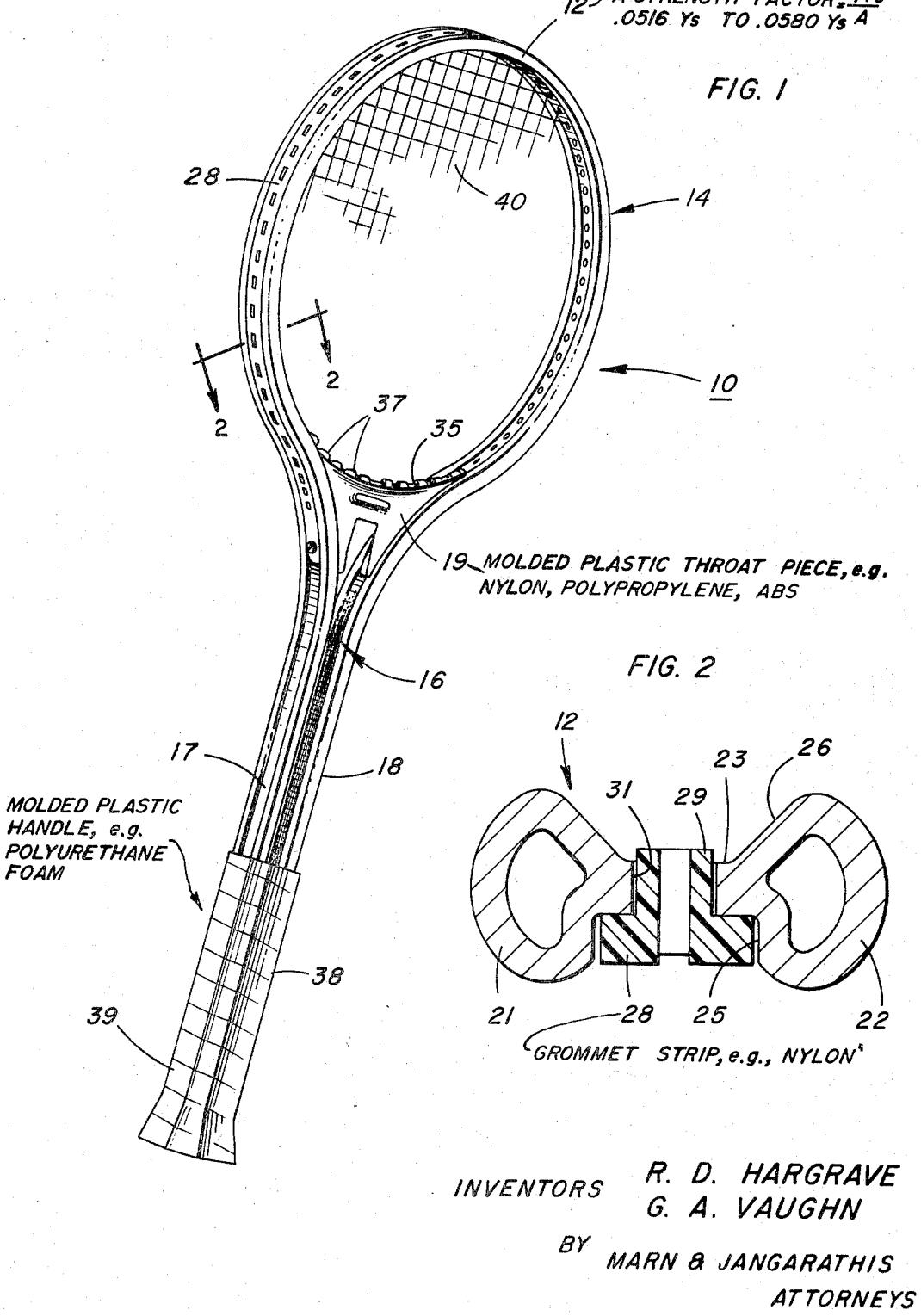
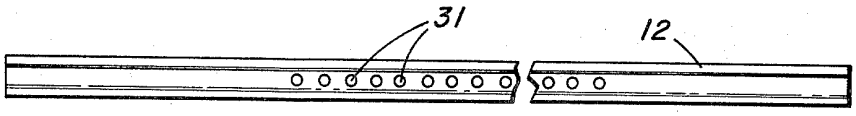


Making a

Meet the Man Who Made Tennis



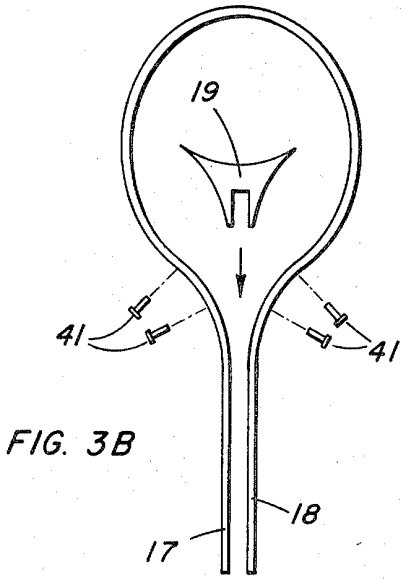
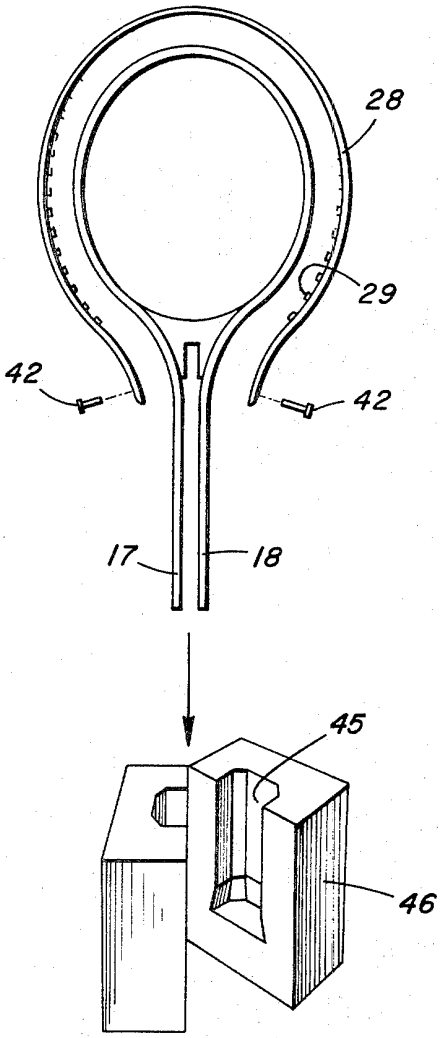


FIG. 3B

FIG. 3C



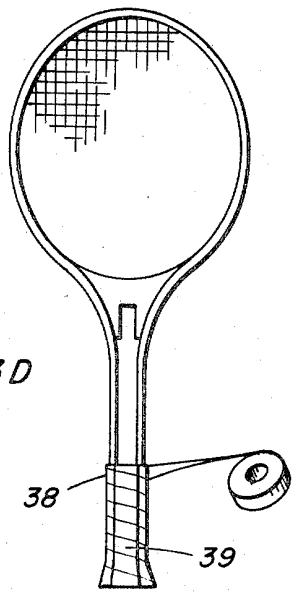


FIG. 3D

Racquet

Equipment Modern.

By **Lydia Horne**

A yellowjacket is attacking a 95-year-old. The victim, George Augustus Vaughn III, or "Arky" (after the 1930s MLB star), swats at it unsuccessfully, barely moving the humid New Jersey summer air that's wilting everything in sight. About 20 feet away, top-heavy hydrangeas, planted by Arky's late wife, Martha, bow down respectfully from the garden.

"I think it likes my shirt," Arky says, gesturing toward the bright yellow sweater he wears over a white collared button-down. He sits with crossed legs, one hand wrapped around a black cane—which reads more like a scepter than an aid. The other hand occasionally floats up to adjust his thick glasses. He has a head of hair that most sixtysomethings at the Princeton Wawa market would drool over.

Arky's 56-year-old daughter, Phoebe Outerbridge, springs into action. Blond and svelte, Phoebe is a notorious doubles player at the Pretty Brook Tennis Club, where her father has been a member since 1971. Fellow club members describe her as an infallible player, which becomes evident as she grabs one of her father's Head Master racquets off the patio table and volleys the offending insect.

It's safe to assume that when Arky first manufactured the Master around 1970, he never imagined it would be used as a flyswatter. He also likely never imagined his racquets would profoundly change the sport, or how tennis greats like Arthur Ashe and Pam Shriver would someday rely on his inventions. Instead, Arky thought about what he would make next.

By all accounts, Arky was always a tinkerer. As a child, he fashioned a boat out of a wooden plank and a bed sheet that he envisioned would carry him all the way from his home in New York to Paris (eventually the *Staten Island Normandy* was abandoned en route). A few decades later, Arky would find greater success in his string-lock technology that accommodated easy racquet tension adjustments and gave players better control over the ball. Then came the retractable golf club, a homemade travel hack that Arky allegedly snuck onto the course at Pebble Beach. And finally, after reading an instructional brochure, Arky built a Fokker DVIII airplane.

In December 1967, at the encouragement of his father and to the dismay of his wife, Arky started MAARK Corporation (a portmanteau of Martha and Arky). The company operated out of an old potato barn in

George Augustus "Arky" Vaughn III, in his Navy whites.

The Head Master and the “Red Head.”

PRINCETON WAS THE SILICON VALLEY OF TENNIS, PERFECTLY SITUATED WITH ACCESS TO NEARBY MANUFACTURING PLANTS AND YOUNG, MATHEMATICALLY INCLINED PRINCETON GRADUATES.

Arky in the Alcoa offices, 1964.

Cranbury where employees found potatoes rolling across the ground floor on their first day of work. Arky had been fired from his last job at Mideast Aluminum Corporation after failing to introduce a product that could generate a significant margin. But it was not for lack of experience: He had spent 10 years cutting his teeth as an engineer at the Aluminium Corporation of America (Alcoa), working with manufactured castings, extrusions, and sheet metal.

While nervous about his new venture, Arky recognized that he had the foundation he needed to set up shop: "I was concerned because I got fired," Arky recalls. "But I said to myself, 'Okay, I've already been working on some cable support systems that I could possibly get along on.' And MidEast said I could have the two guys that were working for me."

Arky's father, who arranged a $25,000 line of credit for his son's new venture, suggested that in order to run a successful business, he needed a copilot. Arky knew Richard "Dick" Hargrave, the tall, handsome Princeton graduate, from their a cappella group, the Private Parts. Arky knew Dick's engineering skills were impressive,

Arky and Dick Hargrave.

and the pair had always struck an easy banter. He invited Dick to visit the potato barn to see what MAARK was up to. It seemed like the right fit. Arky, eager to attract new talent, offered a 49 percent partnership and $14,000 annual salary in exchange for a $25,000 investment. Dick took a leap and said yes.

Sharp and detail-oriented, Dick was the technically minded rock MAARK needed so that Arky could focus on product design and attracting business. They began making metal bulletin boards for Rutgers University and cable systems, but it was slow work and skimpy pay. It was proving to be a tough winter—and the drafty potato barn was chilly with only four kerosene heaters to keep the place warm. Dick recounts, "We soon went to the bank and borrowed $100,000 for operating expenses, which we both personally signed for. The cable tray business was self-destructing."

But Arky had a lead: The clothing brand Paul Sullivan was looking to augment its tennis apparel collection with a tennis racquet and needed a manufacturer. Arky was selected to help with the design, and MAARK created a racquet using a die from extrusions made at Mideast. This caught the attention of Spalding executives, who purchased the Paul Sullivan aluminum racquet concept and commissioned MAARK to make more. Arky and Dick had never seriously considered making tennis equipment before, but they needed the business and hoped it would yield interesting work. Although there was no proven market for aluminum, and no guaranteed promise of success, they would at least try.

Other than a few steel options on the market, the tennis industry hadn't meaningfully pursued metal racquets despite the known benefits: lightweight, stiff, durable. Arky was familiar with Spalding products; his first racquet was their Mercer Beasley model. He would hit with friends as a kid in Staten Island at the Richmond County Country Club, where his family were members. The club would occasionally host celebrity matches on its grass and clay courts that would draw big crowds. One year, Arky was a ball boy when Bobby Riggs came to play. Overwhelmed with excitement and by the proximity to celebrity, Arky forgot to give Riggs a ball before a point. Later, Riggs lost the match. Arky watched as Riggs smashed his wood racquet into tiny pieces that flew across the court.

As an adult, Arky was not an especially remarkable tennis player, but he liked to play and could hold his own. He understood the composition of racquets and how to distinguish between different makes. When it came time to design the Spalding racquet, Arky relied on Dick to carry the bulk of the engineering work. MAARK's racquets would need to be able to endure heavy use, but the early racquet they devised for Spalding, known as the Smasher, wasn't cutting it. The Smasher bent easily; it had a return rate of 10 percent. Although MAARK proposed ideas to improve the product, Spalding wasn't interested. Tennis was such a small part of the company's market, it didn't make sense to invest more.

Head, however, was ready to level up its game. The ski manufacturer wanted to diversify its market and produce equipment that could be used in non-winter months. Joe Boggia, a recent hire from Wilson, was dispatched to MAARK to check out its wares. Boggia pulled up to the potato barn in a Ford Mustang Shelby. Both the car and Boggia were exceptionally loud, but he knew everything about the business and, despite the Smasher's problems, encouraged Arky to submit a few aluminum racquets for Head's consideration.

Arky and Dick got to work, setting up a production line and scheduling meetings

with other manufacturing plants for advice. After all, there was no precedent to making aluminum racquets; MAARK would have to write the book. First, the team replaced the Smasher's throat piece with injection-molded nylon. Next was cushy handles filled with hardened polyurethane foam, and then grommet strips to protect strings from the frame. But the most critical ingredient was an aluminum alloy that Mideast used to produce metal baseball bats. Arky still had access to alloy supplies—maybe it could work for tennis racquets, too.

Critical to all operations was Arky's relationship with Dick. In the office, they positioned their desks roughly eight feet apart to streamline communication. Dick could hear Arky's conversations with vendors over the phone, and Arky could watch Dick deftly adjust calculations to accommodate new design ideas. It was the left side of the brain working seamlessly with the right.

After long nights spent poring over every detail, MAARK was ready. Arky traveled to Sun Valley to pitch the prototype at a Head conference. He came to Boggia's hotel room, where the normally boisterous sales manager was sequestered with an illness. Even bedridden, Boggia liked Arky's pitch. Head sent MAARK an order for 40,000 frames to be fulfilled by the end of 1970. With only several months' notice, Arky and Dick would have to scramble to get the order done in time. They used some of their advance from Head to build a new 50,000-square-foot plant in Plainsboro, which became a surging hub of activity as deadline fast approached. Fortunately they had a few extra pairs of hands: Dick's high-school-aged kids and their friends swarmed the plant, offering to pack shipping boxes full of racquets in exchange for a festive celebratory dinner once the job was done. "It was scary," Dick says of MAARK's first big order. "But definitely exciting."

Arky still remembers the excitement of seeing the Head competition racquet in the hands of Arthur Ashe at the 1971 US Open in Forest Hills. Charlie Pasarell and Bob Lutz were early adopters too. Soon, amateurs could purchase a standard version, the Head Master, at sporting-goods stores. Later, the "Red Head," a stiffer professional racquet with a red throat, would become a best-seller.

Unlike the models of yore, the Master had stamina. The secret to getting there was the Big Whacker, a machine Arky and Dick built in Hargrave's basement that tossed a tennis ball 10,000 times at a mounted racquet to test its durability. Arky rigged a strobe light and camera overhead so engineers could observe the flexibility and fatigue of the strings as it made contact with the ball. Even with the DIY setup, the Big Whacker certainly surpassed MAARK's previous testing technique, which involved Dick and Arky taking a pile of racquets to the nearest park and whacking the strings with mallets.

Sam McCleery, former executive at ESPN and Under Armour, worked at MAARK for his first job out of college. He describes the posterity of MAARK products as something all innovators should aspire to create. "A lot of the same features in that original Head Master are still incorporated in today's racquets," McCleery says. "I can't think of any other industry in which the base technology still has that same core invention functioning as critical to the performance of that product."

Following the success of the Master, MAARK was soon tapped by other manufacturing companies eager to get in on aluminum. Prince, a local tennis-ball-machine manufacturer, approached MAARK with its latest concept: the Prince Classic, an oversize racquet with a large sweet spot. This racquet generated bigger serves, stronger

Arky and Dick in India.

shots, and more surface area for volleys. Steve Davis, former VP of Prince Global Product Management, explains: "The [Prince Classic] being larger meant it was more stable, like an ice skater throwing up her arms. It was more resistant to twisting and had longer, more powerful strings that made the game easier to play." Initially, Arky was reluctant to make the Classic—perhaps correctly anticipating the pushback from the industry, which soon labeled it the "cheater racquet" when it first appeared in 1976. But critics quickly changed their tune when Pam Shriver, then only an amateur, reached the US Open finals in 1978 using the Prince Classic. Junior players were especially keen to use the oversize racquet—it was more forgiving and thus easier to learn with. But it was not only kids; this breakthrough racquet made tennis more accessible to everyone. Davis continues: "The racquet was controversial for a period of time, but as was almost every watershed technology innovation. But of all those technologies, I would say the oversize racquet was the most significant invention the tennis world has seen, or maybe will ever see."

—

By the mid-'70s, MAARK employed about 25 people, many of whom Arky and Dick had hired mostly based on feel. In interviews with prospective hires, they spent most of the time grilling candidates about their vocal range in the hope of attracting new talent to the Private Parts. After all, no one had experience making aluminum racquets because these products were just invented. New hires would have to be taught. Here, Arky took a hands-on approach: On

Nov. 14, 1972 G. A. VAUGHN ET AL 3,702,701
METAL TENNIS RACKET WITH PLASTIC THROAT PIECE
AND MOLDED PLASTIC HANDLE
Filed Aug. 28, 1969 3 Sheets-Sheet 3

FIG. 4A

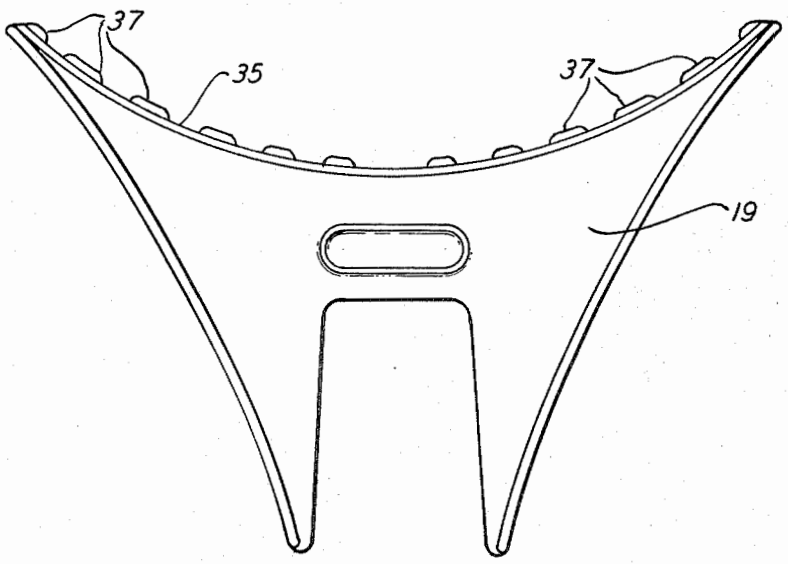
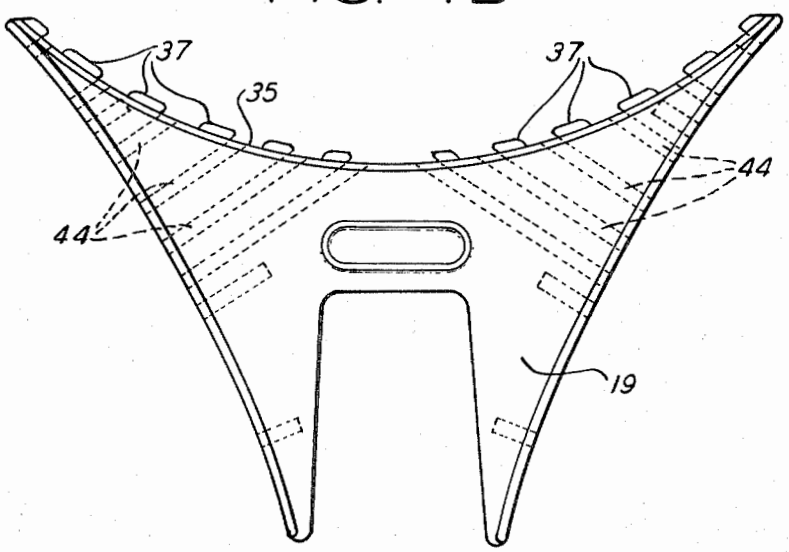


FIG. 4B



INVENTORS
R. D. HARGRAVES
G. A. VAUGHN

United States Patent Office

3,702,701

Patented Nov. 14, 1972

3,702,701

METAL TENNIS RACKET WITH PLASTIC THROAT PIECE AND MOLDED PLASTIC HANDLE

George A. Vaughn and Richard D. Hargrave, Princeton, N.J., assignors to Maark Corporation

Filed Aug. 28, 1969, Ser. No. 853,676

Int. Cl. A63b 49/08, 49/12

U.S. Cl. 273—73 H 16 Claims

ABSTRACT OF THE DISCLOSURE

The metal racket is made from an extruded aluminum strip comprising a pair of opposed tubular sections connected by a web, with a strength factor of IY_s/A in the range of $0.0516Y_s$ to $0.0580Y_s$. The metal strip has a first channel in its outer periphery and a second channel in its inner periphery. A plastic throat piece is provided with outer surfaces shaped complementarily to the configuration of the inner periphery of the metal strip. The racket further having a solid molded plastic handle made of a foamed plastic material molded to the lower extremities of the metal strip.

BACKGROUND OF THE INVENTION

This invention relates to metal tennis rackets.

A long standing and continuing effort by those concerned with the development and manufacture of tennis rackets has been the effort directed to the development of a commercially feasible yet functionally satisfactory tennis racket having a metal frame strip. Typical of the results of these efforts are the racket disclosed in the U.S. patent to La Coste, originally Pat. No. 3,086,777 and reissued as Re. No. 26,128 and the racket disclosed in the U.S. patent to Allward, Pat. No. 2,742,289.

Notwithstanding the efforts expended toward the development of a satisfactory metal frame strip tennis racket, difficulties continued to be experienced and acceptance of such rackets by tennis players has been marginal.

The problems attendant to known tennis rackets having metal frame strips have been vexing. For example, rackets having channel or tubular frame strip structure have been manufactured using both steel and aluminum alloys. Steel rackets, although providing satisfactory racket strength characteristics, have been critized for being excessively flexible. Such flexibility has been complained of for causing the rackets to be "whippy" at the sacrifice of player accuracy. Aluminum rackets, on the other hand, have demonstrated satisfactory rigidity within the limits of their yield strengths but have been subject to criticism for their propensity to permanently deform.

The propensity for permanent deformation has also presented structural difficulties in the manufacture of known aluminum frame strip rackets. More particularly, it has been found that aluminum frame strips of known configuration tend to deform locally rather than uniformly during shaping to form the racket shape. Ordinarily the lines of localized deformation have been through the holes in the frame strip material provided to accommodate stringing. Thus, where such localized deformation occurs, the shaped frame strip defines a polygonal figure rather than a generally oval figure having a smooth curve outline.

A further difficulty experienced with known rackets

this often occurs where the string bears against a relatively sharp edge and is displaced across the edge by the impact of a ball against the strings of the racket. The resultant rubbing causes early failure of the string at that point of stress concentration and wear. String wear within the frame structure ordinarily occurs with tubular frame strips which have been punched, drilled or otherwise worked to form string accommodation holes. The edges of the holes on the inner surface of the tube are inaccessible to finishing procedures and as such ordinarily present sharp edges which cause failure of the strings or string accommodating grommets provided therethrough. In this regard, even the provision of grommets has not satisfactorily overcome this problem since the sharp edges are equally destructive of the grommet material which, upon failure, exposes the strings to wear. Recognizing this, workers such as La Coste have suggested the elimination of stringing holes and have proposed that the strings be supported by a wire coiled around the racket frame. Such structure, however has subjected the string material to short radius deflections which generate rapid wear and for this, as well as other reasons recognizable to those in the art, is considered to be unsatisfactory.

With respect to the problems created by deflecting the strings around excessively small radii (e.g. the ordinary radius around which a string may be supported in known racket structures is generally in the range .030 to .040 inch), it will be recognized by those skilled in the art that supporting a string which is loaded in tension on a short radius fillet generates a point of stress concentration. Heretofore, a solution of the short radius problem by increasing the radius dimensions of support surfaces for the racket strings has been impossible because of the lack of available space resulting from the structural configuration of the frame strip.

A further difficulty with respect to aluminum frame strip rackets has been the relative racket weakness. Such weakness has been found to be caused by the shape of the frame strip cross-sections. Specifically, known aluminum frame strip cross-sections have relatively large concentrations of material along their longitudinal axis. It appears that this may have resulted from attempts to provide a solid web of material through which to provide stringing holes in an attempt to avoid the problem discussed above relating to internal sharp surfaces and the attendant string wear. The strength factor of structural shape, however, is directly related to the moment of inertia of the particular shape and the yield stress of the material in question, and inversely related to the area of material exposed in a cross-section thereof. Thus, while concentration of material in the central or axial section of known frame strips eliminates the incidence of string breakage resulting from sharp inner frame strip surfaces, it also resulted in a general weakening of the racket frame strip material.

A final difficulty experienced in the prior art metal frame strip racket structures has been a lack of strength in the throat of the racket. Specifically, rackets of known structure have been subject to deformation in torsion around the throat, which deformation has often resulted in the permanent deformation of the racket material thus misaligning the racket.

SUMMARY OF THE INVENTION

Arky flies in a Spitfire to mark his 90th birthday.

a typical day, he would "work on the design of the racquet, and then I would go out on the floor and help make them." As a manager, Arky maintained his personal values. The factory, despite the drips of epoxy resins and wood chips everywhere, would be kept clean and tidy. New employees would be invited over to the Vaughn house for dinners and parties, where they were surprised to find themselves having fun. Their youthful-looking boss, who would get carded at liquor stores well into his 40s, was youthful-seeming as well. His friends called him the "Toastmaster" of dinner parties.

But it was Arky and Dick's bond that shaped MAARK's supportive environment. David Hargrave, Dick's son, can't remember there ever being conflict between the duo. "They both loved solving problems, and Arky was good at listening to new ideas and piv-

oting. They respected each other." Dick and Arky ate lunch together every day, and the Vaughn and Hargrave clans would congregate for trips to Lake Placid on long weekends. Arky and Martha tapped Pam Hargrave, Dick's wife, to be godmother to Phoebe. Arky still brightens at the mention of Dick's name. "He was my business partner and very, very close friend," Arky says. "You've got to have a partner—because what else will you do?"

The kids loved visiting their fathers at work, where they were allowed to run around on the factory floor. Phoebe would answer calls with the receptionist. On special occasions, she and her sisters were allowed to pour polyurethane into coffee cups, gawking as the foam hardened as if by magic.

All around MAARK, other companies were innovating too. Princeton, Arky's home for nearly 60 years, has hosted acclaimed overachievers for centuries: Albert Einstein, John McPhee, Toni Morrison, Joyce Carol Oates. (There are others, like J. Robert Oppenheimer and Samuel Alito, but these names don't grace the fronts of university-owned buildings or public parks). Arky's inventive local contemporaries included Robert McClure, founder of the Prince Manufacturing Company, who spent his early professional years trying to make a ball-throwing machine in a factory along Route 1. These were the days of Howard Head and Donald Dell—a.k.a. the start of the tennis boom, a materials revolution that inspired sports companies to invest in manufacturers that would make seismic advancements in tennis technology. Fortunately for Arky, Princeton was the Silicon Valley of tennis, perfectly situated with access to nearby manufacturing plants and young, mathematically inclined Ivy League graduates.

In 1977, MAARK Corp. was sold to AMF, the large manufacturing company that had recently acquired Head. Arky was named president of Head Racquet Sports, and his duties shifted to overseeing the protection of racquet patents and traveling to observe factory production. Other things changed too: Aluminum frames eventually became graphite, an even lighter material. While their designs and constructions were still instructive to the manufacturing of modern racquets, slowly Arky and Dick's interests wandered from tennis into other industries displaying exciting new advancements. Perennial problem solvers, they were ready to tackle something new.

—1—

Arky gave up tennis years ago, but his daughter carries the torch. Phoebe has tennis in her veins by blood and marriage: Her husband is a descendent of Mary Ewing Outerbridge, the woman belatedly attributed with bringing tennis to the U.S.

At our next meeting, Phoebe opens the door with a slight limp. She's sore from playing a doubles tournament at Pretty Brook the day before. "Did she tell you she won?" Arky calls from the next room. Phoebe looks demure; Arky beams. He knows it's a drop in the bucket: Phoebe's name already graces the walls of the club from the numerous tourneys she's won.

Arky still visits Pretty Brook during the summer to watch members play "105," a cardio-intensive tennis game that involves rotating positions and teammates. Afterward, players pile their racquets and gather for dinner. Tonight they're watching the US Open quarterfinals, Kyrgios vs. Khachanov, on the overhead TV. After losing, Kyrgios pummels a Yonex racquet on the court, though the graphite frame is unwilling to smash in a way he finds satisfying. So Kyrgios whips out another Yonex and throws it, hard. Fortified by a strong graphite frame, with design origins tracing back to a potato barn in New Jersey, the racquet bounces right back. Intact.