his machine.

Says Arnold R. Smythe Jr., a New Orleans consulting engineer, "Quite frankly, I really don't know why this machine works, but I do know that it works." Adds electrical engineer Gerald A. Miller of Fountain Valley, Calif., "It's doing things I don't understand ... but I can't walk away from it until I understand it."

Meanwhile, Newman has attracted a group of investors who are helping him to fund his battle with the Patent Office. So far, he says, the ordeal, stretching over five years, has cost more than $100,000. Now, Newman faces another court hearing later this month. He would like the judge to grant him the "pioneering patent" he seeks, overruling the decision of the Patent Office.

For Newman, the dispute has turned into a crusade on behalf of all inventors against allegedly unjust actions by the Patent Office and the precedent that Judge Jackson's decision may set. "The law states what they should do," he says, "and they have not done it."

"I'm a fighter," he adds. "I'll fight like hell." —*I. Peterson*

Satellite revived after 11-month effort

It was not a matter of miracles, or technological breakthroughs, or inspired insights into exotic, previously unimagined difficulties. Nor did it even involve the all-too-common method of resolving high-tech problems by burying them in money. Rather, it was more a matter of informed guesswork followed by plain old tenacity in the face of contrary orders to drop the whole thing. But as a result, the National Oceanic and Atmospheric Administration's $50 million NOAA-8 weather satellite is about to go back on the job, nearly a year after it suddenly started to tumble uselessly in space.

Launched on March 28, 1983, NOAA-8 was placed in a pole-crossing orbit about 500 miles above the earth. Besides monitoring meteorological conditions such as temperatures at different depths in the atmosphere, it was the first U.S. entry in the international Search and Rescue Satellite-Assisted Tracking (SARSAT) system, equipped to detect emergency beacons from imperiled ships and aircraft. Two Soviet satellites were already at work in SARSAT, and had made headlines by guiding rescuers to the locations of several mishaps.

NOAA-8 was designed to last for two years, with the expectation, based on its predecessors' experience, of a considerably longer lifetime than that. But on June 12, 1984, barely 14 months after launch, it went out of control. Data transmitted to the ground suggested a failure in the satellite's primary oscillator, a central source of timing and frequency information without which its scientific measurements would be garbled, many of its subsystems would not function and the whole satellite would be unable to maintain its orientation in space.

There was a second oscillator aboard, but NOAA-8 was designed with no way for controllers on the ground to command a switchover to the backup system. The satellite was supposed to make the switch itself, by sensing when the amplitude of the primary oscillator got too weak. But the change did not take place, and the drop, if any, in amplitude was so gradual that controllers at NOAA and the NASA Goddard Spaceflight Center (which had been responsible for the satellite until it was aloft and NOAA took over) could not even be sure that the oscillator was truly at fault.

Because the tumbling satellite's solar panels were now pointed only occasionally at the sun, the controllers turned off most of its systems — including its transmitter — to save power. This compounded the frustration, since it meant that only by turning on the transmitter for a precious few minutes at a time could there be any signals to help Gay Hilton, the NASA Goddard meteorological satellite systems engineer in Greenbelt, Md., find out whether the problem had been correctly diagnosed. And if the oscillator was indeed to blame, its readings were untrustworthy anyway.

As if that were not trouble enough, another satellite in the same series, NOAA-6, happened to be sending data at a frequency very similar to NOAA-8's. This meant that, in order to prevent confusion when the satellites were at similar orbital positions, NOAA-6 had to be shut off whenever NOAA-8's transmitter was about to be turned on. The result of that restriction, says Tom Karras, manager of NOAA's Satellite Operations Control Center in Suitland, Md., was that for about four weeks out of every eight, any attempt to find out more about the fate of NOAA-8 required an approximately 10-minute loss of data from NOAA-6.

The months rolled by, as the engineers continued to have little more to chew on than hypotheses, while Hilton struggled to determine whether the oscillator's amplitude was really shrinking. "Just about everybody gave up on the satellite except Gay and I," Karras says. "We were told basically to stop wasting time and spending resources."

Finally, in March of this year, the signals from NOAA-8 began to indicate that the backup oscillator was beginning to assert control, as Hilton's analysis showed the primary one to be weakening enough to trigger the switchover. For a while the satellite seemed to be uncertain as to which oscillator was really going to end up with the job, but on April 20, the primary finally give up the ghost. Unless, of course, the true culprit was a questionable detection circuit responsible for monitoring whichever oscillator happened to be in charge at the time.

Either way, NOAA-8 seemed finally to have made up its mind. But now the problem became one of more than just analysis: to stop the satellite from tumbling.

At this point, Karras called in Ken Ward, Roger Hogan and Mike Cummings, three engineers from RCA Astro-Electronics Division in Princeton, N.J., the satellite's builder. "Those guys have pulled us out of worse situations than this," Karras recalls. And one of those situations had been ominously similar to the problem at hand.

Ordinarily, bringing such a tumble to a halt should have been a simple matter of firing the satellite's nitrogen-gas steering jets. But shortly after the launching two years before, a leak had allowed all the gas to escape. The RCA team's solution was to radio up some computer instructions that would guide a series of magnetic coils on the satellite to work "against" earth's magnetic field, creating a "magnetic drag" that halted the unwanted motions. The more recent difficulty seemed to be of the same ilk, and "this time," says Karras, "the software was right on the shelf." (A similar method had been used a year before to stop the tumbling of the "Solar Max" satellite so that space shuttle astronauts could pick it up and replace some of its components [SN: 4/14/84, p. 228].)

The computer program was sent up to NOAA-8 on May 1, and the tumbling soon began to slow down. By May 10, it had virtually ceased, and at 6:18 EDT that night, the command was sent to terminate the coils' special programming, returning the satellite to its normal method of operation. NOAA-8 was under control.

"That," says Karras, "was when we popped the champagne."

NOAA-8 apparently came through its ordeal in remarkably good shape, Karras notes, considering that the tumbling exposed its various surfaces to the sun's heat in an altogether unplanned fashion. Only one of its half-dozen scientific instruments (a high-resolution infrared sounder) and one of four earth-sensor assemblies seem to have suffered, and the NOAA/NASA team hopes to work around those problems with reprogramming. The satellite is expected back on duty by July 1.

Meanwhile, its successor, NOAA-9, has been in orbit since Dec. 12 — and with a couple of changes: Its detection circuit has been redesigned, and either of its oscillators can now be activated from the ground. NOAA-9 also carries the second U.S. SARSAT emergency monitor.

One final pleasure is the bill. Ward, Hogan and Cummings had to be flown down from New Jersey for 10 days to reapply their postlaunch remedy for "the tumbles," but other than that, says Karras, "it didn't cost any money. Just working people harder." —*J. Eberhart*