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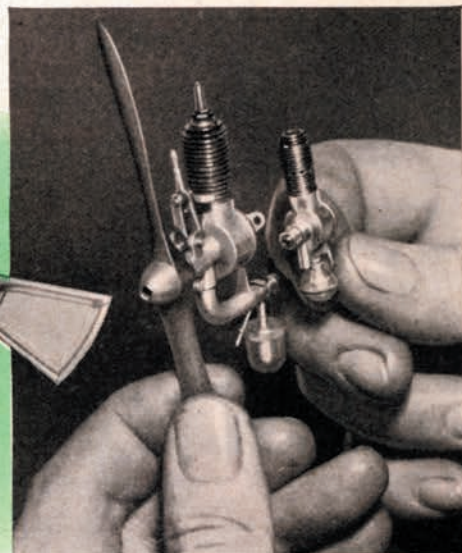


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He Builds the WORLD'S



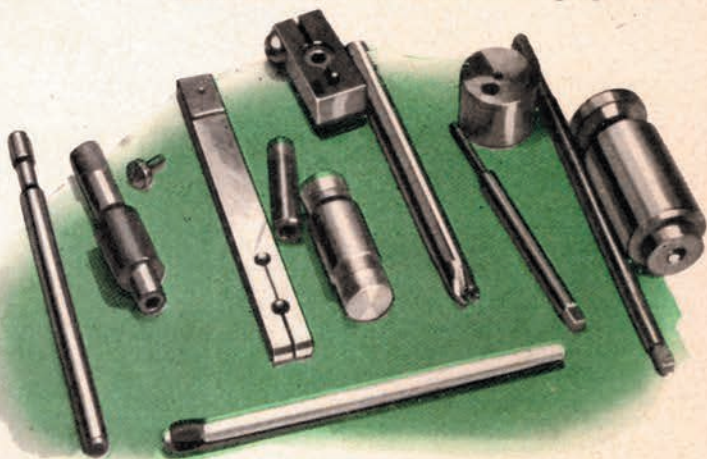
Ray Arden with the first of his midget airplane motors, completed in 1908. His present world's smallest engine is seen at right, above, with its immediate predecessor

IMAGINE a motor so tiny it spins 18,000 times on a single drop of gasoline! Imagine a spark plug so minute it is hardly larger than the head of a safety match, yet so perfect it will fire 300 times a second! Imagine a carefully designed power plant, complete in every detail, that weighs less than a .22 caliber cartridge!

That world's smallest gasoline motor has just been completed in the workshop of a Baldwin, N. Y., inventor. Among the towering structures, the rainbow colors, the thrilling pageantry of the New York World's Fair, it will form an exhibit spectacular because of its littleness. The story of this tiny power plant and of the thirty-year ambition which led to its creation, is the story of an extraordinary inventor—Ray Arden, creator of Lilliputian machines.

Ever since he was in kindergarten, Arden has been inventing things. One day, when he was only five years

old, his grandfather, who had noticed his mechanical precocity, brought him two ailing timepieces. He had wagered a friend that the child could fix a broken clock. As an incentive, he promised to give the boy the second timepiece if he repaired the first. As soon as young Arden had won his reward, he used the clockwork mechanism to propel his



Special tools used in making the pygmy engine, compared with a match

SMALLEST MOTORS

first invention, a toy automobile with two speeds, one for level ground, the other for inclines. By slipping the clockwork motor into place so that either a large or a small cogwheel engaged the ground, the kindergarten inventor could make his toy go fast or slow, as he desired.

By the time he was eleven, he was riding around in a homemade steam automobile. A relative had died and left the boy a half-horsepower steam engine which had been used to run a lathe in a back-yard machine shop. Automobiles were still a novelty in 1904 when young Arden steered his cracker-box limousine around the block with a long trail of shouting boys racing behind. A New York City newspaper ran a special article on the event with a picture of the youthful inventor seated in his "road locomotive."

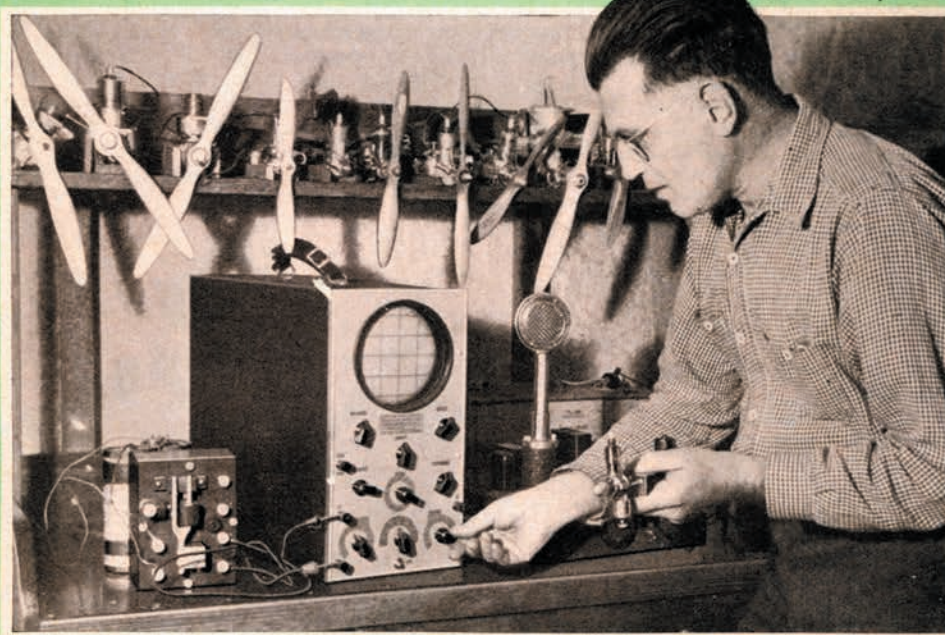
About this time, he acquired a huge steam whistle which had seen service

on a launch. With this mounted on his steam car, he pulled up in front of his home and let off an ear-piercing blast that rattled windows on both sides of the street. When heads popped from doors and windows to see what was going on, he opened the throttle and prepared to get under way in a blaze of glory. But the machine refused to budge. That one toot of the whistle had used up all the steam in the boiler!

The following winter, something occurred that made him neglect his steam machine and devote himself to the work that has made him famous. A neighbor took him to see a sportsman's show at the old Madison Square

Garden. Before one of the booths, the boy remained rooted all afternoon. Supper time came and went. At eleven o'clock at night, when the show closed, he was one of the last to leave. The exhibit that had held him fascinated was a six-foot model biplane

By
**John E.
Lodge**



Here Arden is using a cathode-ray oscillograph to measure the efficiency of one of his power plants. Such tests have shown that his latest product, which weighs only an eighth of an ounce, is more efficient, for each cubic inch of cylinder space, than the best modern two-cycle motor-boat engines!



In addition to building midget motors, Arden has taken out more than 400 patents on inventions of many kinds. Here he is demonstrating his range-finding telescopic rifle sight, said to be a great improvement in its field

equipped with a crude single-cylinder gasoline engine weighing only two pounds. Both were the handiwork of A. M. Herring, an engineer who had worked with Octave Chanute during the latter's pioneer gliding experiments in 1895. The model had been placed in the booth to attract attention to a motorboat engine that Herring had on display.

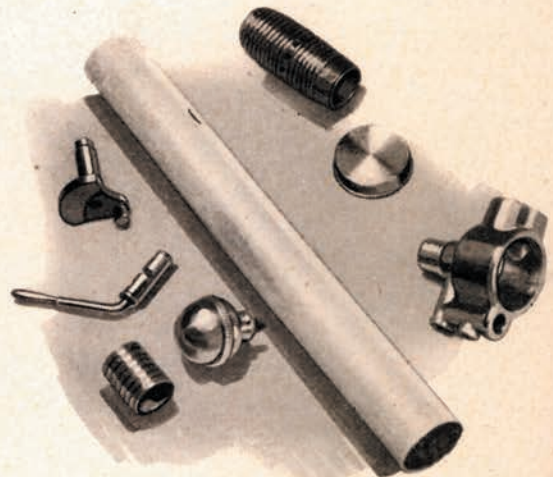
But Arden hardly saw the marine motor. Day after day, as long as the show lasted, he returned to gaze on the tiny motor and the flying machine. He determined to build the smallest aerial motor in the world. For thirty years and more, he has been spending odd hours working toward his goal. Year after year, he has seen his little engines better former marks until, today, his World's Fair exhibit has broken all records for miniature aerial power plants.

During the winter of 1907-8, young Arden rushed home from school every day and buried himself in his basement workshop. Without any previous training and with only relatively crude tools to help him, he built a motor half the weight of Herring's. This four-cycle, single-cylinder engine spun, at 3,000 revolutions a minute, a primitive propeller fashioned of steel rods covered with oiled silk. Arden still has this first of his long line of midget engines. Even today, more than thirty years after it was built, it runs as well as ever. In the summer of 1908, this

Adam of the Arden motors pushed a model biplane, with a wing spread of six and a half feet, into the air on a long flight across a race track on the northern edge of New York City.

The machine with its one-pound motor was exhibited at one of the first aeronautical shows ever held in New York. Alexander Graham Bell, inventor of the telephone, was greatly interested in young Arden and his work. After the show was over, he gave the boy a number of the cells from his famous tetrahedral kite for experimental purposes.

Another innovation of Arden's, not long afterwards, attracted the attention of additional pioneers in aerial navigation. At the time, the best spark coil weighed three quarters of a pound and gave a spark half an inch long. Characteristically, Arden decided to make a smaller coil. He succeeded in producing one that cut the weight by a third and yet gave a spark half again as long. Glenn Curtiss was one of his first customers, and the coil was used on the motor of a propeller-driven wind wagon built by Curtiss years before he rose from the ground in his first crude biplane.

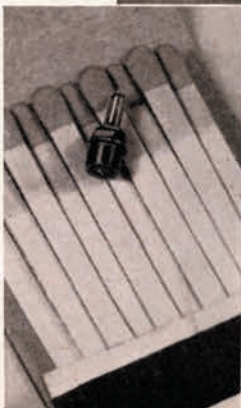


Parts of the smallest aircraft engine, compared with a cigarette. Assembled, it can be carried in a spectacle case

The motor in operation, spinning a propeller 18,000 revolutions a minute. Below, a medicine dropper is being used to fill the fuel tank, which holds just four drops of a special mixture of gasoline and oil



Since producing that smaller coil, Arden has developed a long string of midget innovations, almost all of them advances in the direction of compactness, lightness, and reduced size. All told, he has taken out more than 400 patents. They cover everything from toys and electric-clock improvements to gun sights and surgical instruments. For years, Arden has been recognized as one of the ace toy inventors of the country. Several new trends in playthings have come from his Baldwin workshop. Once, a manufacturer paid him \$1,000 for a week's work. During that time, Arden redesigned a faulty toy that had been advertised and then found defective in design.



Here the diminutive spark plug is dwarfed by a book of matches

But, all through these years while he was bringing out profitable innovations, Arden was devoting his spare time to building smaller and smaller engines. By 1910, he had produced a two-cylinder midget which weighed only fourteen ounces. In the quarter of a century that followed, Arden whittled off more than twelve additional ounces. In 1936, his two-ounce motor, humming like an angry bee, spun a ten-inch propeller at 12,000 revolutions a minute. Based on a new principle, the single-cylinder, two-cycle power plant has a bore and stroke of only half an inch. One of America's leading toy manufacturers is planning to put a refined model of this motor on the market in the near future.

Last year, just thirty years after he completed his first miniature power plant, Arden passed a goal of long standing, producing a motor that weighed less than an ounce. It

has a bore and stroke of only five sixteenths of an inch and spins its propeller at 15,000 revolutions a minute. Complete with the propeller, the Tom Thumb motor weighs but 215 grains, approximately three eighths of an ounce.

Work on his World's Fair Lilliputian engine, which slices this weight to one third, or only an eighth of an ounce, commenced early last autumn. It was finished

about the first of the year. The pygmy spark plug alone took Arden 100 hours to make. It weighs, completely assembled, only four and a half grains. Platinum-iridium forms the electrodes, with fused quartz for the insulating material and heat-treated alloy steel for the base of the plug. So delicate was the work of turning out these parts that diamond-pointed tools were used for the cutting, with fine copper wire and diamond dust employed for drilling through the quartz.

Arden has reduced the weight so nearly to the minimum on his little engines that, in spite of infinite care, he was able to save only 1/8,000 of a pound in turning out this latest spark plug. Before he could begin work on the engine, he had to make a special kit of midget tools—taps, dies, drills, and laps no longer than a kitchen match. The work is (Continued on page 240)

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World's Smallest Motors

(Continued from page 93)

so delicate that Arden must cut and drill to within 1/10,000 of an inch. He has an amazing capacity for careful work and only one part of his little motor had to be remade.

Fitted together—with the high-chrome molybdenum cylinder and piston, the duralumin crankcase, and the platinum-quartz spark plug all in place—this tiniest motor measures only one and one-sixth inches in height, five-eighths of an inch in depth, and seven-sixteenths of an inch in width. To protect it from damage, Arden carries it about in a spectacle case. The gasoline tank, looking like a metallic dewdrop, is approximately three-tenths of an inch in diameter. It holds four drops of gasoline mixed with oil. Arden "fills 'er up" with a medicine dropper after the fuel has been strained through a triple filter paper to remove the last traces of solid matter. The jet through which the explosive fuel enters the cylinder is so small that a magnifying glass is required to see it clearly. On one filling of the tank, the engine will run for four minutes, spinning the propeller 72,000 times.

This Lilliputian engine is far from being a freak. By increasing all its dimensions in proportion, its scale drawings could be used as the basis for a full-size motor. Making tests with a cathode-ray oscillograph and other delicate scientific apparatus, Arden has discovered an astonishing fact. His midget is more efficient for each cubic inch of cylinder space than are the best two-cycle racing motor-boat engines of today. By reducing the strength of the various parts, Arden could have cut thirty percent from the weight of his tiny power plant. However, throughout his work, he has striven for scientific efficiency as well as minuteness. His products are more than oddity machines; they are strong, well-constructed power plants based on sound engineering practice. As a consequence, Arden has produced innovations which can be applied to full-size engines as well.

Today, he has gone far on the course he set for himself so many years ago in front of the booth at the sportsman's show. His latest mechanical midget weighs less than 1/250 as much as the Herring engine which started him on his labors. But, even now, he is planning another and tinier power plant, a semi-Diesel engine of radically new design. With this flyweight mechanism, Arden expects to attain his ultimate goal. This is a gasoline-driven airplane which will weigh, complete—motor, plane, and fuel—less than a single ounce!