1 **UNITED STATES DISTRICT COURT**

2 **CENTRAL DISTRICT OF CALIFORNIA - SOUTHERN DIVISION**

3 **HONORABLE JAMES V. SELNA, U.S. DISTRICT JUDGE**

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MR TECHNOLOGIES, GMBH,	
Plaintiff and Counterclaim Defendant,	**Certified Transcript**
vs.	Case No. 8:22-cv-01599-JVS-DFM
Western Digital TECHNOLOGIES, INC.,	
Defendant and Counterclaim Plaintiff.	**DAY 3, VOLUME I**

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14 REPORTER'S TRANSCRIPT OF PROCEEDINGS

15 JURY TRIAL

16 THURSDAY, JULY 18, 2024

17 8:36 A.M.

18 SANTA ANA, CALIFORNIA

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1 passed around to look at -- the main thing you see when you
2 open up the disk drive, the main component -- or one of the
3 main components where the data is stored is the disk.
4 Remember, this is a -- it has a substrate where thin
09:42AM 5 magnetic layers are applied on top. These layers are real
6 thin, and the substrate is what gives it physical rigidity.
7 Maybe one thing that didn't come up yesterday is
8 there's magnetic materials on the topside and the bottom side
9 of the disk, and there's recording heads on the top and bottom.
09:42AM 10 So that means data is recorded on both sides of the disk.
11 So usually we've heard a lot about things going
12 towards the bottom, so that would be reference to the topside;
13 things could go towards the top, I guess, if you were on the
14 bottom. But always, when we refer to that, it will be towards
09:42AM 15 the substrate.
16 Q Where are hard disks used?
17 A Hard disks are used lots of places, so in your personal
18 computers. There could be portable hard drives or external
19 ones that are set up next to your personal computer or game
09:43AM 20 station. They're used in large data centers and in the cloud.
21 So the cloud is, you know, this amorphous thing
22 maybe, we say. But it's -- if you go for -- get a Netflix
23 movie or get on your Instagram or send emails, the cloud is
24 where all that data is stored and retrieved.
09:43AM 25 Q And can you just give us a brief refresher on how a disk

1 actually stores data?
2 A Sure. So as we've heard, there's these small grains that
3 are oriented perpendicular to the surface of the disk. So
4 these are individual grains that are separated from each other.
09:43AM 5 And they're magnetized in the up-and-down direction. And by
6 using that encoding of the magnetization being up or down, you
7 can turn that into bits.
8 Q And bits are what?
9 A So bits are a representation of digital data, ones and
09:44AM 10 zeros, and you can encode all these large sequences of ones and
11 zeros into a movie or, you know, PowerPoint slide like we're
12 looking at now or a Word file or -- you know, basically
13 anything that's digitized is done in this way.
14 Q So can you just briefly recap how a write head writes
09:44AM 15 data to a disk?
16 A Sure. So what we're seeing in this animation is a write
17 head above the media, and the grayish arrows are representing
18 the field that's coming out of the write head. When the field
19 is in the direction of the magnetization on the bits, it
09:44AM 20 doesn't affect it. But when it's in the opposite direction, it
21 can switch it, turning, say, a one to a zero or a zero to a
22 one. So this is the way that you can write data on the disk,
23 as shown in this animation.
24 Q And what is the property of the material that allows the
09:45AM 25 disk to actually hold that magnetization and data?

A So that's called ferromagnetism. These disks store the data in ferromagnetic materials. That means that the magnetization is basically aligned along the up-or-down direction of these disks. And all the little spins, as
09:45AM Dr. Suess spoke yesterday, are parallel to each other, giving these grains some magnetic features, magnetic moment.
Q How about the term "anisotropy"? Can you explain that briefly?
A You're learning a lot of funny terms. You're going to be
09:45AM experts in this by the end. Anisotropy is the resistance to change of the magnetization from an up-or-down direction. So it's how stuck it is, if you will, in that up-or-down direction.
Q And how about "coercive field"?
09:46AM A So coercive field is the field required to change that magnetization, and it's basically determined by the anisotropy.
Q What happens if the grains are thermally unstable?
A So if the temperature increases, at some point there can be enough thermal energy that it's kind of oscillating the
09:46AM magnetization, and they can actually flip. So if things get too high or way too long, the magnetization in these bits can start to oscillate and flip.
Q Okay. So you spent 11 or so years at IBM, broke some areal density records. You went to Read-Rite, broke some areal
09:46AM density records.

1 And then early days at Seagate up to about, you
2 know, the mid-2006 time frame, was the industry facing, at that
3 time, some kind of a major problem as far as areal density
4 goes?
09:47AM 5 A Yes. This was a huge problem. We called it the recording
6 trilemma or the superparamagnetic limit. This was a real limit
7 to the industry. It's not like the speed limit around here.
8 This was a real limit. So there was really no way to get
9 beyond this trilemma barrier.
09:47AM 10 Q And did Dr. Suess's invention solve this trilemma?
11 A It did. You know, this was something that was really
12 viewed as unsolvable. There was always a tie between the
13 stability that we talked about, the anisotropy, and the
14 writeability. So if anisotropy was too high, it became
09:47AM 15 impossible to write. And it was really no way that we knew of
16 to separate those two phenomena.
17 Q So can you just give a brief explanation of how it solved
18 that problem?
19 A Sure. So on the left-hand side of this graph, we see what
09:48AM 20 the conventional recording was at the time before the
21 invention. So basically there was a hard magnetic storage
22 layer that the write head would interact with and store the
23 bits either in an up-or-down direction. After --
24 Q Can you briefly explain how the invention improved over
09:48AM 25 that?

A Of course. So the invention was to have this multilayered nucleation host. So "multilayer" means more than two layers connected -- or coupled to a hard magnetic storage layer. And we'll explain how this solved the invention -- or solved the problem, this superparamagnetic limit.

Q When did you first hear of the invention?

A So as Dr. Suess mentioned, he gave a presentation at the 2006 Intermag Conference in San Diego, which is where I first heard of the invention.

Q And what was your reaction to it?

A I thought it was crazy and that this is never going to work.

Q Why did you think it wouldn't work?

A Well, first, there was this multilayered nucleation host, which was, you know, a bit softer than the hard storage layer. And usually when you have a softer layer on top, it will tend to spread the field, which is not what you want to do. Furthermore, you know, again, we knew of no way to separate the thermal stability from the coercivity or the -- how you write the disk.

Q Is coercivity also referred to as coercive field?

A Sorry. Coercive field, yes. It's the same terminology. But it separated the thermal stability from coercivity, which, as I said, there was no known way to do that.

1 Q Were there any other ways that the invention helped
2 increase areal density?
3 A Yes. The invention, again, unexpectedly tended to sharpen
4 the write field, which made, you know, interfering with
09:50AM 5 adjacent bits less likely.
6 Q Was that unexpected?
7 A Very unexpected.
8 Q Why is that?
9 A Just typically, you know, that's not what a softer
09:50AM 10 material would do. It would -- it should spread the field. So
11 this sharpening of the field, improving the write gradient was
12 completely unexpected.
13 Q Is there another way to think about how it sharpens the
14 write field?
09:50AM 15 A Yeah. I guess you could think of like a garden hose, if
16 you were watering and you had it on the spray feature. So
17 that's typically what would happen, but somehow this "move the
18 dial to the jet" feature so the field was more sharpened.
19 Q And so the invention helped confine the write field
09:51AM 20 within the bit that you want to write --
21 A That's correct.
22 Q -- without disturbing the other ones around it?
23 MR. LUMISH: Objection. Leading.
24 THE COURT: Overruled.
09:51AM 25 BY MR. CHANG:

1 Q Without disturbing the other ones around it?
2 A That's correct.
3 Q And does that relate at all to SNR?
4 A Yes, it does. So if -- so that's signal-to-noise ratio.
09:51AM 5 So you want high signal and low noise so it's easy to see.
6 Like moving the microphone so you could hear me, that was
7 improving the signal to noise.
8 And so in this case, it improved. Since you weren't
9 interfering with adjacent grains, there was less noise and
09:51AM 10 better signal.
11 Q How about the hard storage layer being on the bottom?
12 A Yeah, that was really crazy. So the industry spends a lot
13 of time trying to get the head very close to the disk, the
14 media surface. And putting the hard storage layer far away
09:52AM 15 where the write field would be decreasing, again, made no sense
16 at all. That was one of the main reasons I felt this wouldn't
17 work.
18 Q Okay. Can you just give a summary of some of the key
19 aspects of the invention?
09:52AM 20 A Sure. So the invention consists of a multilayered
21 nucleation host with an overall increase in anisotropy as you
22 head towards the hard storage layer, which is on the bottom of
23 this stack.
24 Q Okay. Stepping back one second. So you said that you
09:52AM 25 heard about Dr. Suess's invention?

A Uh-huh.

Q And your reaction was, "I don't think it would work." Did you do anything after that to investigate?

A Knowing that I can be wrong, we did test this, and we

09:53AM found to our surprise that it did work and saw that it could have a path forward, like a roadmap, to keep increasing areal density.

It was also -- you know, I said we made these. So that was good, too, because basically it required little to no

09:53AM change to the manufacturing systems that make these disks, which means it could be very cost-effective. And furthermore, it didn't require changes to other components within the system, still perpendicular magnetic recording. So, again, it could be implemented in an efficient way.

09:53AM Q And is that because the invention is at the media level as opposed to outside of that, having to do with other components?

A Yes. That's correct.

Q Were there other attempts to solve the trilemma outside

09:53AM of the media level?

A There were. So there were some other methods that would try to maybe increase or put in some other kinds of energies, like heat, to lower the coercive field to make it easier to write. But those weren't practical because of the major

09:54AM changes involved in a short period of time.

1 Q Okay. So my apologies. Getting back to this slide.
2 A Yes.
3 Q Can you explain, again, some of the key aspects of the
4 invention.
09:54AM 5 A Sure. So as I mentioned, a multilayered nucleation host
6 with an overall increase in anisotropy as you head towards the
7 hard storage layer on the bottom of this stack.
8 Q So I notice there are some dot-dot-dot on the left figure
9 and a dot-dot-dot on the right figure. What does that
09:54AM 10 represent?
11 A So what I'm trying to represent here is, you know,
12 "multilayer" means two or more. So the dot-dot-dots could mean
13 that there could be many of these magnetic layers in the
14 nucleation host.
09:55AM 15 Q And do the patent claims cover more than two layers?
16 A Yes, they do.
17 Q Do they -- do the patents teach why you might want to use
18 more than two layers?
19 A The patent does. It teaches that it would improve the
09:55AM 20 writeability and basically the aerial density capability of the
21 disk.
22 Q So as you add G layers or mag layers and ECLs, what does
23 that do?
24 A It basically keeps improving the properties of the disk.
09:55AM 25 So you can use, you know, high anisotropy materials that you

1 couldn't write without these multilayered nucleation hosts.
2 Q And who was it that set out this roadmap to such high
3 areal densities?
4 A That was based on Dr. Suess and his inventions described
09:55AM 5 in the patent.
6 Q Now, were there other attempts at the media level that
7 tried to solve the trilemma?
8 A There were. So I think you've seen these yesterday as
9 well. So there was a couple of concepts proposed that had a
09:56AM 10 single soft uniform magnetic layer on top, both in 2005, by
11 Dr. Suess and Dr. Victora.
12 Q Do these attempts solve the trilemma?
13 A There were limited improvements that you could get, you
14 know, factors of two or four, but they really didn't break that
09:56AM 15 fundamental limit, that superparamagnetic limit of decoupling
16 the stability from the write field.
17 Q So you said that there could be two layers in a
18 nucleation host in the invention; right?
19 A Yes.
09:57AM 20 Q Can you explain an example with a two-layer nucleation
21 host?
22 A Sure. So shown on this slide is a two-layer nucleation
23 host on top of a hard storage layer. So it would have a lower
24 anisotropy on the top layer, followed by a higher anisotropy,
09:57AM 25 and then a -- the highest anisotropy on the bottom layer. So

1 you would see an overall increase in anisotropy in the
2 nucleation host going towards the hard storage layer on the
3 bottom.
4 Q Have you prepared an animation showing how this works?
09:57AM 5 A Yes, I have. So the write field would turn on, it would
6 start to interact with the first layer. That layer, because
7 it's exchange coupled to the next layer, would interact with
8 the following layer. And then those would help to switch the
9 hard storage layer.
09:57AM 10 Q Is there another way to think of how these layers
11 interact with each other?
12 A Yes, there is. So I like this domino analogy, where the
13 dominos -- the size of the domino represents the anisotropy.
14 So I might not have enough force to push over a very big
09:58AM 15 domino, but I could push over a little domino. And the
16 momentum from that would knock over the next bigger domino,
17 which would knock over the biggest domino.
18 Q Can you explain an example that has more than two layers
19 in the nucleation host?
09:58AM 20 A Yes. This particular example has five magnetic layers in
21 the nucleation host. It has an overall increase in anisotropy
22 towards the hard storage layer on the bottom of the stack.
23 Q And does this work kind of the same way as the two-layer
24 nucleation host example?
09:58AM 25 A It does.

1 Q Can you explain that?
2 A Sure. So, again, with our domino analogy, we can push
3 over that little-bitty domino, which gains momentum on the next
4 domino, and the next, until it can flip the largest domino, or
09:59AM 5 the hard storage layer.
6 Q And is that how adding more G layers and ECLs helps
7 increase areal density?
8 A Yes. I think this is a good analogy to represent that
9 point of how more layers can help.
09:59AM 10 Q Now, we have the nucleation host on top and the hard
11 storage layer on the bottom. Are there any similarities
12 between the layers of the nucleation host and the hard storage
13 layer?
14 A Yes. They're made of very similar types of materials,
09:59AM 15 cobalt-chrome-platinum alloys. So they have, you know,
16 relatively high anisotropy for the layers in the nucleation
17 host. A little different than the bilayer prior art that we
18 looked at, which were softer and uniform. They also have, you
19 know, fairly high -- I think I mentioned, fairly high
10:00AM 20 anisotropies.
21 Q And how about switching and storing, are there any
22 similarities there?
23 A Well, yes. Since, you know, as we saw in the figure, they
24 all help to switch each other. They're all ferromagnetically
10:00AM 25 coupled together, which means that they all switch. You can't

1 have one not switch. That would not be stable.
2 It would be like knocking over all the dominos but
3 somehow one of them stands up in the other direction or flips
4 the other way. That just can't happen. And it can't happen
10:00AM 5 here because these ferromagnetic materials are coupled
6 together, so they will all rotate together.
7 Q So the ferromagnetic layers of the nucleation host, those
8 also store data?
9 A Yes, they do.
10:00AM 10 Q Are there any differences between the nucleation host and
11 the hard storage layer?
12 A The average -- or the effective coercive field of the
13 nucleation host is lower than that of the hard storage layer.
14 Q So just in simple terms, for example, in a domino
10:01AM 15 analogy, how can you think of that relationship between the
16 coercive field in the nucleation host and the coercive field of
17 the hard storage layer?
18 A So the size of the dominos, if you will, in the nucleation
19 host is smaller, or the, you know, effective size of that
10:01AM 20 domino is smaller than the size of the single domino in the
21 hard storage layer.
22 Q And so how does that relate to the coercive field, like
23 how easy it is to flip the nucleation host versus the hard
24 storage layer?
10:01AM 25 A Right. So the nucleation host would be easier to flip,

1 which is how you can get things moving and ultimately flip the
2 hard storage layer, which you wouldn't be able to flip without
3 the nucleation host.
4 Q So would it take more or less energy to flip the row of
10:02AM 5 nucleation host dominos compared to the hard storage layer?
6 A It would take less energy.
7 Q Does the hard storage layer have to be the hardest or
8 have the highest anisotropy?
9 A No. It doesn't have to have the highest anisotropy, as
10:02AM 10 we'll see in the claims. The requirements are that it has a
11 coercivity over 0.5 tesla and a -- I'm sorry, a coercive field
12 larger than that of the nucleation host.
13 Q What is it that allows these layers to interact this way?
14 A Yes. So this is something called "exchange coupling." I
10:02AM 15 believe Dr. Suess explained this yesterday, but it's a property
16 of magnetic materials that allows the magnet -- or requires the
17 magnetizations to be aligned. We've got our dominos flipping
18 again here.
19 So it's -- in these materials we have -- you can
10:03AM 20 have either a direct coupling, where the materials are in
21 contact, or exchange break layers or exchange coupling layers,
22 as we may call them.
23 Q Can you explain to the jury a little more about how
24 exchange coupling layers work.
10:03AM 25 A Yeah. So as I said, they can be in direct contact, which

1 would be the maximum coupling, or have some coupling layer in
2 between so you could optimize the coupling.
3 And an analogy with our little dominos here is the
4 spacing between the dominos. So if I had all my dominos
10:03AM 5 together, it might be very difficult still to push over the
6 stack, because it's supported by the big domino. And if I had
7 them too far apart, they wouldn't hit each other, so the
8 momentum wouldn't be transferred. But I can get to that
9 Goldilocks spot where I do get the switching of all the layers,
10:04AM 10 or all the dominos.
11 Q So we talked about this overall increase in anisotropy as
12 we go down the nucleation host. Does it have to increase at
13 every layer in the nucleation host?
14 A No. It only requires an overall increase in the
10:04AM 15 anisotropy. And as the patent states, it says the variations
16 of K(z) -- it's kind of a mathematical term. So K is the
17 anisotropy, and z we're saying is the direction perpendicular
18 to the surface. So this just represents how does the
19 anisotropy change in this z direction.
10:04AM 20 Q And so what does that say? Is that from the patent?
21 A This is from the patent. And it says, "The variation of
22 K(z) can take many different forms."
23 Q Does it give you examples of some of the shapes of the
24 change in anisotropy?
10:05AM 25 A It does. So the shape can be linear, just increasing in a

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