on one "out" opening, closing the other "out" with finger. Valves must be airtight.

Lockwire all exposed screws after acceptance test has been passed successfully.

**INSTALLATION.**

The Liberty "12" pump has a splined drive which fits into the rear end of the crankshaft. It is attached by nuts holding it down to six studs on the rear of the crankcase. Figure 4 shows this pump mounted.

The Wright Model "H" pump has a square drive which fits into a special nut which replaces nut (11240) on the end of the magneto drive gear shaft (13127). It is attached to the rear end of the magneto bracket. Figure 5 shows this pump mounted.

Either "in" and either "out" may be used in piping these pumps. The "in" and "out" not used must be plugged. Care must be taken not to get dirt into the valve chamber when this work is done.

The ½-inch P, T, tapped hole about half way down on one side should be piped through the bottom of the fuselage. This acts as a drain in case of gasket leak or other failure, thus reducing fire hazard, and making it less difficult to locate the trouble.

Figure 6 shows a typical piping installation using this type of pump.

**PRECAUTIONS.**

Study figures 1 and 2 and read "Disassembly" carefully before attempting disassembly.

The pump base should be thoroughly cleaned of lubricant, and fresh vaseline put in every 300 hours of service.

Do not attempt to repair a leaky bellows.

If a pump is under capacity, do not force it by increasing the tension of the actuating springs. Something else is wrong which might cause future trouble.

In putting in top screws be careful that a washer is used for each screw.

After installation in the airplane, the functioning of the pump should be checked up occasionally to see that both of the pump units are operating. This may be determined as follows: Note the engine revolutions per minute, say it is 480. The impulses from the bellows can be seen on the pressure gauge and their frequency noted. The frequency in the example would be either 60 or 120 a minute, depending on whether one or two pumping units are working. If the impulses are only 60 per minute, the pump must be taken down. Probably either the valves are clogged, or a plunger has stuck in its bearings.
FIG. 4—Bellows pump mounted on Liberty "12" engine.

FIG. 5—Bellows pump mounted on Wright Model "H" engine.
Fig. 6—Typical fuel system employing Bellows pump.