PROJECT "HUSH"

by Duke Fox

This article is a culmination of several months experiments conducted with the object of producing a substantially quieter running 2 cycle engine than now is available. The results we hoped for were (1) to come up with a super effective muffler that we could sell and make a profit, and (2) to make it easy for our customers to have a quiet running Fox motor that would not be banned at sound sensitive fields. To save you suspense, we had no luck at all with item 1, but fantastic success with item 2.

We were able to get our Delux 40 running so quiet that at a distance of 100 feet, there was only a 4 decibel rise over a background of 64 decibels, and at very little loss of performance. To get to the bottom line right away, the effective ingredients were the use of two propellers, stacked one in front of the other on the crankshaft, and adding an after muffler made from a polyethylene fuel bottle. For a 40 size engine in a sport situation, our recommendation is as diagram #1. You see that we have two 9-6 propellers stacked at 90 degrees on the crankshaft. Stacking two propellers in this manner is a little strange in appearance, but it flies your airplane okay and really does make a substantial difference in sound. In an unmuffled or slightly muffled engine, the propeller noise is not noticeable until the muffler becomes reasonably effective, then the propeller becomes the predominant sound. It is necessary to quiet both the propeller and the exhaust. One without the other does very little good. Regarding quieting the exhaust, note: No metal muffler by itself that we have tested comes anywhere near the amount of sound reduction with as little power loss as our standard muffler with a 6 oz. Sullivan polyethylene bottle coupled to the tail. Again, this is a little strange in appearance, but it really does work. We had some tuned pipe silicone tubing, 7/16 I. D. by 1/8 long, that slipped over the tail of our stock muffler and into a 6 oz. Sullivan fuel bottle just fine. It is advisable to leave an inch or so of space between the muffler and the fuel bottle as the fuel bottle is about on the upper limits of its temperature capability just coping with the exhaust heat, and transferred heat from the metal of the muffler could be a little too much. The fuel bottle that we used had eight 1/8" holes drilled in the outside diameter of it fairly evenly spaced. I doubt that the positioning of these holes had any significance, but I did not try any other arrangement. Incidentally - polyethylene as used in fuel tanks will stand more heat than styrene type bottles.

Now, in case you are interested in how we came to these conclusions - the formula was to try anything and everything. A complete report would look like a book. Also, various tests started were discarded without completion if they looked like they were going nowhere.

Following is a general report on how we went about this project and a bit of the data collected. We have deleted the portion entirely dealing with multiple chamber metal mufflers as this seemed to lead nowhere.

Equipment used, (1) Realistic sound meter, obtained at Radio Shack, (2) a medium size tool post grinder, (3) a portable test stand that could be wheeled out into the field away from the noise of our shop. All final tests were conducted using our 40 Delux R/C motor.

Originally, we started using both our 40 and 60 size motors. However, as tests started to take direction, we were more interested in results than an official looking document - and running both did take a lot of time. We felt that the nature of the observations should be fairly applicable to all motors that we produce. In preparation for the tests, a rather wide assortment of propellers was collected, some rather ridiculous in proportions. All the motor tests were conducted outside about 200 feet away from our building. It was observed that if we ran the motor closer to the building, the echo factor picked up and did increase the sound readings. At the 200 feet that we were away from the building, we think that the echo factor was probably less than one DB. All sound measurements were taken at a distance of three meters, or 10 feet from the motor. It was felt that if we took our readings at a greater distance, like the 10 meters suggested in FAI, that our test would be less accurate due to the intrusion of manufacturing noises, airplanes passing overhead, highway noise, wind, etc. The first tests were just running the motor with a 10-6 propeller. The background noise was measured at 72 decibels. We got readings of 108 decibels wide open throttle with a 10-6 Zinger prop, and about 105 decibels with a 10-6 Rev-Up prop. We then installed our stock muffler. With our stock muffler, we observed readings of approximately 92 decibels. It was observed that directly in line with the propeller and directly in back of the motor, we got a little less (1 or 2 decibels) reading than we did about 45 degrees from directly back. A variety of propellers were used, running all the way from a 9-4 up to an 11-71/2, representing a speed range of over 15,000 RPM down to 9,300 RPM. It was rather disturbing to note that there was very little change in the D.B. readings. I had felt certain that running the engines slower on a larger propeller would substantially

reduce the noise. This did not seem to be true as the difference was only in the order of a couple of decibels. At this point, I felt that I must somehow separate the propeller noise from the engine and muffler noise. Fortunately, we were able to rig up a mount on our Themac tool post grinder, which would turn various propellers almost as fast as our 40 engine. The RPM and decibel readings we got are listed on chart #3. While the higher background noise makes it impossible to directly relate the two, it was quite a shock to find how much noise a propeller did make. Upon an impulse, I stacked two propellers on the tool post grinder, and immediately we achieved a vast reduction in sound, dropping from 92 decibels produced by one 10-6 propeller, down to 82 decibels produced by two 9-6 props stacked. The power absorbed by the two 9-6's were slightly more than the power absorbed by the one 10-6, yet the sound dropped a full ten decibels. Three stacked propellers seemed to make no further sound reduction. We then tried a couple of mismatch propellers, a 9-6 and an 8-4, and the sound went up about three decibels.

The next day we were able to go out in the yard and run some more tests. The tests shown in schedule 4 that were run to explore the effect of different propellers and our quietest metal muffler. The test muffler is a hand made muffler having about three times the volume of our stock muffler, and a smaller outlet. The large volume muffler did help a couple of decibels, but is not considered really significant compared to the bulk and mechanical problems a customer could have. Besides - the smaller the outlet - the hotter the motor ran. It was concluded that two 9-6 propellers seemed to be our best-recommendation where prop noise reduction was concerned.

From the tests that we had run earlier, we had concluded that an after muffler was good for another substantial decibel drop if the after muffler was made out of polyethylene. Any other kind of plastic bottle seemed to melt, but the Sullivan polyethylene six ounce fuel tank would fit up to our exhaust when using a small silicone tubing coupler. We put about eight 1/8" holes in the polyethylene bottle. The final result was the motor with our stock muffler, with two 9-6 propellers on it, and a six ounce Sullivan fuel bottle with eight 1/8" holes in it, hung on the back of the muffler. This looked rather weird, but the result was an engine which only measured 87 decibels or less at three meters (10 feet) and still had very little apparent performance loss. I realized that this is not beautiful looking, but if it is what is necessary to fly and keep our flying fields, I think that this is the way to go.

Observations: One of my observations is that the meter readings do not always coincide with my sense of sound That is, it is possible to have two set-ups that give the same meter reading, and yet have one sound considerably louder than the other. The advantages of the combination of two propellers and polyethylene after muffler is that not only is the decibel reading lower, but the apparent sound is such that a couple of hundred feet away, the sound just blends in with the wind and other extraneous noises of nature.

Now, about the polyethylene bottle for an after muffler. It seemed like the polyethylene has a great deal to do with the sound deadening characteristics. The application of a metal can in similar proportions doesn't quieten the motor near as much. Stacking of the two propellers was very easily accomplished by using a longer prop stud. However, a spinner could not be used with this double stacked propellers. After making some of these tests and realizing the contribution that the prop noise makes to the overall noise, and observing that the four blade configuration was so much quieter, I made calls to both Joe Zingaldi of Zinger, and Chris Machin of Rev-Up, and told them of my findings, and encouraged them to make at least some four bladed propellers. It seems at this time Top Flite has shut down their prop line and are in the process of modernizing their manufacturing facilities.

I am sending copies of this report to Du-Bro Products and Pylon (Sullivan) Products in the hopes that they will develop and market plastic aftermufflers with the attachment pieces and fuselage side support pieces.

DIAGRAM # 1

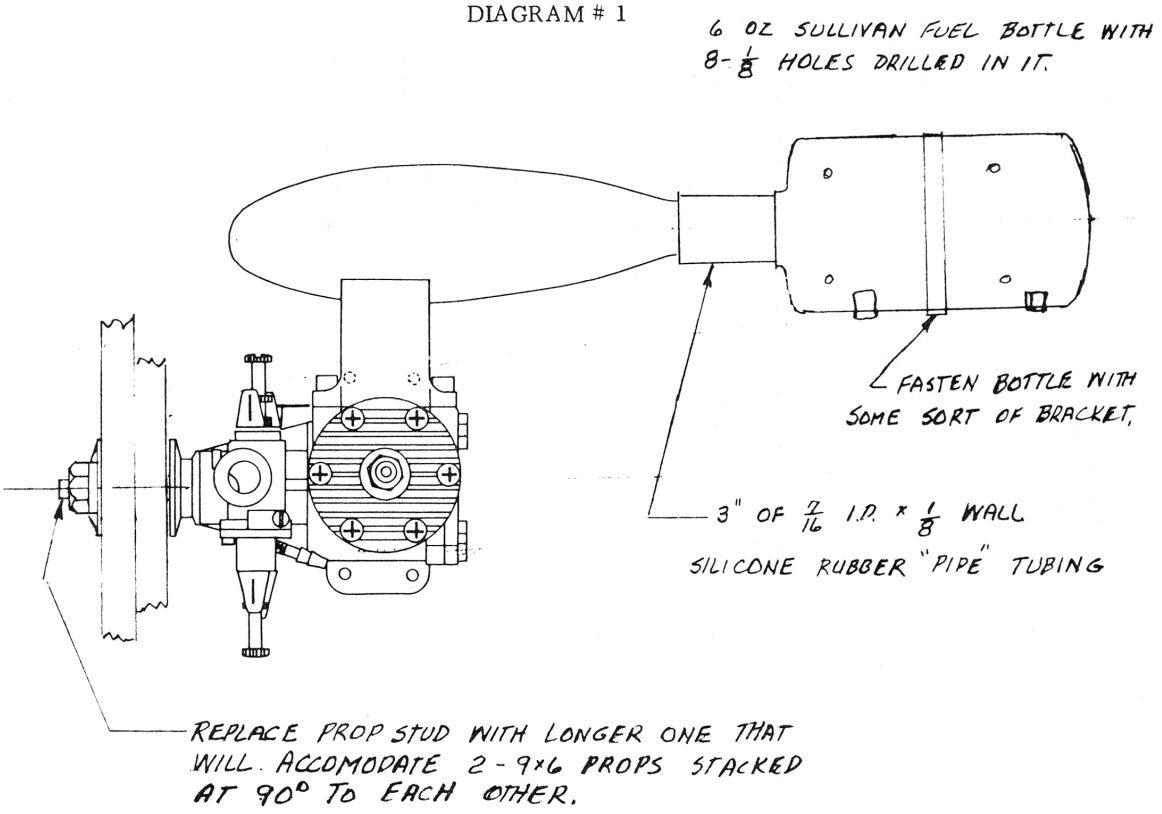

CHART #1 – COMPARATIVE RESULTS
FOX 40 RC DELUX – WIDE OPEN THROTTLE

	D.B. AT 10 FT	D.B. AT 10 METERS (39 FT)	D.B. AT 100 FT	MOTOR OFF D.B.
Fox 40 – 10 –6 Prop. NO MUFFLER	108	-	-	72 Afternoon
Fox 40 – 10 –6 Prop. Stock Muffler	92	-	-	72 Afternoon
Fox 40 – 2- 9 – 6 Props Stacked. 1 – 6 Oz. Polyehylene After Muffler	84	72	68	64 Morning

Tests were run at our plant. Difference in background noise due to absence of city traffic noise on test 3. Tests done about 500 ft. from a business thoroughfare.

CHART #2 – NOISE READINGS AT 10 FT (3 METERS) WITH VARIOUS PROP AND MUFFLER COMBINATIONS.
ALL WITH FOX 40 DELUX AND 10% FUEL.
ALL WITH 72 D.B. BACKGROUND NOISE.

MUFFLER SET-UP	PROPELLER	D.B. READING	RPM MEASURED
None	10x6 Zinger	108	12,600
None	10x6 Rev-Up	108	13,200
None	9x6 Rev-Up	105	15,300
Stock Muffler	10x6 Zinger	92	12,200
Stock Muffler With Outlet Restricted (Motor rapidly overheated with restricted outlet)	10x6 Zinger	85	10,000
Stock Muffler	11x6 Zinger	92	10,000
Stock Muffler	2 – 8x5 Rev-Up	95	15,500
Stock Muffler	2 – 9x4 Rev-Up	95	14,100
Stock Muffler	2 – 9x6 Rev-Up	90	11,200
Stock Muffler	1 – 9x6 Rev-Up	95	14,750
Stock Muffler	1 – 10x6 Rev-Up	94	12,800
Stock Muffler	2 – 10x6 Rev-Up	91	9,500
Stock Muffler	1 – 11x71/2 Rev-Up	93	9,300
Large Volume Muffler 7/32 Outlet	1 – 9x6 Rev-Up	96	15,500
Large Volume Muffler 7/32 Outlet	2 – 9x6 Rev-Up	88	11,000
Large Volume Muffler 7/32 Outlet	1 – 11x71/2 Rev-Up	90	8,600
Large Volume Muffler	2 – 10x6 Rev-Up	90	9,000

CHART #3 – PROP NOISE MEASURED AT 10 FEET WITH 78 D.B. COMBINED BACKGROUND AND GRINDER NOISE.

PROP	D.B. READING	PROP RPM
9x6 Zinger	89	11,400
10x6 Zinger	92	9,800
11x6 Zinger	90	8,00
12x9 Zinger	90	7,200
2 – 10x6 Zinger Stacked	83	8,300
8x5 Rev-Up	84	14,200
9x4 Rev-Up	90	13,00
11x8 Rev-Up	86	8,750
2 – 9x6 Rev-Up Stacked	82	9,900
3 – 9x6 Rev-Up Stacked	82	8,700
1 – 9x6 and 1- 8x4 Rev-Up Stacked	85	11,400