S purred by the energy and creativity of the controversial Andy Granatelli, America has moved last into the turbine age of racing. Europe pre
ceded her, with the technical elegance and success of the two Rover turbine cars at Le Mans, and with a very workable and meaningful turbine car performance formula, has America learned from this, to build an even better basis for turbocar competition in its major events? Unfortunately not. In fact, the total ineptitude, both political and technical, of the U.S. Auto Club has made the inevitable transition as painful and embarrassing as possible.

Running uneerringly true to form, USAC moved precipitously right after Indianapolis in 1967 to impose crip
cpling limitations on the use of turbine engines in its Championship racing category. It did so on the basis of the STP-Paxton Turbocar, an exceptional machine which enjoyed a small but significant margin over its competition in the 1967 “500”; and in order to penalize this car and its owner, USAC threw out all its earlier commitments and acted on the flimsiest and least accurate technical grounds.

Can it really be possible that this organization, which sanctioned 134 events in 1967 with total prizes of $2,273,516 knows very little about the history, technology and responsibility of the sport it is supposed to govern? Its president, Tom Binford, recently de

fended USAC’s new turbine limits in a letter to a critic:

Binford: “...the 500-Mile Race is the only place in the world where conditions are such as to attract a competitive turbine in the first place.”

Facts: At Le Mans in 1963 a Rover turbine car collected the long-standing prize of $5000 for the first such car to run the race at better than 93 mph, and an improved version finished the race with distinction again in 1965. In 1968 a Howmet TX turbine sports car will compete for top honors in the world’s long-distance races.

Binford: “...many people do not realize the 500-Mile Race has never been an unrestricted race.”

Facts: For the 1954 Indy race, in the first great wave of enthusiasm for turbines, such engines were allowed, for the first time, on an unlimited basis. The rules said that any entries would be weighed and measured as an aid to determining future limits which would be applied after the 1955 event— not earlier. Thus a car built for the 1954 race would have been guaranteed two tries in the “500.” In the following years, all the way through the 1966 race, the rules read simply: “turbine engines ... of unlimited size.”

Binford: “If the formula proves to be considerably too small ... the Board has agreed to change it again in 1969.”

Facts: That’s just the trouble, as Andy Granatelli says. They probably will change it again, just as capriciously and selfishly as they did for 1968. That’s why Granatelli has filed suit to be allowed to race, in 1968, cars which conform precisely to the 1967 regulations — as did his STP-Pax

ton Turbocar.

How did Andy Granatelli, one-time hot-rodder and speed equipment manufacturer and now president of Studebaker’s STP Division (actually a separate corporation since January 9), become a champion of the turbine engine? Andy and his brothers, Vince and Joe, had always wanted to win at Indianapolis and toward this end they acquired the Novi engines and cars in 1961. At that time no turbine car had ever tried to qualify at Indianapolis, though tire testing laps had been turned in 1955 by an old Kurtis 3000 chassis in which a Boeing 502 turbine the car could be made to go faster.

What are the main problems? They are torque and response, and they’re related. Turbines are noted for their high torque at low output speeds, highest at Indy just as the car comes off the corners. If the high torque cannot be harnessed to the job of acceleration right at that point, without wheelspin or loss of control, most of the turbine’s performance advantage will be thrown away. With 2-wheel drive and the narrow tires of the early Sixties, wheelspin could not be avoided. Compounding this was the typical turbine response lag of a second or more from the desire for more power to the availability of that power.

And once you put your foot down to ask for full power, “Brother, you’re committed”, as Granatelli says. Simply backing off on the throttle doesn’t reduce power instantly, as it does on a piston engine. So wheelspin, once started, was almost impossible to stop with earlier turbine cars.

The solution, indispensable to and inseparable from the success of the STP-Paxton car, was 4-wheel drive, combined with the latest in Firestone wide-tread tires. Only with all four wheels driving could a car actually use that turbine torque that looked so tempting on paper.

Granatelli had become involved with 4-wheel drive as a means of using the 700+ hp of the fabulous supercharged

The Incredible Story of the World’s Most Advanced Racing Car

The turbine era in international racing is not just around the corner; it’s here. It was brought in a cloud of controversy by a superbly-engineered racing car, the STP-Paxton Turbocar, whose future is now being fought out in the courts.

Novi V-8. Stirling Moss first suggested the idea to Andy on a visit to the U.S. in late 1961, just after he’d won a race at Oulton Park in the British Ferguson P99 4-wheel-drive car. Tony Rolt of Ferguson was advised of this contact but nothing came of it until June, 1963, when Andy asked Ferguson to bring a car over for tests at Indy. The very tired P99 was flown over and buzzed around the track by Jack Fairman and Bobby Marshman at an almost constant speed of 142 mph on August 8-9.

After an official go-ahead from Granatelli on December 6, construction of the Ferguson P104 proceeded rap
didly. In March the car was air-freighted to Indy for engine installation and it turned its first laps of the track, Andy at the wheel, on March 28. A garage fire at the track set the program back but the Granatelli’s persevered and had
the car ready for May—a beautiful, immaculately prepared automobile.

The Ferguson-Novis had terrible luck at Indy. In 1964 the car was knocked out in a 2nd-lap accident. In 1965 a new, lighter model was wrecked in a practice crash, hitting a spinning car, and the older one retired with a broken oil line on lap 69. In 1966 a single light car with a rear-mounted radiator was wrecked in practice by a rookie driver.

There was only one 4-wheel-drive Novi at Indy in 1966 because Granatelli and his men were already well under way on their Ferguson-drive turbine car. The system they used was essentially that of the P104, with shafts along the left-hand side of the chassis. A new housing contained the same Monolok center differential used in 1964, set to allow the front wheels to overspeed the rear ones by only 5%. In principle the front and rear differentials were Ferguson, without limited-slip, though Granatelli changed from straight bevel gears to hypoid gearing to get a lower drive line. Bendix constant-velocity universal joints took the drive to the wheels.

Geared to this drive system Granatelli had an excellent gas turbine engine, not the most powerful one available. ("I learned from the Novis that horsepower alone doesn’t win this race.") It was the ST-6 industrial version of the PT-6 turbine built by United Aircraft of Canada Ltd.—owned peak of 890 lbs.-ft. with the driveshaft stalled at zero speed. The lowest torque is at the peak shaft speed: 495 lbs.-ft. At Indy it was widely whispered that the turbine has an "adjustment screw" which with a twist will increase output to 900 or more hp. United Aircraft engineer Fred R. Cowley, who’d been assigned to the project, confirmed that there was such a screw—but it was only for trimming the output of production engines and had a range of no more than 20 hp.

With aircraft engines, the most important part of the physical shape is the frontal area, the diameter. It has to be as small as possible; length is relatively unimportant. Thus the ST68-62 was far too long to sit in line with the driver, yet slim enough to be placed alongside him, on the left-hand side of the car. The location on the left is related more to the drive line placement than to the 60% left-hand weight bias, since the engine weighs only 260 pounds.

That’s how the car was conceived: turbine engine, side-by-side mounting, and 4-wheel drive. That’s how each part of it is inseparable from the others, merged in a genuinely integrated machine. Who actually planned this integration, and designed this remarkable car? More than to any other single man the credit goes to British-born Kenneth B. Wallis. With a sound background in aerospace engineering, Wallis began to work with the Granatelli as an outside consultant, when the turbine car project was begun in mid-1964. In November, 1965, when fabrication started in earnest, Wallis became a full-time chief engineer for the Paxton Products plant of Studebaker’s STP Division. Andy’s brothers, Joe and Vince, were responsible for actual construction of the car.

In broad principle the suspension design of the Turbocar followed closely the proven layout of the P104 Ferguson-Novis. Like the latter, coil-shock springing units were placed inboard at all four corners to reduce aerodynamic drag. The rear suspension was almost identical to the Ferguson design, with some added adjustability for chassis tuning. At the front the coil-shock units were moved behind the front-drive differential, to permit in view of the minimum weight at Indy of 1350 pounds. The final car weight was only 1410 pounds dry.

Ken Wallis laid out the frame bulkheads to contain five Firestone fuel cells with a capacity of 44 gallons. One-way valves caused the front and rear pairs of cells to feed the center one, with the remarkable result that both lateral and longitudinal weight distribution remained unchanged as fuel was consumed. Gravity from the center cell fed the kerosene fuel to a gallon tank at the right rear, within which was an electric fuel pump to supply the engine. When tests at the track showed that fuel consumption was higher than expected, 3.66 rather than 3.85 mpg, an additional 9-gallon cell was installed in a container cantilevered from the front of the frame, inside the nose.

by Karl Ludvigsen

An amazingly light frame made of stainless steel weighed only 90 pounds. The car was revolutionary in nearly every way: weight, powerplant and driver position, which is a sure way to incur the wrath of USAC. Another sure way is to render nearly any piston engine obsolete.

84% by United Aircraft Corp. Early in the Sixties United Aircraft—today a $2 billion company—decided it would take an interest in all aspects of transportation. Its PT-6 turbine, designed in 1959 and produced since 1963, now at a 100-per-month rate, has been used in all kinds of aircraft, including the business plane owned by Mr. Shirley Murphy, sponsor of A. J. Foyt’s 1967 Indianapolis-winning car. Two of the engines were used in “Thunderbird,” an ocean-racing boat that caused almost as much controversy in its field in 1966 as the Turbocar did in 1967.

The ST68-62 turbine as supplied to Granatelli develops 550 bhp at 5230 rpm at 59°F at sea level. At 80°F the power drops to 515 bhp, and to 450 bhp at 100°F. (The temperatures on the two days of the race were 59° and 68° F.) Output torque reaches a shorter, lighter frame. Special compact and precise anti-roll bar mountings were developed for both ends of the car. Halibrand cast the magnesium wheels, with rim width at the (then) legal maximum of 9.5 inches.

Against the front face of the frame a rack and pinion steering gear is bolted, providing only one-half turn from lock-to-lock. The lock, of course, is not very generous. "After you’ve turned the front wheels 11 degrees," says Andy, "it doesn’t matter any more." Films taken during practice at Indy showed that Parnelli Jones used no more than about 20 degrees of steering wheel movement on the corners anyway. As first built, the steering gear had a single hydraulic damper mounted within the body. This was replaced by two dampers, each attaching directly to one of the forward-facing steering arms.

Construction of the STP-Paxton Turbocar pushed ahead in early 1966, with a target of that year’s Indy 500. Made out of stainless steel, the frame was impressively light at 90 pounds. It had to be heat-treated as a complete assembly in a huge oven, however, and when it was completed, they found it had warped beyond repair. Granatelli: "That was a low moment in my life."

All hope abandoned of a 1966 race entry, a new frame was riveted of 7186-T6 aluminum alloy. It was heavier, at 137 pounds, but this was not serious..."
World’s Most Advanced Racing Car continued

With side-by-side construction, the car had to be wide. Its projected frontal area was as high as any car at Indianapolis. After thorough wind tunnel testing of models, however, a body shape was developed which had very low drag, more than compensating for the extra frontal area. Careful internal air flow planning also contributed to the low drag. Aircraft-type flush inlets on the top of the body admitted air to the engine and differential oil coolers, at the rear of the frame, and to the turbine inlet, farther forward. Air for the turbine was ducted through the frame from the 51-square-inch inlet, redirected by turning vanes, and filtered through a fine mesh screen to hold back the unidentified floating objects that can destroy engines at Indy.

Though the STP-Paxton car didn’t make it, there was a turbine-powered car at Indy in 1966—one which unwittingly set off the whole current furor over turbine limits. It was the Jack Adams Aircraft Special, with a General Electric T-58 engine in the front of a 1961 Watson “roadster” chassis. The 1300-hp car had tire-smoking acceleration, straightaway speed over 200 mph, and very good handling and brakes. It never came close to qualifying, but it left a lasting impression on the USAC Rules Committee. In September, 1966, they recommended that turbines be banned altogether, on the grounds of the supposed danger of explosion. But they were told by the USAC Board to go out and get a formula that would limit turbines to about 600 hp.

Headed by ex-driver Henry Banks, the Rules Committee developed a formula which was ratified by the USAC Board on January 12, 1967. It specified a maximum area for the actual air inlet of the turbine compressor of 23 square inches for axial-flow compressors, and 28.5 square inches for the less efficient centrifugal-flow compressors. This change, in a formerly unlimited formula, was made effective immediately, literally without notice. By sheer luck the suggested axial-flow limit of 23 square inches was just barely in excess of the inlet of the ST6B-62 engine.

In framing the formula USAC officials may have kept the STP car in mind, because they’d been told about the car and invited by Andy to see it in late 1966. The first racing outsider to see the chassis was ace mechanic George Bignotti, on March 15, 1967. His reaction, after 10 minutes of silence: “I think I’ll go back into the florist business.”

When he was asked to try the car at Phoenix, with the prospect of an Indy ride, the semi-retired Parnelli Jones thought to himself, “They’ve got rocks in their head. How can they ever get good throttle response? And Andy says they only have 550 horses. What a sad waste of a lot of time and money. But I’ll give it a fair trial and then we’ll see.” Parnelli ran at Phoenix just 1/2 second away from the track record.

“I was testing my own car there and I didn’t want to get back in it. It was like getting back into a prop job after you’ve been riding in a jet plane. Driving the turbine I could hear the universal joints, the pucks clamping the brake discs, and every little squeal from the tires. And with kerosene fuel it has to be safer than the other cars.”

Late in March Parnelli and Jim Clark tried the car at Indianapolis. Computer readouts had told them to expect speeds of 200 mph on the straight and a potential lap speed of 173.5 mph, but with the gearing the computer told them to use they couldn’t average better than 152. After a change in the gears between turbine and center differential they lapped at 162, in March, with a peak of 191 on the straights.

Parnelli was not entirely happy with the braking in these tests, so they doubled up on the pucks in the 12-inch Airheart brakes, using Raybestos sintered copper linings. At the rear Walls also engineered a hydraulically-raised braking flap, which was automatically erected when brake line pressure rose above a certain limit. Parnelli handled the brakes so smoothly during the race that the flap came up only when he slowed for pit stops and when he had his heart-stopping spin. Even then he praised the Turbo: “I never felt I lost control of it. I never spun in my life in any other car and felt that way.”

Parnelli also liked the car better when it was full of fuel, perhaps because the ride was slightly better that way. A full load made no difference to handling, and most of the May practice laps were turned with full tanks.

Between Phoenix and Indy the chassis required virtually zero adjustment. During May the USAC "experts," obsessed by the spectre of turbine disintegration (though they ride in jet planes many times a year and God knows the piston engines at Indy blow up violently enough with a banzai load of nitro), demanded that Andy install a steel scatter shield around the hot section that would have weighed 300 pounds. Granatelli satisfied them—but with a 3/4-inch titanium shield that cost $3800 and weighed only 38 pounds. Weight was reduced in compensation by eliminating the elaborate practice instrument panel with its 13 indicators and nothing more than a simple panel with only two dials.

The story of practice and the near win of the Turbo car is now well known. But some aspects of that hectic month of May are not common knowledge:

1. The car was unable to get above 163 mph until just three days before the first qualifying weekend. The crew was then by no means confident. Parnelli’s starting position was the worst he’d ever had at Indianapolis.

2. Qualifying was a fingers-crossed proposition with a bolted-up set of transfer gears made from the pieces of several sets, improperly heat treated, that had failed in practice.

continued on page 84
3. Granatelli went to Bendix to try to get them to reset the fuel flow control to provide more power, but Bendix said they couldn’t do that without asking United Aircraft first. And Andy knew U.A. wouldn’t approve.

4. The engine’s built-in overspeed protector worked perfectly during the several driveline failures. It shut fuel off so fast that the driver couldn’t detect the slightest initial rise in engine speed.

5. Starting on lap 178 Andy showed Parnelli the “save fuel” sign to slow him down, not because there was any fuel problem but because he didn’t want Jones to lap Foyt—an event that could have had unpredictable consequences. Actually slowing the Turbo- car would have used more fuel, as Andy well knew, due to the turbine’s fuel consumption characteristics.

6. The cracking of an inner bearing race that retired the car was an absolutely random failure, with no sign of high temperatures or lack of lubrication. But a fatigue failure might have been hastened by the two starts and the 64 laps run under the yellow flag, when the turbine was running in its high-torque speed range.

7. Checks at the end showed the tires would have been good for 4300 miles and the brakes for 1470 miles of racing. During the entire month the turbine used only a half-quart of oil—against the 150 to 200 gallons that Andy’s Novis used to consume.

8. In the race Jones had an advantage of 1 to 2 mph over his competition, “about the same margin I had with my roadster in 1962 and 1963. So help me God,” Parnelli swore, “I did not sandbag the entire month of May. I drove it as hard as I would any car.”

9. Andy Granatelli allotted the credit for the car’s performance this way: 30% to the engine’s torque characteristics; 40% to the 4-wheel drive, and 30% to the driver and the weight distribution.

10. The Turbo-car had exceptional luck with the weather, with temperatures of 59 degrees and 68 degrees F. on the two race days. A 90-degree day could have erased its lap speed margin.

For Granatelli the immediate post-Indy scene was one of victory in defeat, of vindication of a dream, of recognition granted that had been long withheld. The engineering and construction of his car was widely and freely praised. Plans were made for Studebaker to make a miniscule return to the car business by building 20 Turbo-cars to retail for some $68,000 each. Aware of the threat of a limitation on his engine by the capricious USAC board, Granatelli pleaded, with reason: “Add 15% to our weight, allow more pit stops at Indy, check our power before the race and keep a man with me to see that I don’t cheat—I’ll even pay his salary and expenses for the month of May. But please don’t chop down our inlet size.”

In an apparent outburst of wisdom, the USAC Rules Committee decided on June 8 to refer the question of a turbine limit to a committee of industry experts. The outburst was more apparent than real, because by USAC custom the previously-declared limits should have been left alone for at least two years. But with kangaroo-court speed the experts were individually consulted by the Committee, headed by Henry Banks, which recommended that turbines be required to run on methanol, that in curious contradiction water/alcohol injection be banned, and that “a 25% reduction in inlet annulus area . . . be considered.”

On June 26 USAC issued its final ruling, cutting annulus size of all turbines to 15 square inches, a reduction of 35% from the former limit for axial-flow turbines. Conveniently forgotten by the Board was its former more generous limit for centrifugal-inlet com-
pressors. The water/alcohol injection was banned on the remark of a GM engineer that its use could increase power by up to 25%, even though the same engineer noted that it would have to be injected at a rate of three gallons per minute for the STGB-62 turbine. The car would have to have a 200+ gallon tank for the water/alcohol mix alone! And if the requirement to use alcohol fuel had been adopted it would have doubled the turbine's basic fuel consumption rate.

In promulgating their precious inlet-annulus formula, USAC ignored an excellent turbine formula developed after long study in 1964 by Britons Peter Spear and Noel Penny, later adopted for international racing. After exhaustive analysis they decided a relationship based on the compressor pressure ratio and the area of the internal turbine nozzles gave the best comparison to the piston engine. They studied a formula of the USAC type, but discarded it because it was a significantly less reliable guide to the turbine's probable output. And why did USAC, almost peremptorily, dismiss the idea of the Spear-Penny formula for Indy? Because, they said, it would take too long to take the engine apart to check the nozzle size. It would take a couple of days, they said. Funny that they didn't consider that even if that were true, it would effectively prevent a competitor from taking his engine apart during May to make some sort of internal change after it had been initially USAC-approved at the factory. Besides which it's almost impossible to change, in the field, the parameters of the Spear-Penny formula anyway. Maybe USAC thinks there are really little pistons in there somewhere.

How did the STGB-62 turbine rate on the Spear-Penny-F.I.A. scale? On the basis of gasoline fuel, for which the formula was planned, it is equivalent to 303 cubic inches (5040cc), the Indy stock-block limit, as it happens. On an alcohol-fuel basis it is equal to a 260-cu.-in. (4260cc) piston engine, as close as makes no difference to the present Indy unblown limit. And if alcohol with 10% nitromethane were considered, a mixture many use for the race, the equivalency would be 240 cubic inches (3940cc).

After the axe fell Granatelli did consider the idea of a Novi engine in the car, and he also made a trip to Italy to talk to Ferrari about an engine. But then he realized: "That's just what USAC wants me to do. I'm not going to step backward for them. And I've been spoiled by these turbines. I don't ever want to pull a spark plug again." He also realized there would be no point in building a new car, at colossal cost, for the smaller inlet limit. "If I did it and it was a good one, they'd only change the limit again." And he's right. That's why the matter went to the courts, hopefully for a judgment during March.

What's really needed at this point is a limit on the piston engines. If they were prevented from using nitromethane, or if they had to qualify on the same fuel they use in the race, which is one of the most reasonable, then some turbines might be able to make the starting field. Even with the smaller annulus, a turbine might do well in the race but it could never qualify.

There's another angle too. The turbine uses its air supply for both cooling and combustion, supplementing its cooling needs with an external oil radiator. Why not ration equally the amount of air that both types of engines, pistons and turbines, may use for both purposes? Why should the piston engine's air inlet be free while the turbine's is restricted? That's probably more than USAC is able to grasp, however. Meanwhile Granatelli is getting ready to stir up trouble in new fields. He's "doing more than just thinking" about building a turbine car for the current Grand Prix Formula 1. Is the Grand Prix circuit ready for Granatelli? When the STP pajamas appear at Monaco, we'll know.

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