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Richards et al.

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(54) **INSTRUMENT FOR AUTOMATED TESTING OF DISPLAYS**

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CPC ***G01R 31/308*** (2013.01); ***G02F 1/1309*** (2013.01); *G01N 2021/9513* (2013.01)

(58) **Field of Classification Search**
CPC G02F 1/1309
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,826,057	B2	11/2010	Kim et al.	
7,831,086	B2 *	11/2010	Kondo	G06T 3/0062 345/419
7,941,237	B2	5/2011	Parker et al.	
8,492,739	B2	7/2013	Choi et al.	
8,561,288	B2	10/2013	Bawolek	
2003/0215129	A1 *	11/2003	Yang	G06T 7/0002 382/149
2005/0167620	A1 *	8/2005	Cho	G01N 21/95 250/559.45
2008/0284455	A1 *	11/2008	Obikane	G01R 31/2893 324/754.08
2010/0148083	A1 *	6/2010	Brown	G01J 3/02 250/372
2013/0068368	A1	3/2013	Kim et al.	
2014/0009181	A1 *	1/2014	Xue	G01R 31/312 324/754.03
2014/0295771	A1 *	10/2014	Finlow-Bates	H04W 24/06 455/67.14

* cited by examiner

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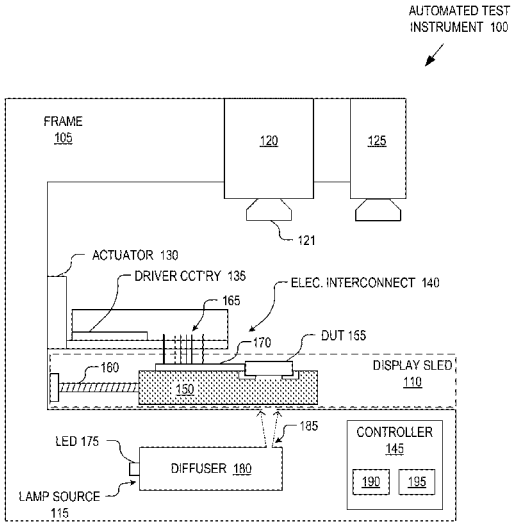
(57) **ABSTRACT**

A test apparatus includes a display sled having a mount for holding a display under test ("DUT"). The display sled is supported by a frame and moves between a test position and a load position. A lamp source is supported by the frame and positioned to illuminate the DUT when the display sled is in the test position. A measurement camera is supported by the frame and positioned to capture one or more test images output by the DUT when the DUT is illuminated by the lamp source. Driver circuitry generates the one or more test images to drive the DUT. An electrical interconnect establishes an electrical connection between the driver circuitry and the DUT when the display sled is in the test position. An actuator is coupled to physically manipulate the electrical interconnect to engage or disengage the electrical connection between the driver circuitry and the DUT.

20 Claims, 5 Drawing Sheets