

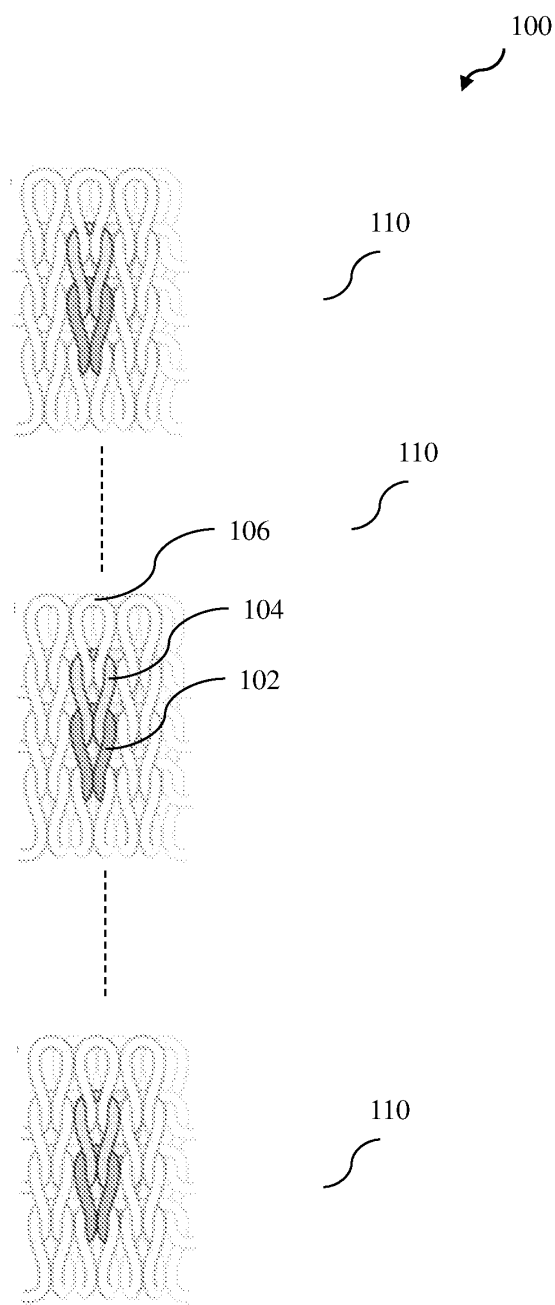
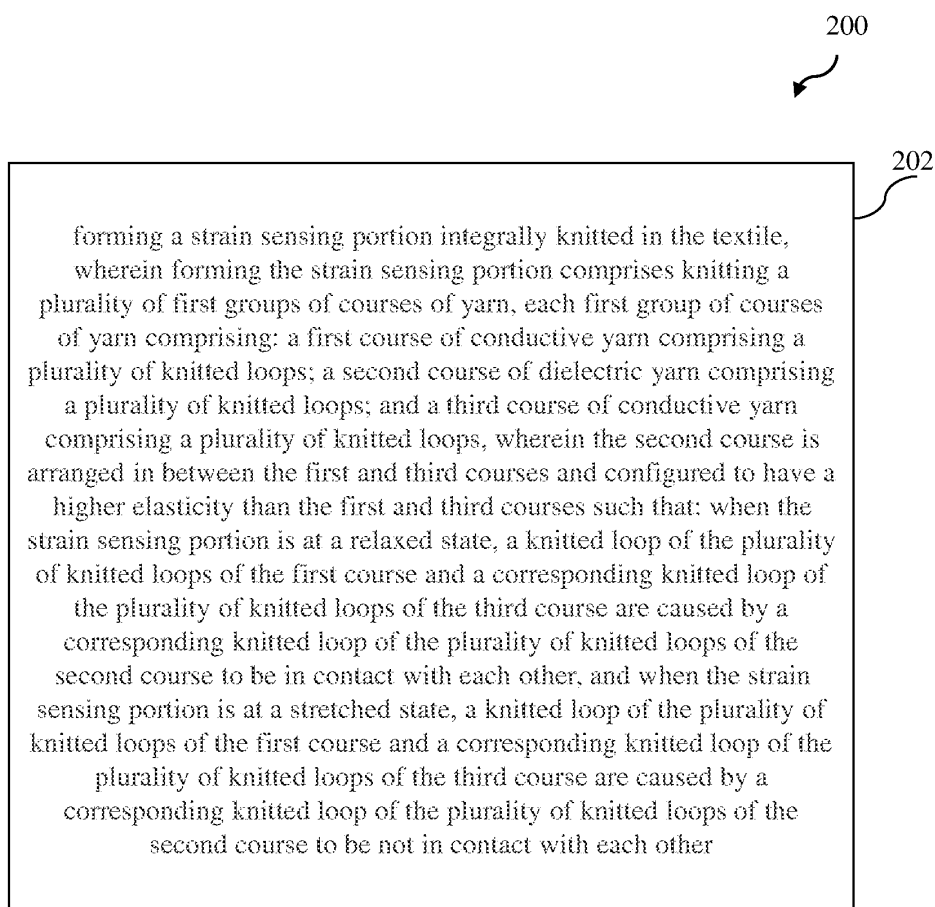
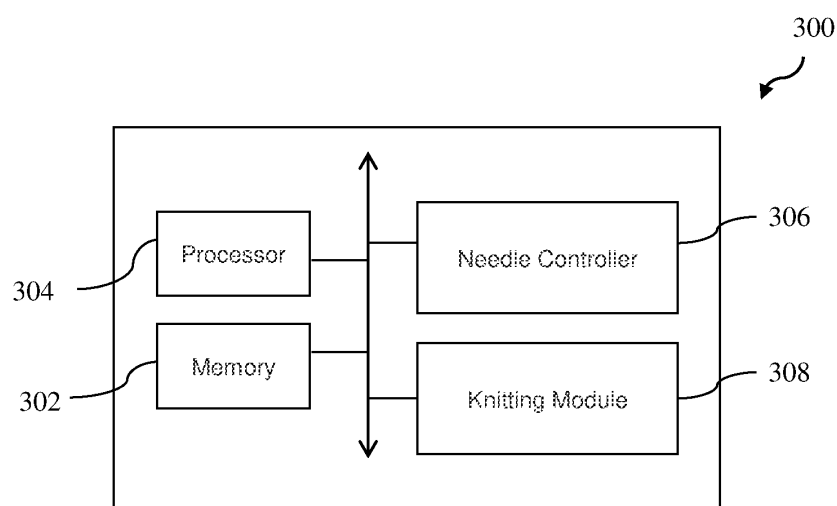


FIG. 1

**FIG. 2****FIG. 3**

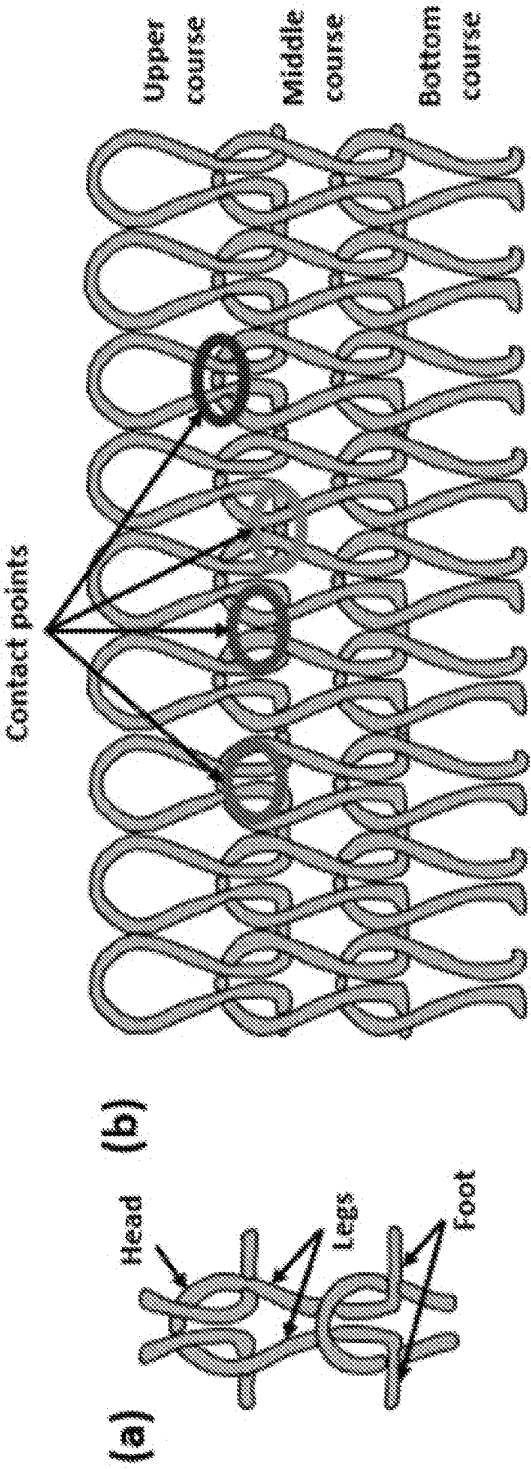


FIG. 4B

FIG. 4A

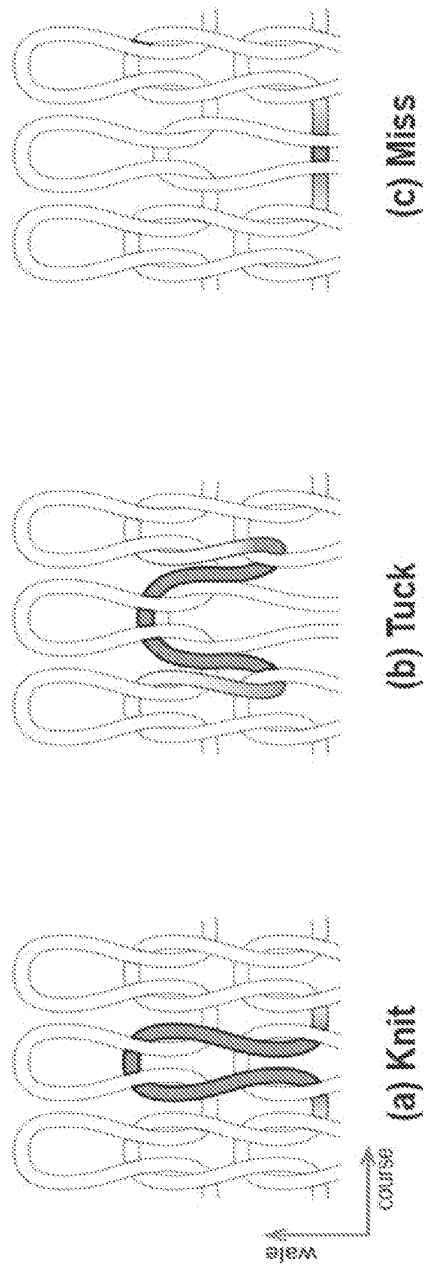


FIG. 5

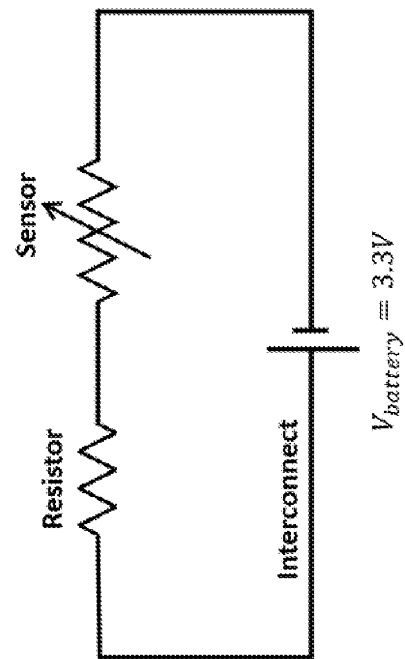


FIG. 6

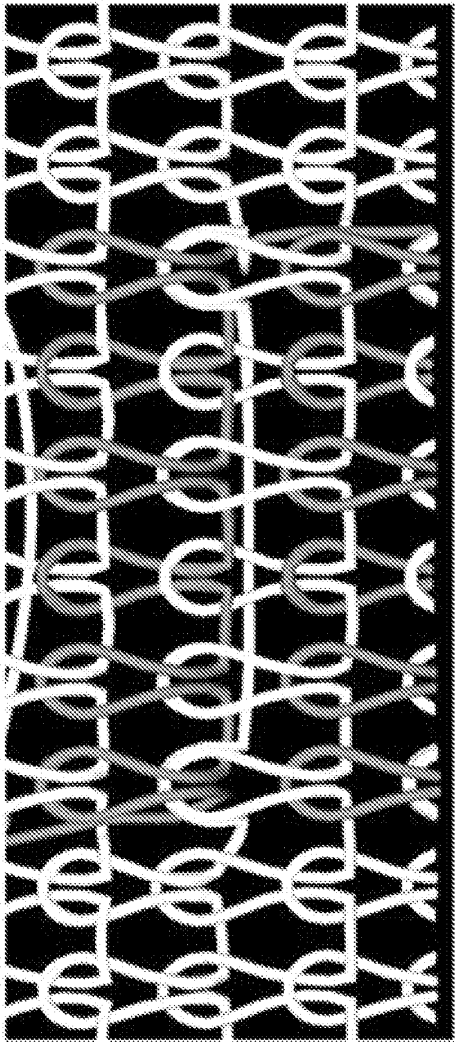


FIG. 7B



Rib 1x1



Front Knit



Back Knit

FIG. 7A

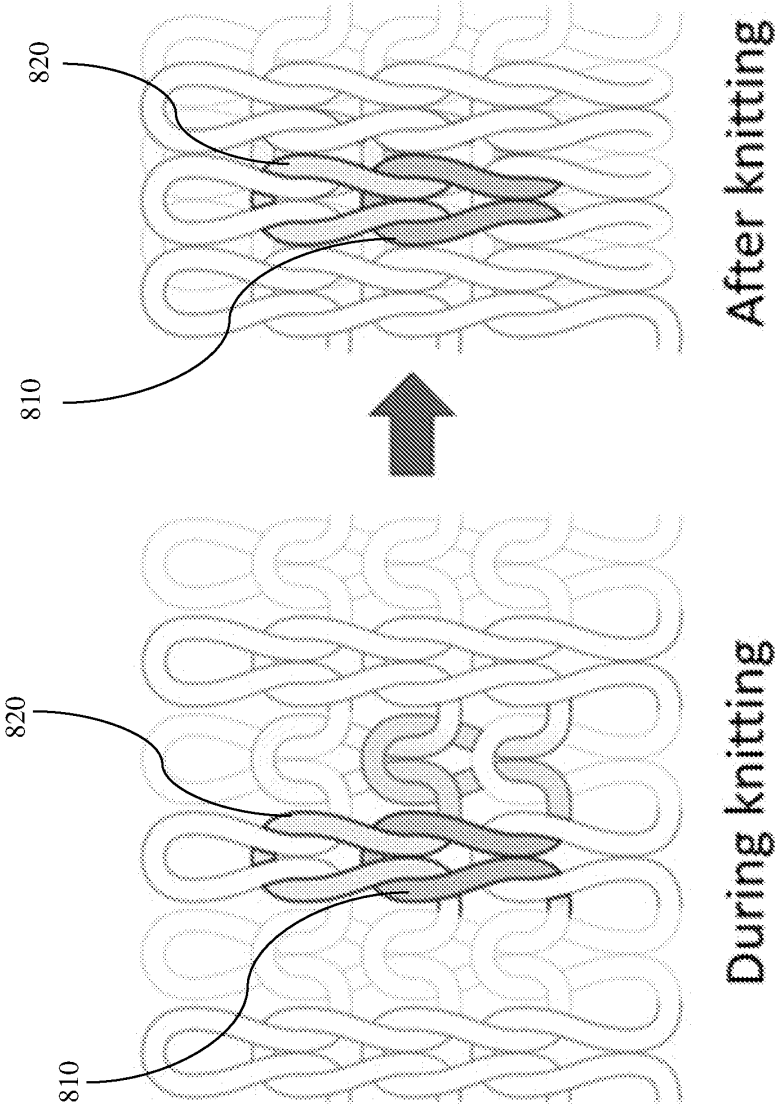


FIG. 8B

FIG. 8A

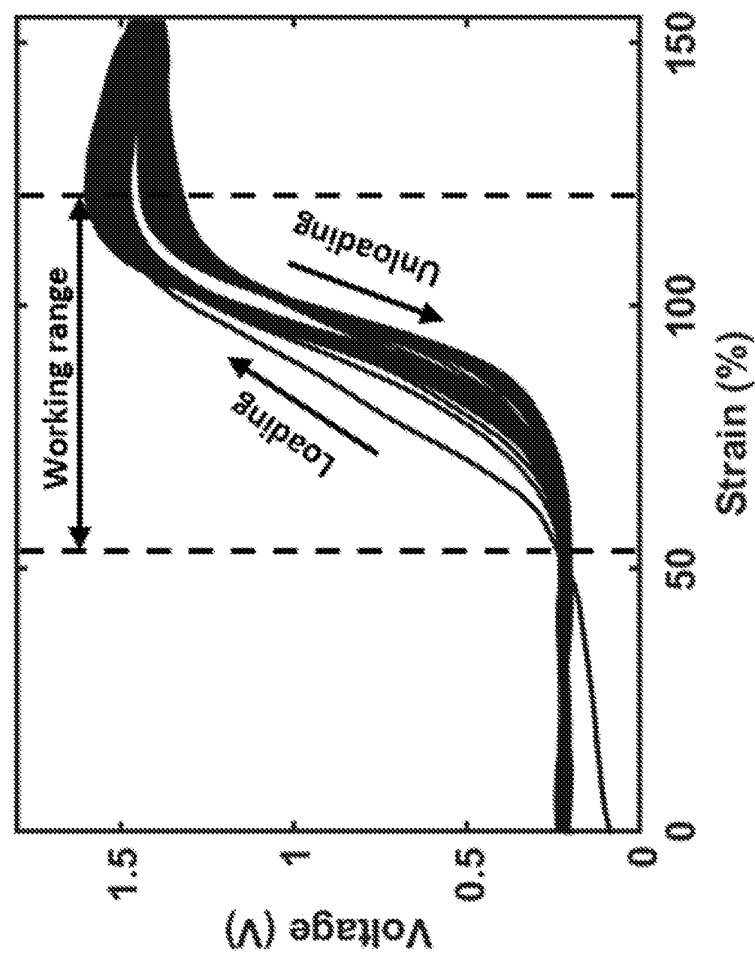


FIG. 9A

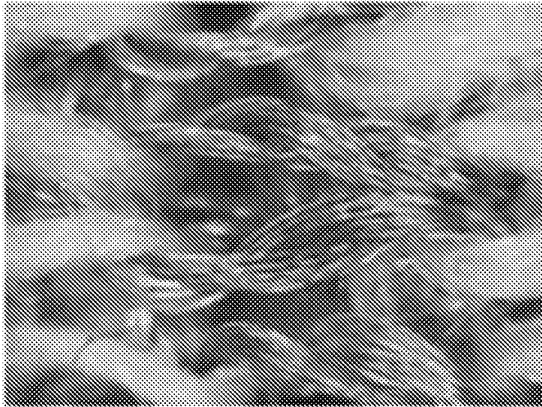


FIG. 9D

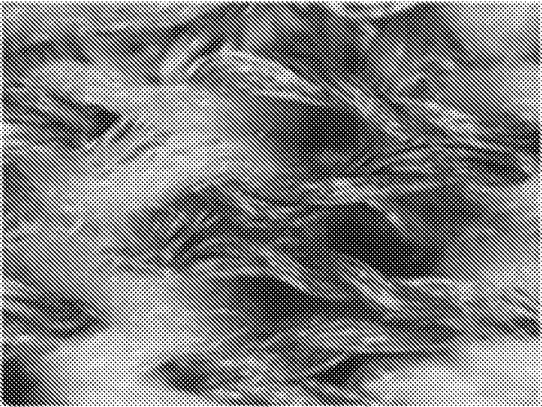


FIG. 9C

← stretching

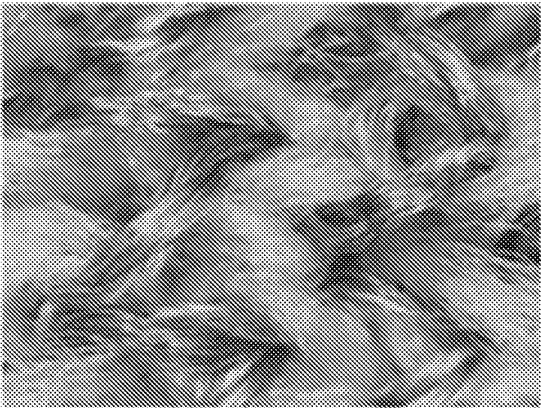


FIG. 9B

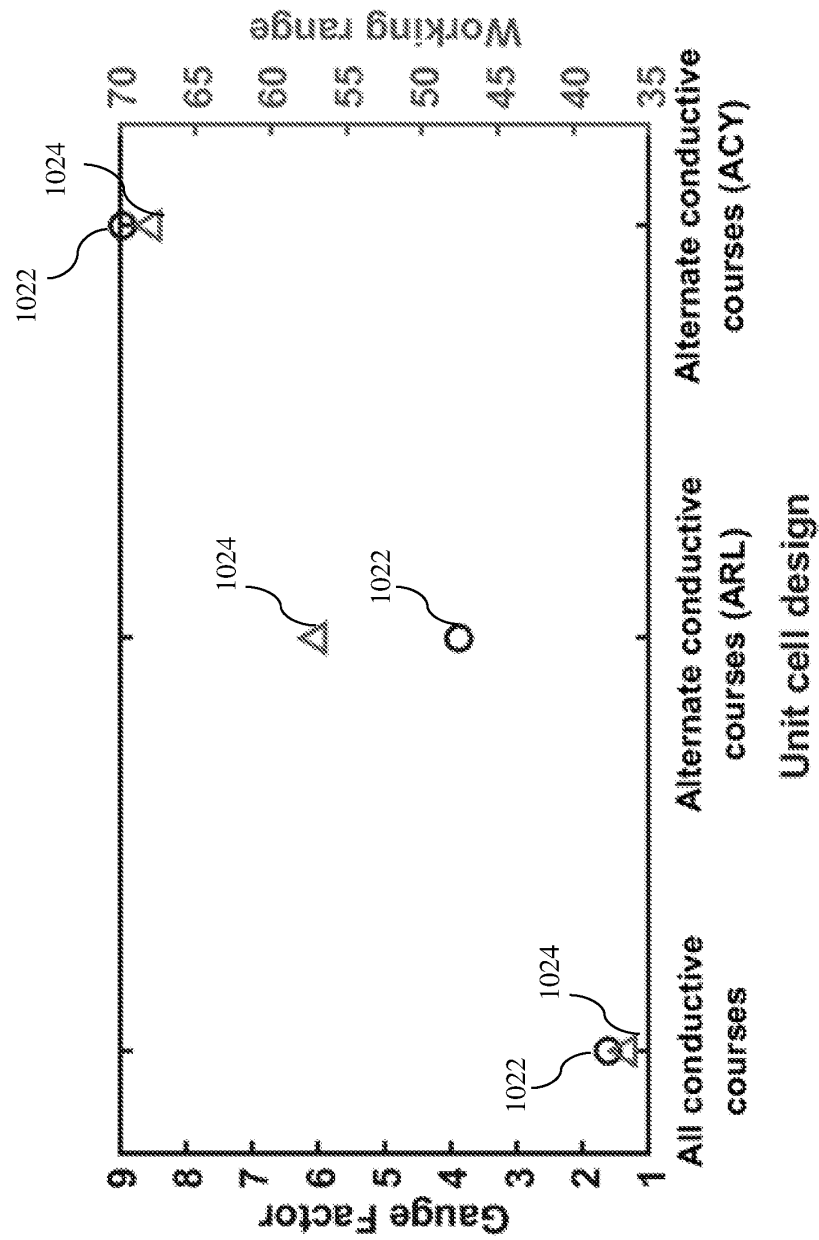


FIG. 10

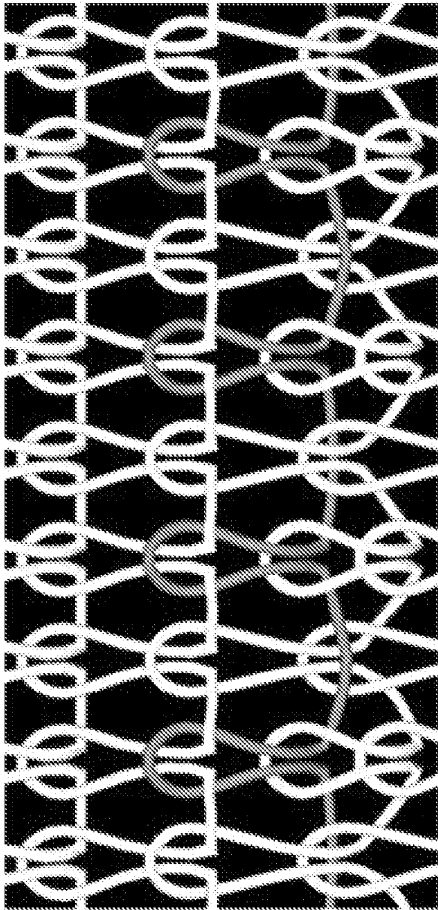
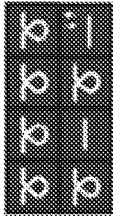


FIG. 11B



Knit-Miss-Knit-
Miss with Transfer

FIG. 11A

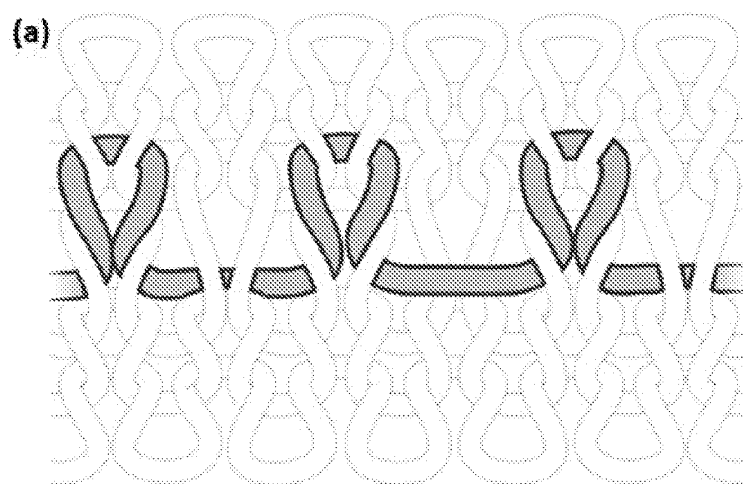


FIG. 12A

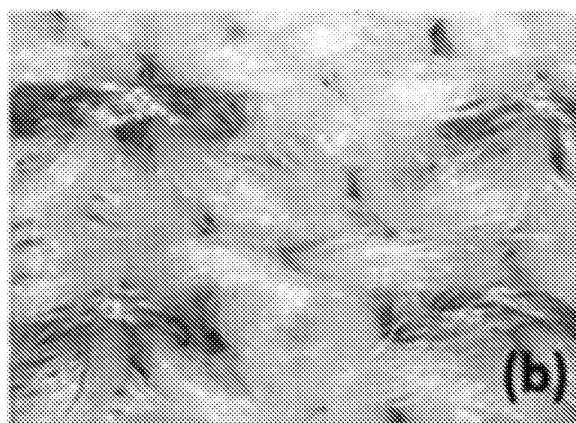


FIG. 12B

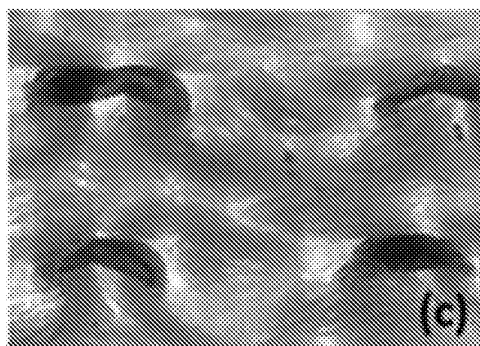


FIG. 12C

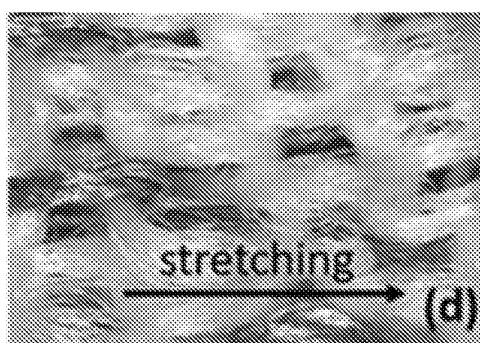


FIG. 12D

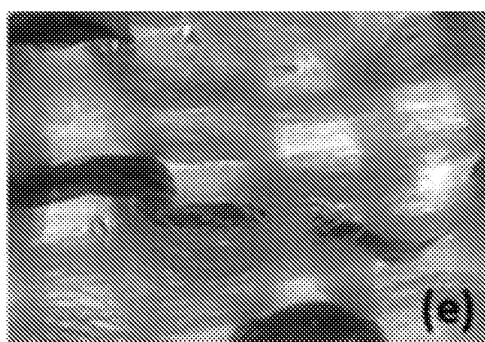


FIG. 12E

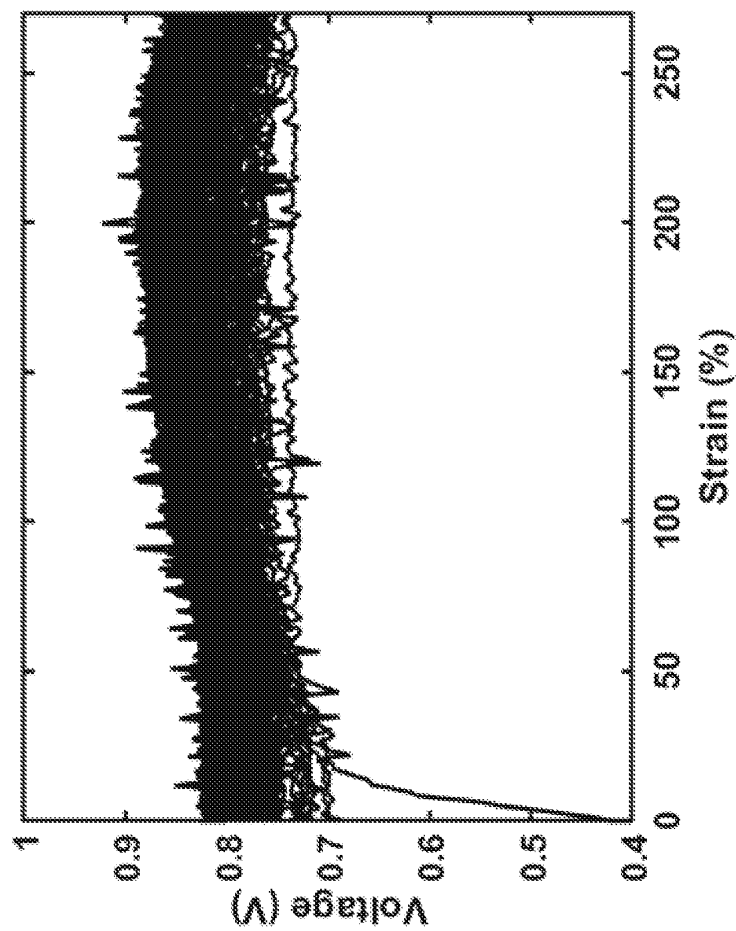


FIG. 13

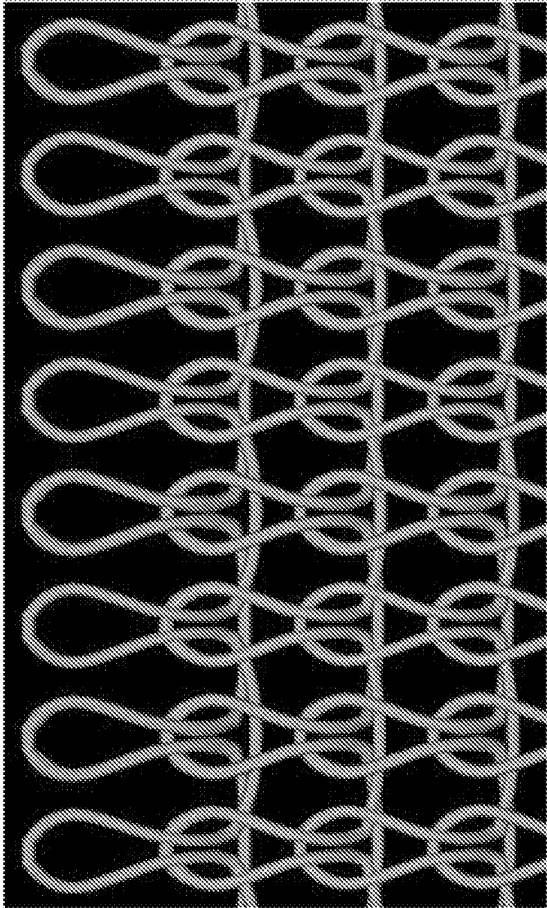


FIG. 14B

(a) (b)

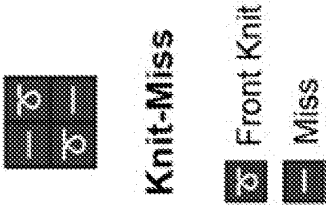


FIG. 14A

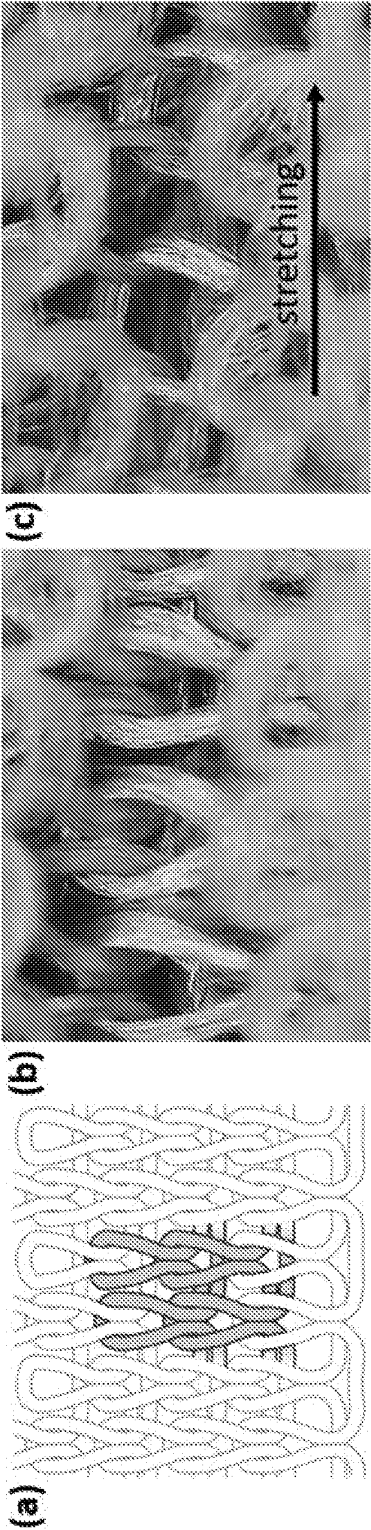


FIG. 15C

FIG. 15B

FIG. 15A

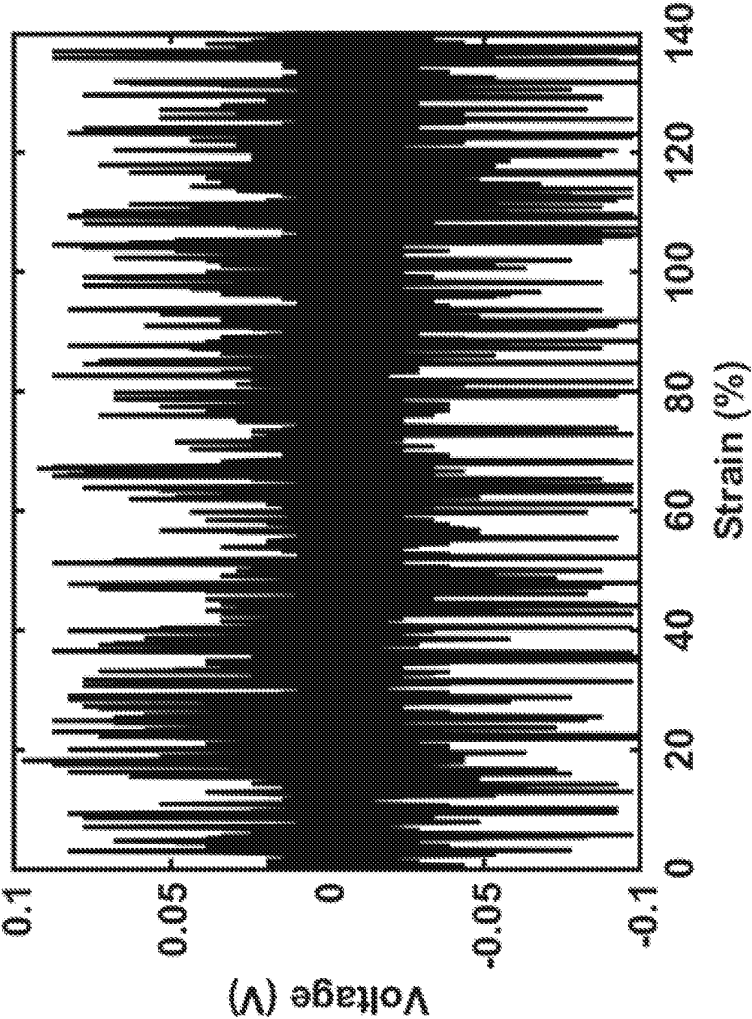
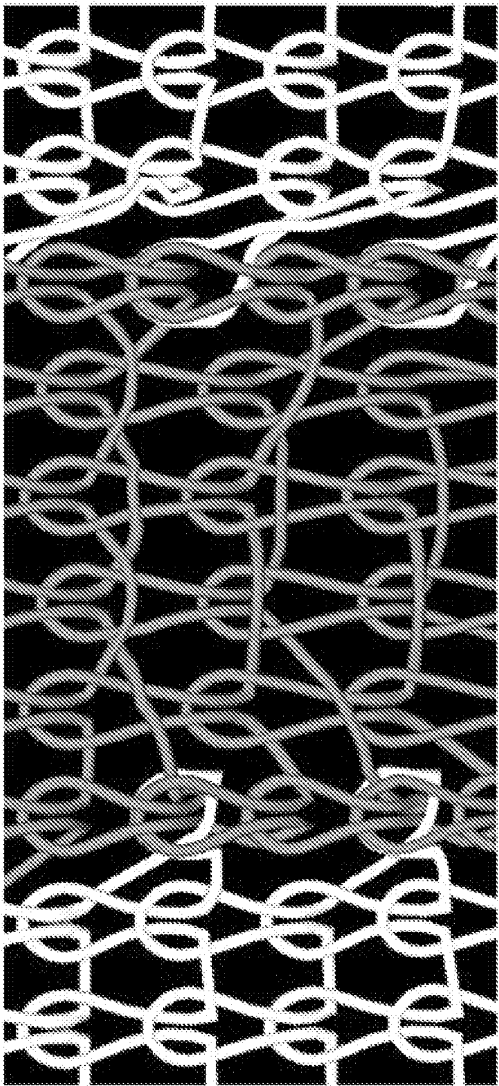
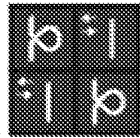


FIG. 16



(b)

(a)



Linen

Front Knit

Miss with Transfers

FIG. 17A

FIG. 17B

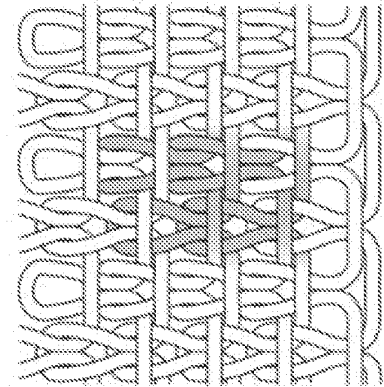


FIG. 18A



FIG. 18B

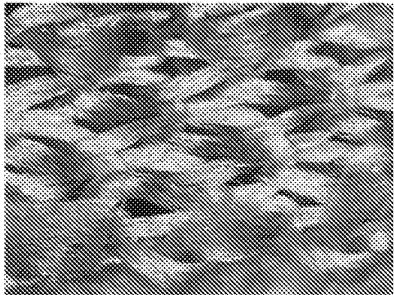


FIG. 18C

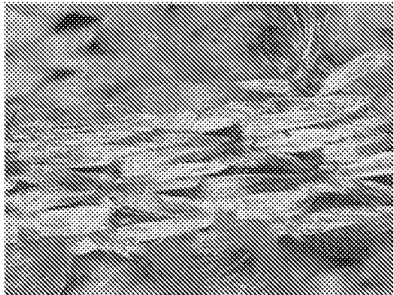


FIG. 18D

stretching

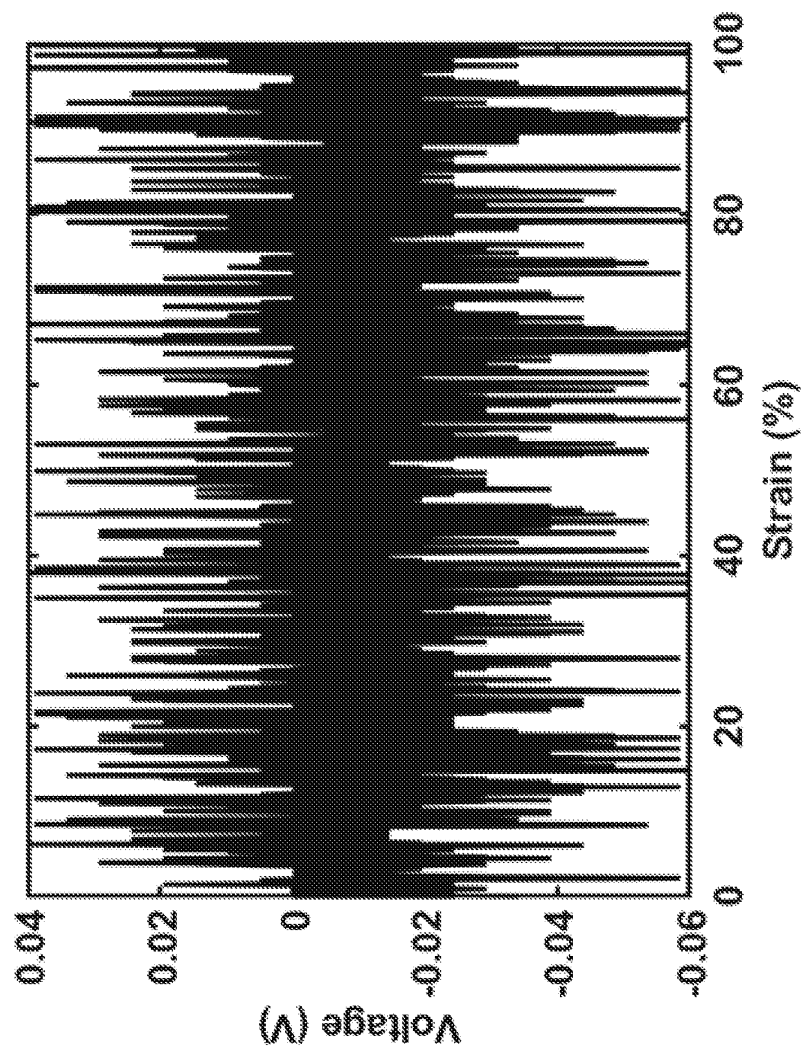


FIG. 19

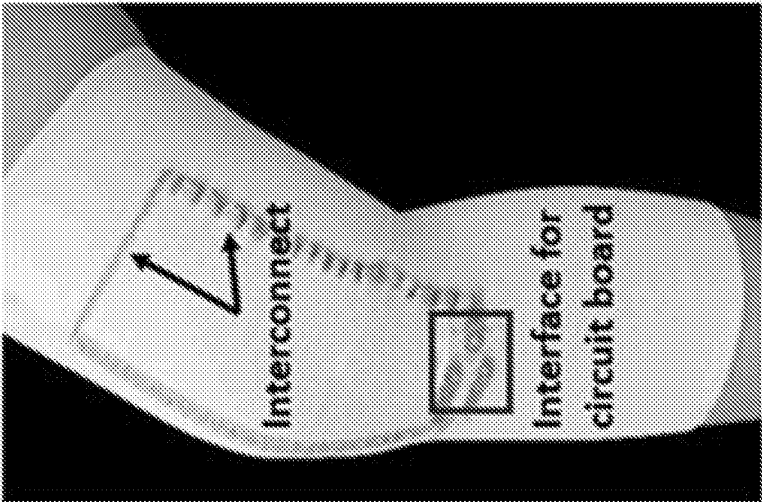


FIG. 20B

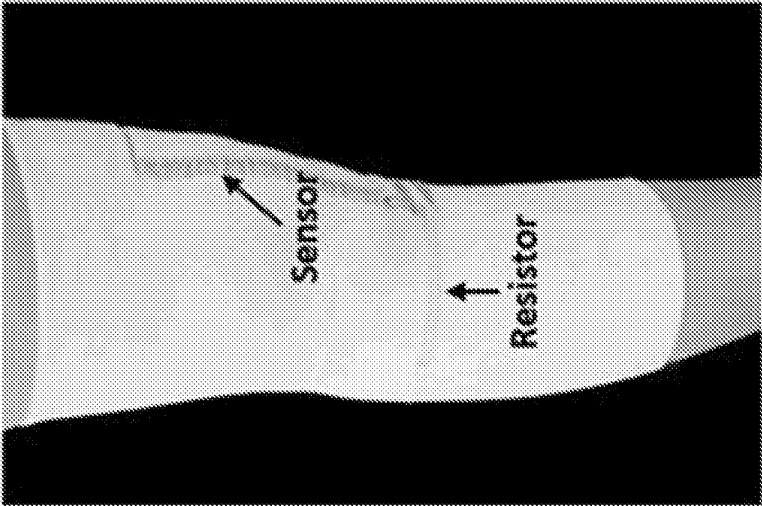


FIG. 20A

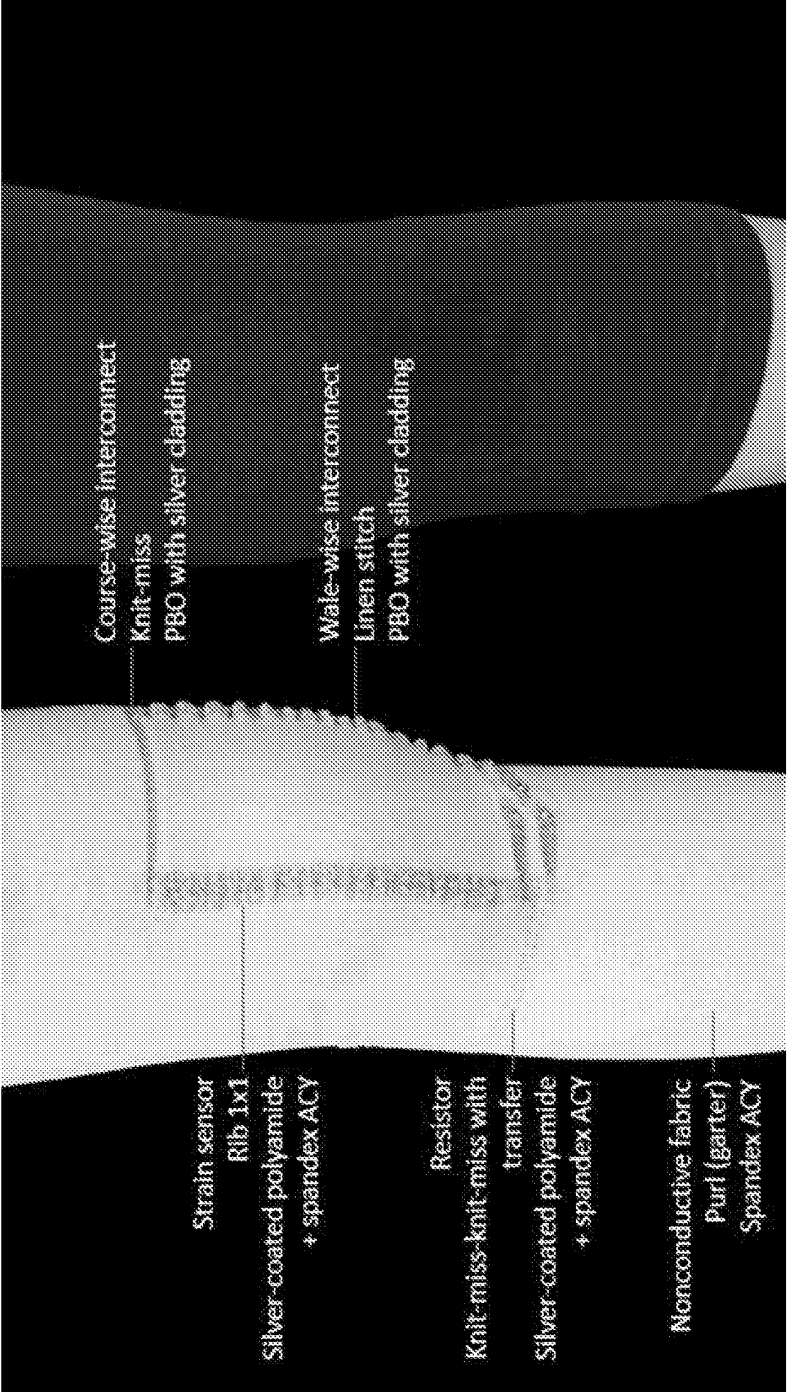
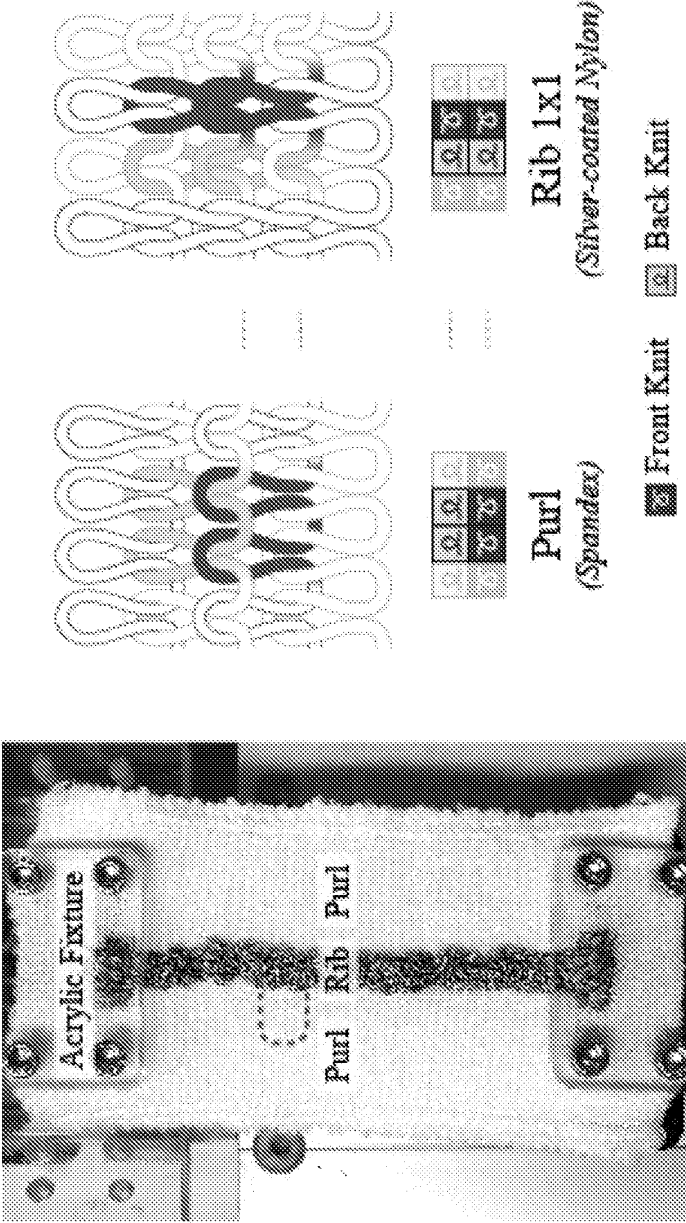


FIG. 21



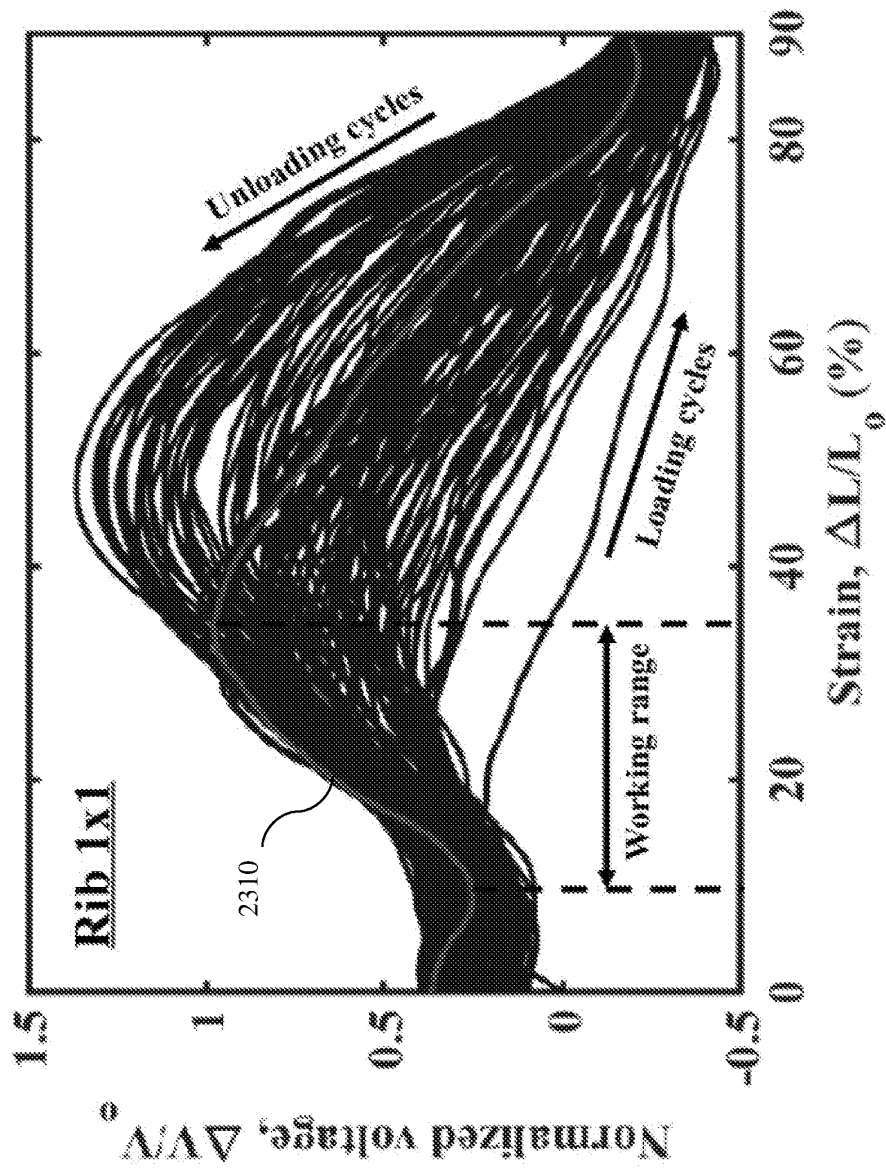


FIG. 23

Table I
ELECTRICAL PROPERTIES OF STITCH PATTERNS

Stitch Pattern ^a	Beds	Gauge Factor		Working Range (pp)		Resistance (Ω /100mm)	
		Mean	SD	Mean	SD	Mean	SD
Half Cardigan (HC)	Single	1.06	0.55	21.17	4.74	3.61	0.20
Knit-Miss 1x1 (KM)	Single	1.17	0.09	29.54	1.03	3.61	0.98
Linen Stitch (LN)	Single	0.25	0.08	23.59	1.07	2.66	0.04
Mesh (MESH)	Single	0.71	0.07	22.28	6.42	4.11	0.39
Pique Lacoste (PL)	Single	0.46	0.07	14.69	0.44	3.34	0.21
Purl (Carter) (PURL)	Single	0.78	0.17	19.35	3.17	4.38	0.44
Rib 1x1 (RIB)	Single	1.36	0.09	21.70	2.70	2.61	0.24
Seed (SEED)	Single	0.59	0.08	25.63	0.58	3.63	1.13
Single Jersey (SJ)	Single	0.64	0.21	31.67	2.35	3.06	0.22
Full Cardigan (FC) ^b	Double	0.47	0.33	13.93	2.01	2.36	0.27
Full Cardigan x2 (FCx2) ^c	Double	1.35	0.15	36.24	2.59	1.95	0.12
Interlock (ITL) ^b	Double	1.23	0.31	25.13	2.30	1.70	0.23
Interlock x2 (ITLx2) ^c	Double	1.79	0.29	40.44	2.20	1.25	0.07

^aFor stitch pattern descriptions, refer to [14] for Knit-Miss 1x1, [15] for Linen Stitch, [16] for Pique Lacoste, [17] for Seed, and [18] for all others.
^bConductive patch dimensions: 6 wales x 44 courses.
^cConductive patch dimensions: 6 wales x 88 courses.

FIG. 24

Table II
PAIRS WITH STATISTICALLY SIGNIFICANT DIFFERENCES ($P < 0.05$)

Gauge Factor		Working Range		Resistance	
FC - FCx2	PL - FCx2	FC - FCx2	ITL - ITLx2	PL - SEED	ITLx2 - HC
FC - ITLx2	PL - ITLx2	FC - ITL	KM - ITLx2	PL - SJ	ITLx2 - KM
FC - RIB	PL - RIB	FC - ITLx2	LN - FCx2	PURL - FCx2	ITLx2 - MESH
LN - FCx2	PURL - ITLx2	FC - KM	LN - ITLx2	PURL - ITLx2	ITLx2 - PL
LN - ITL	SEED - ITLx2	FC - SEED	MESH - FCx2	PURL - SJ	ITLx2 - PURL
LN - ITLx2	SJ - ITLx2	FC - SJ	MESH - ITLx2	RIB - FCx2	ITLx2 - SEED
LN - KM		HC - FCx2	PL - FCx2	RIB - ITLx2	ITLx2 - SJ
LN - RIB		HC - ITLx2	PL - ITLx2	SEED - FCx2	RIB - PURL
MESH - ITLx2		ITL - FCx2	PL - KM	SEED - ITLx2	ITL - SEED

One-way ANOVA, Tukey's HSD post hoc test, $p < 0.05$. Lower group mean is on the left.

FIG. 25

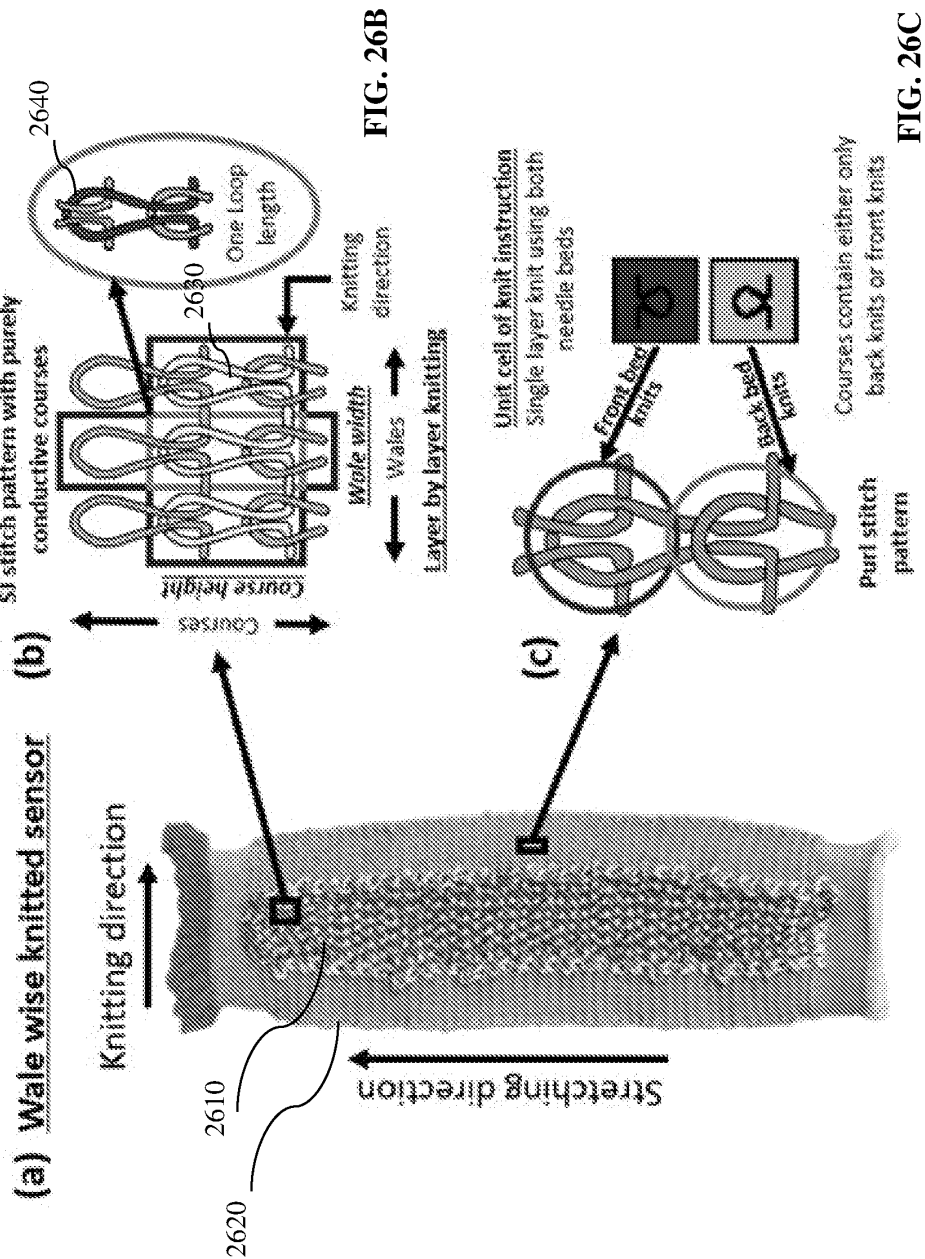


FIG. 26A

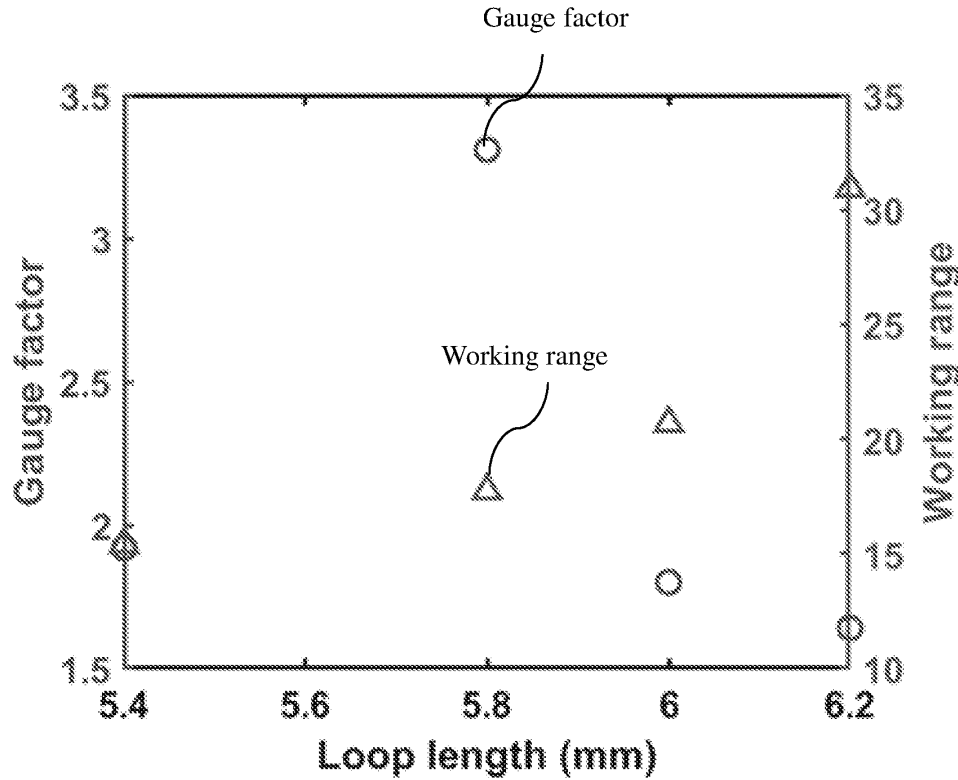


FIG. 27

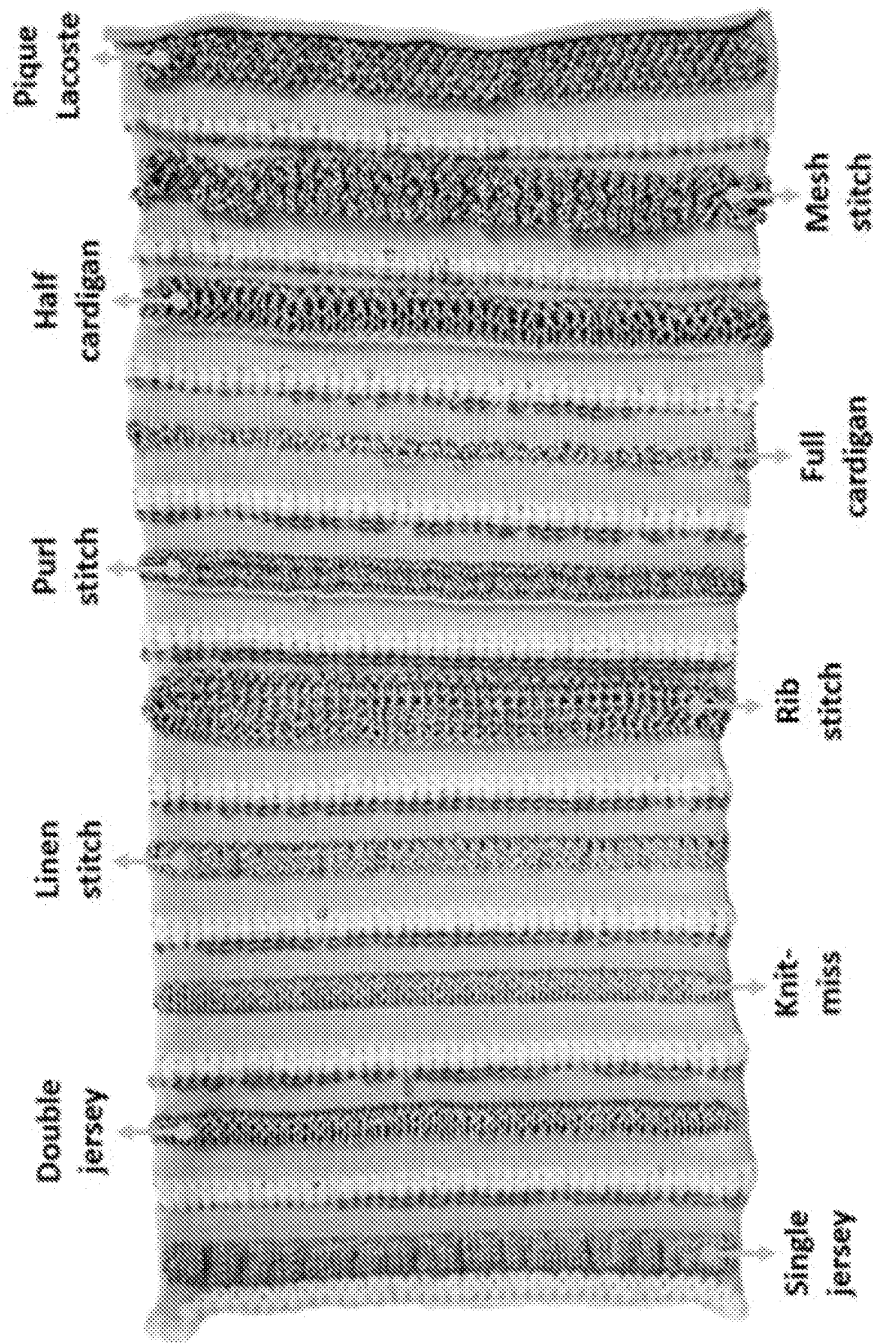


FIG. 28

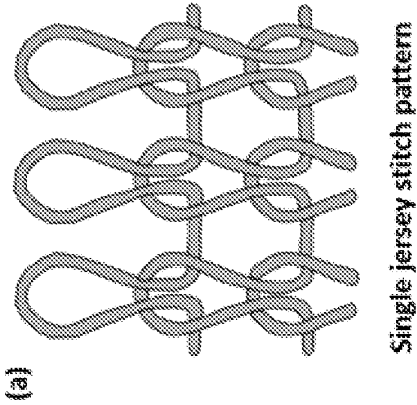


FIG. 29A

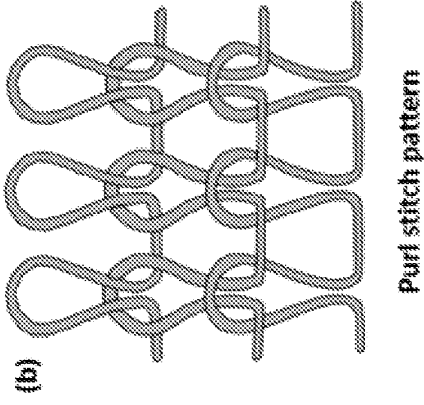


FIG. 29B

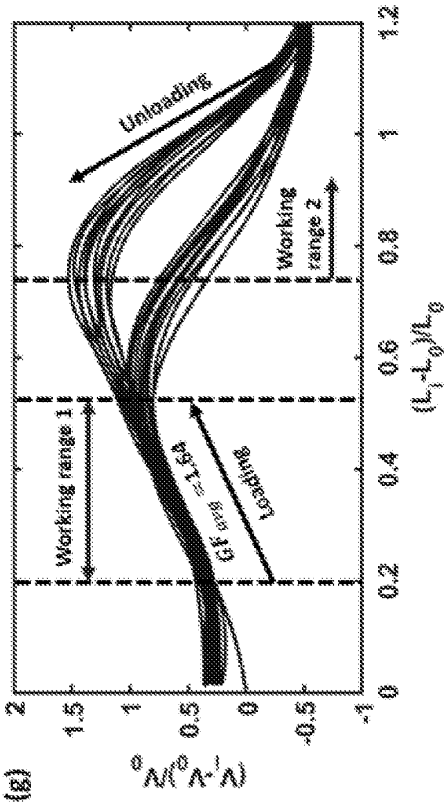


FIG. 29G

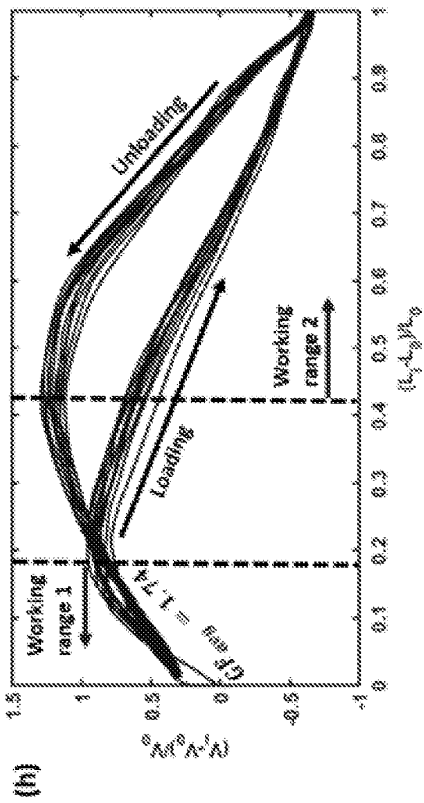


FIG. 29H

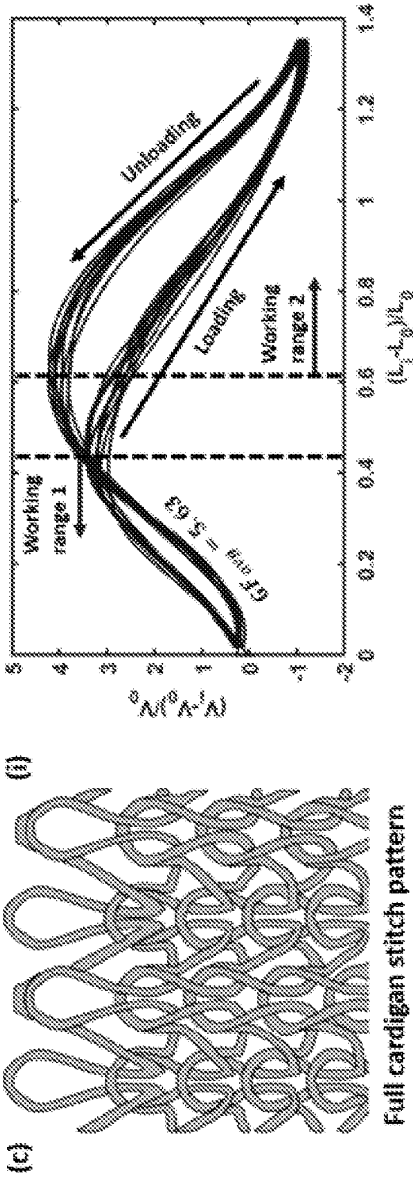


FIG. 29I

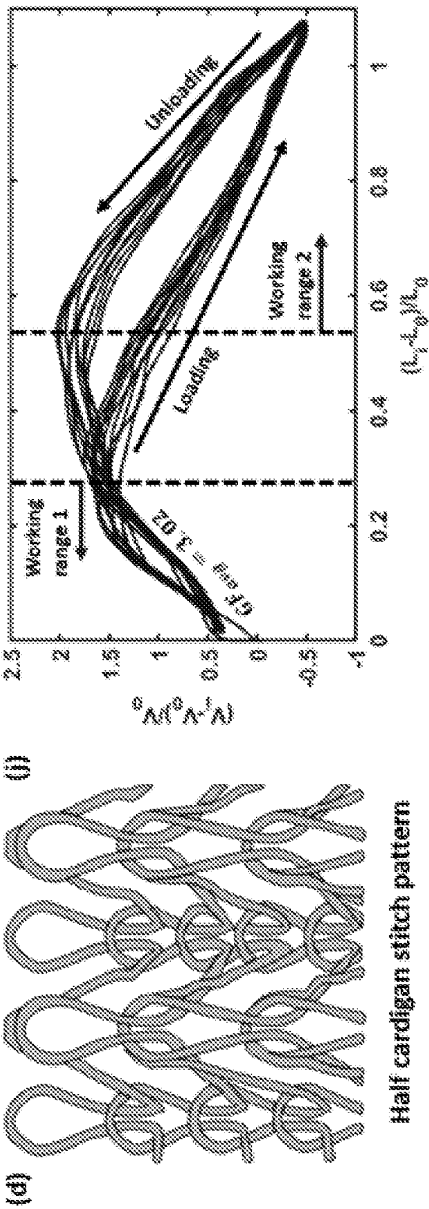


FIG. 29J

FIG. 29C

FIG. 29D

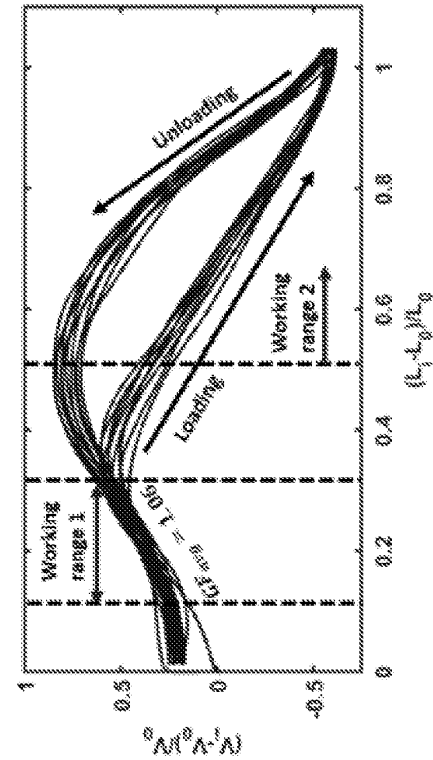


FIG. 29K

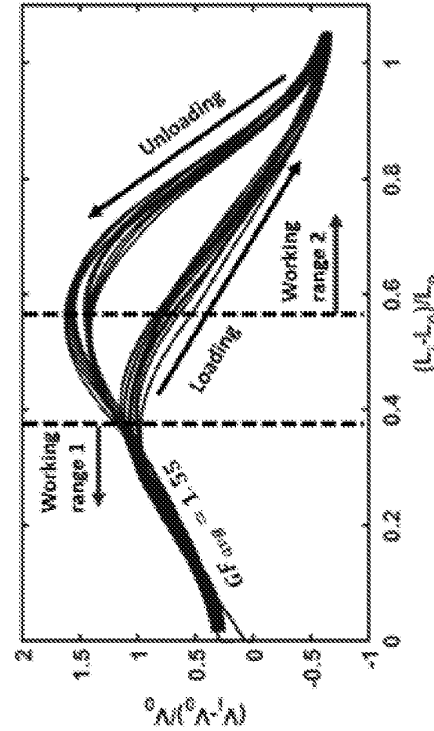


FIG. 29L

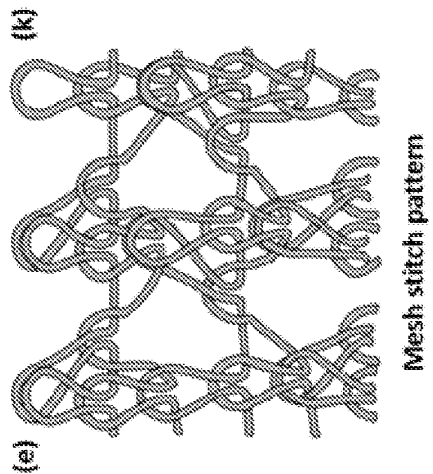


FIG. 29E

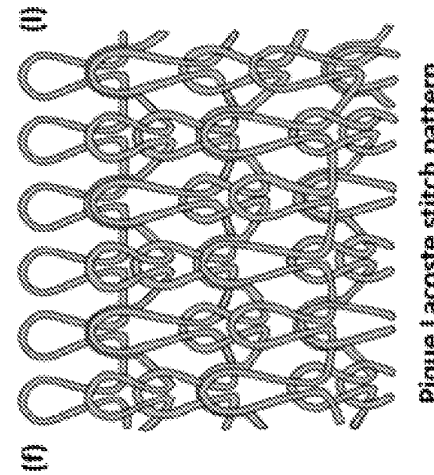


FIG. 29F

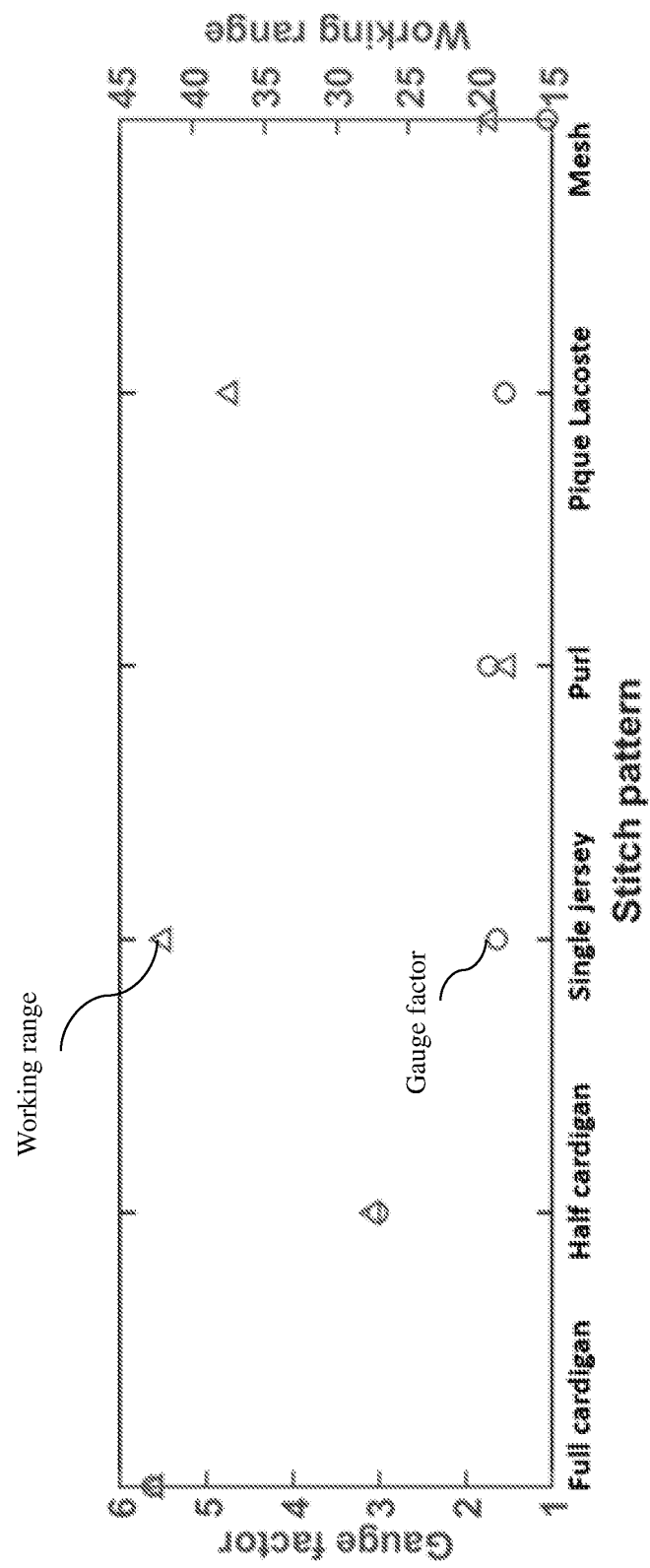


FIG. 30

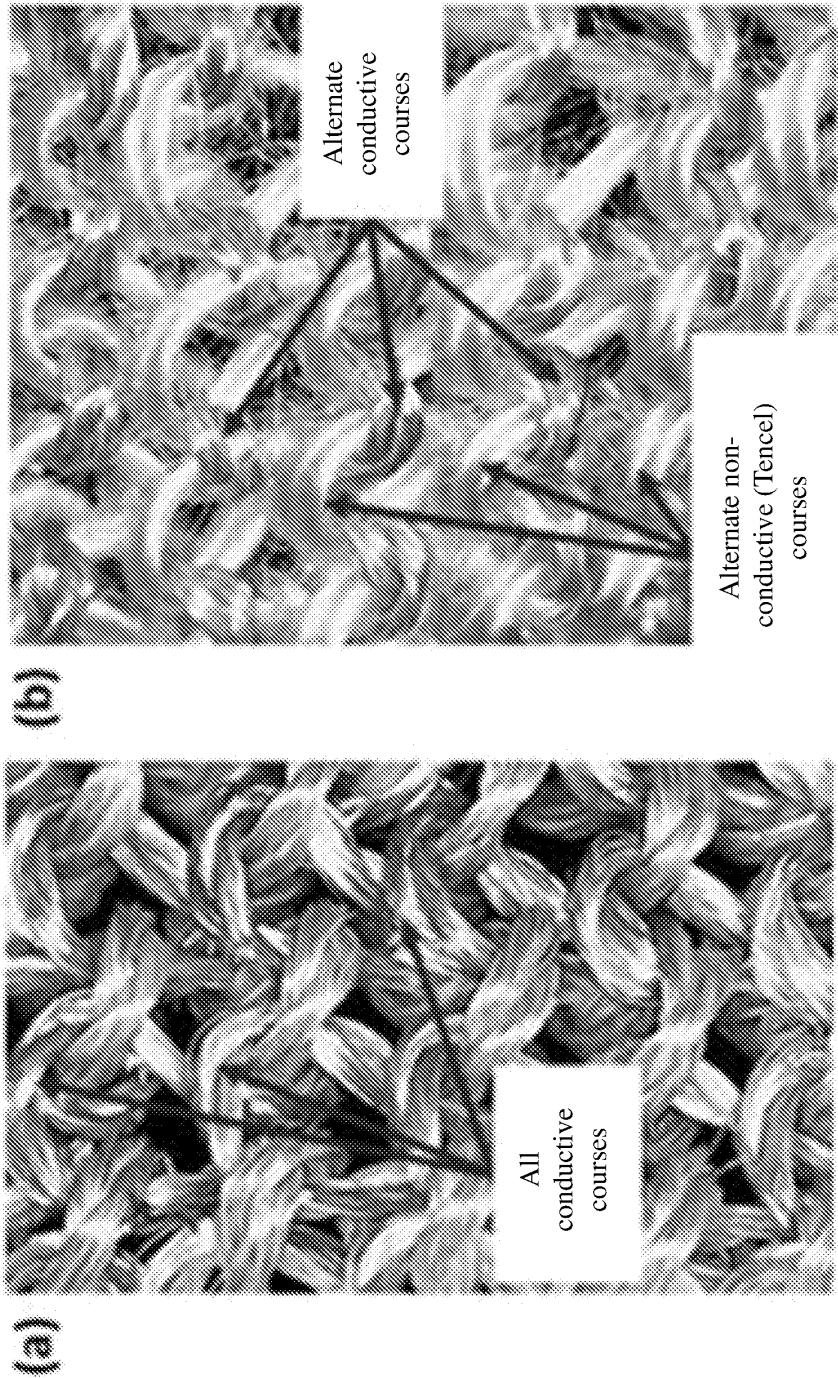


FIG. 31A

FIG. 31B

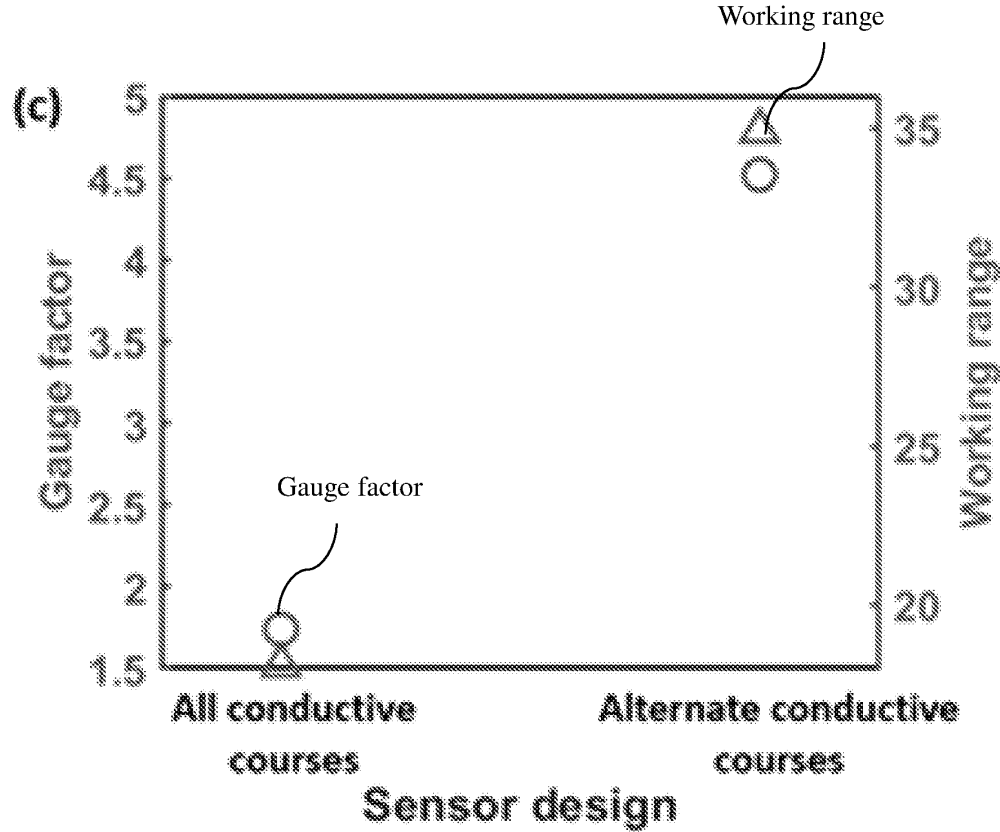


FIG. 31C

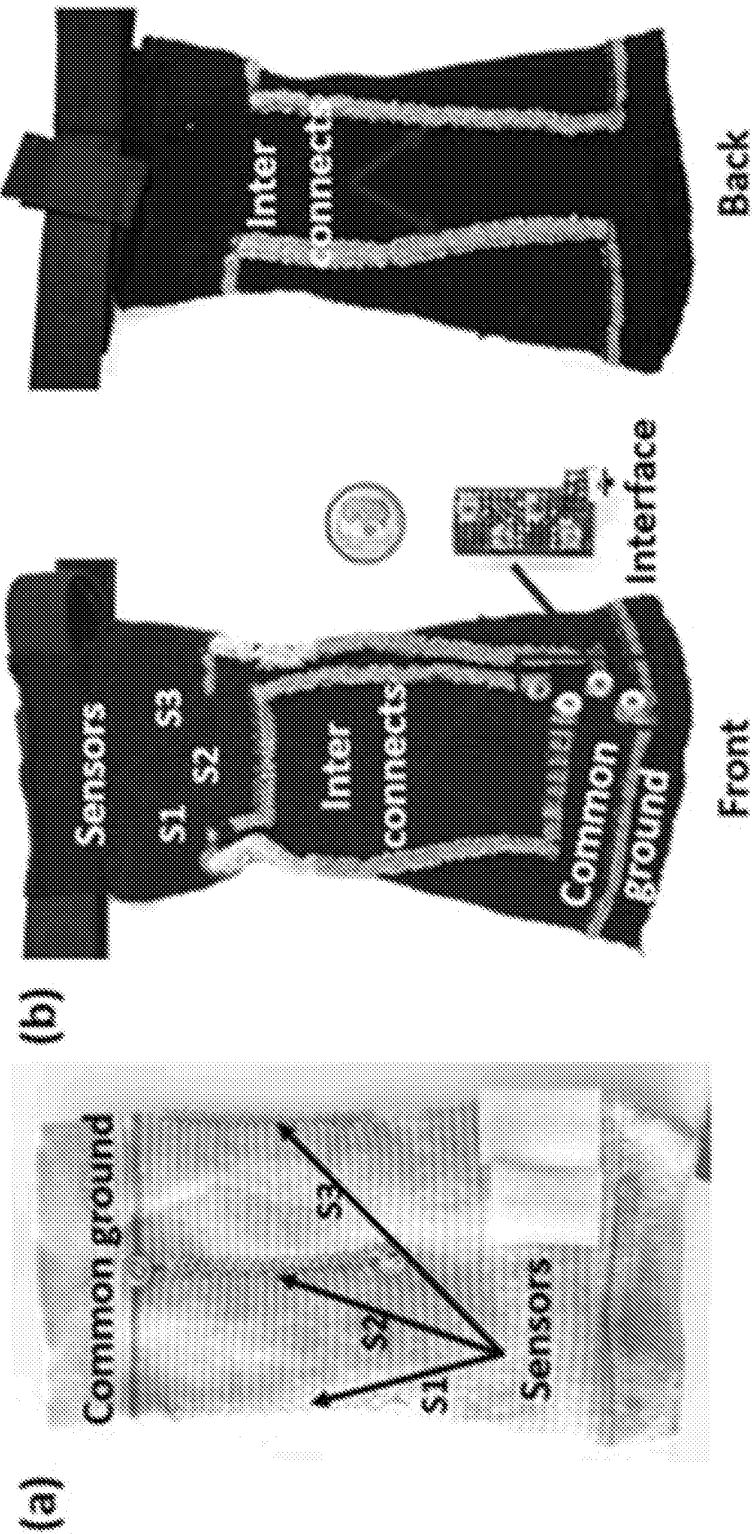


FIG. 32A

FIG. 32B

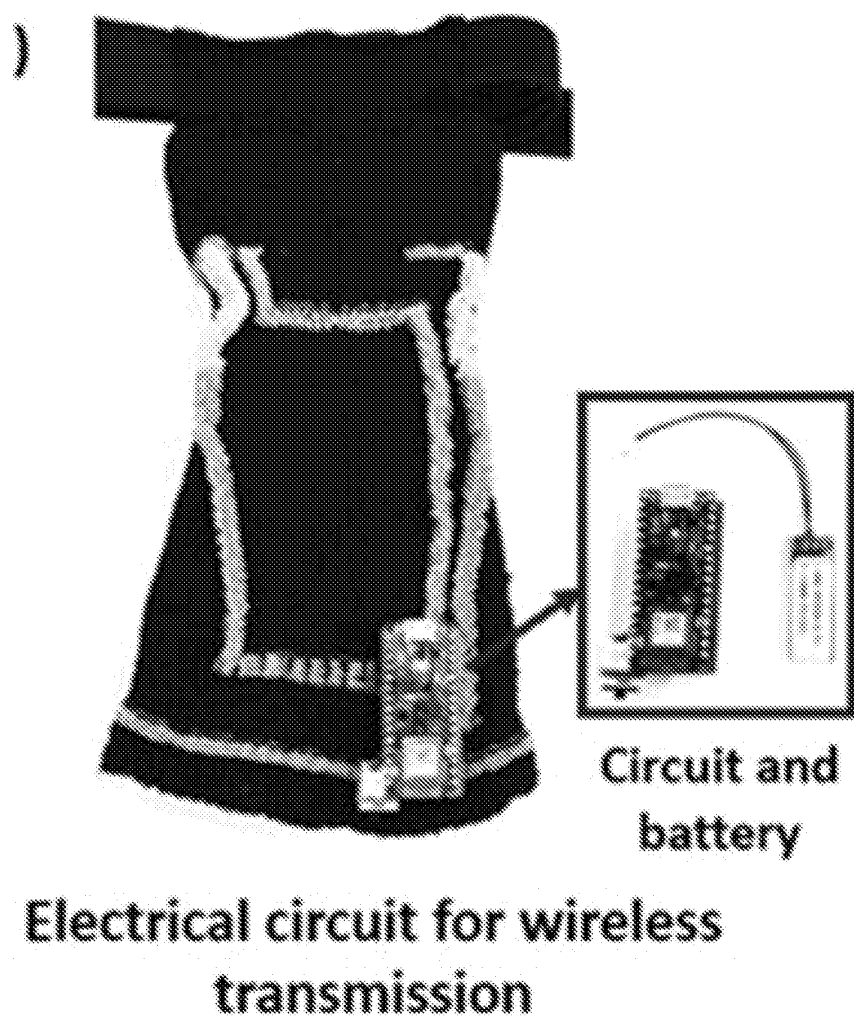


FIG. 32C

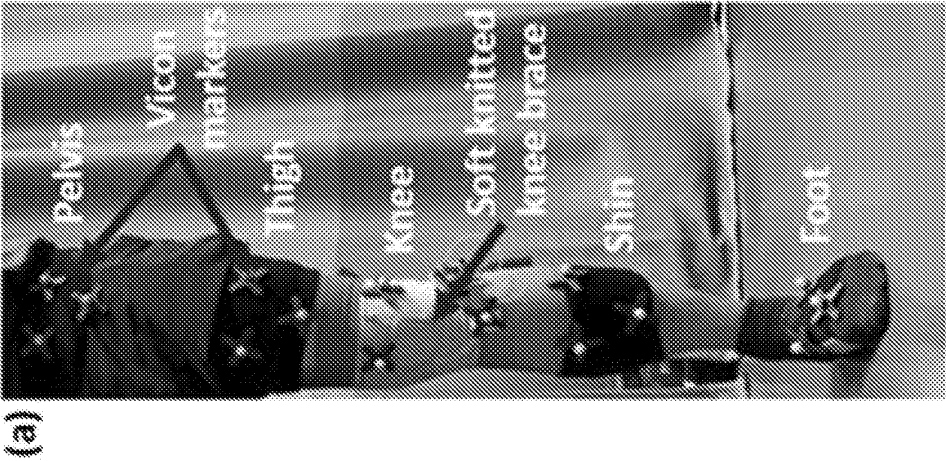


FIG. 33A

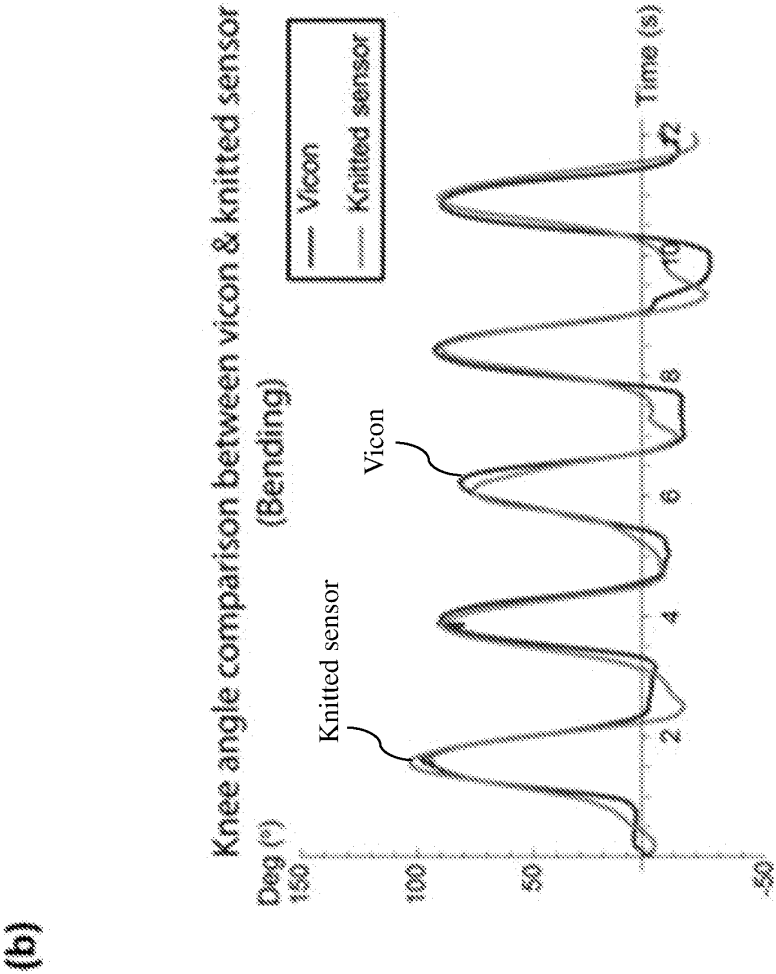


FIG. 33B

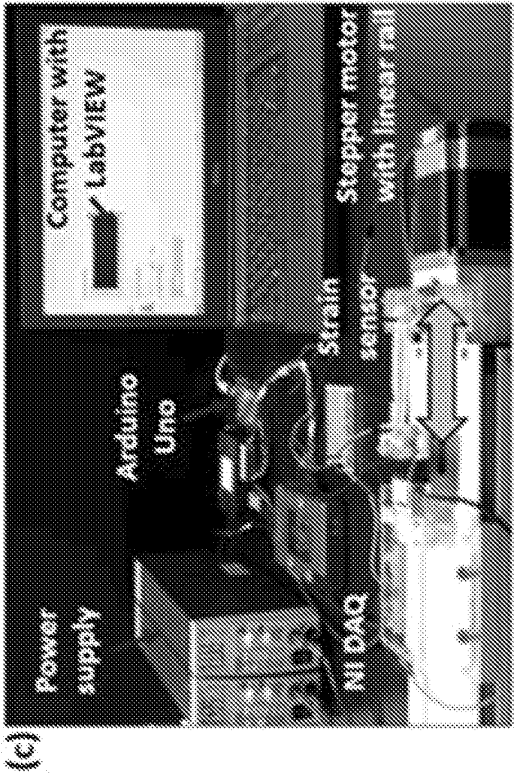


FIG. 34C

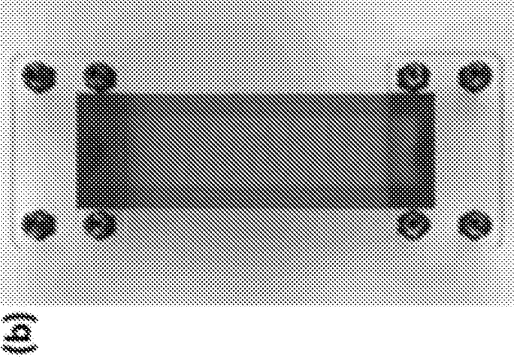


FIG. 34B

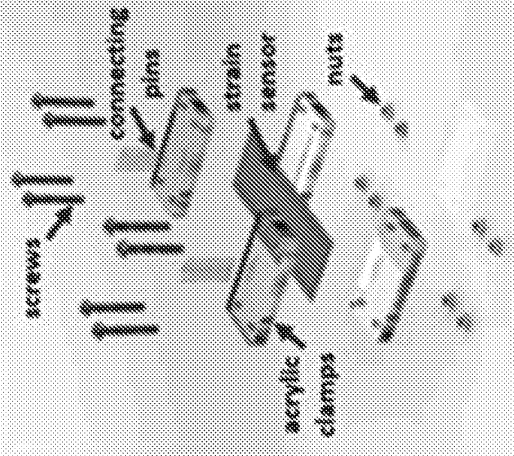


FIG. 34A

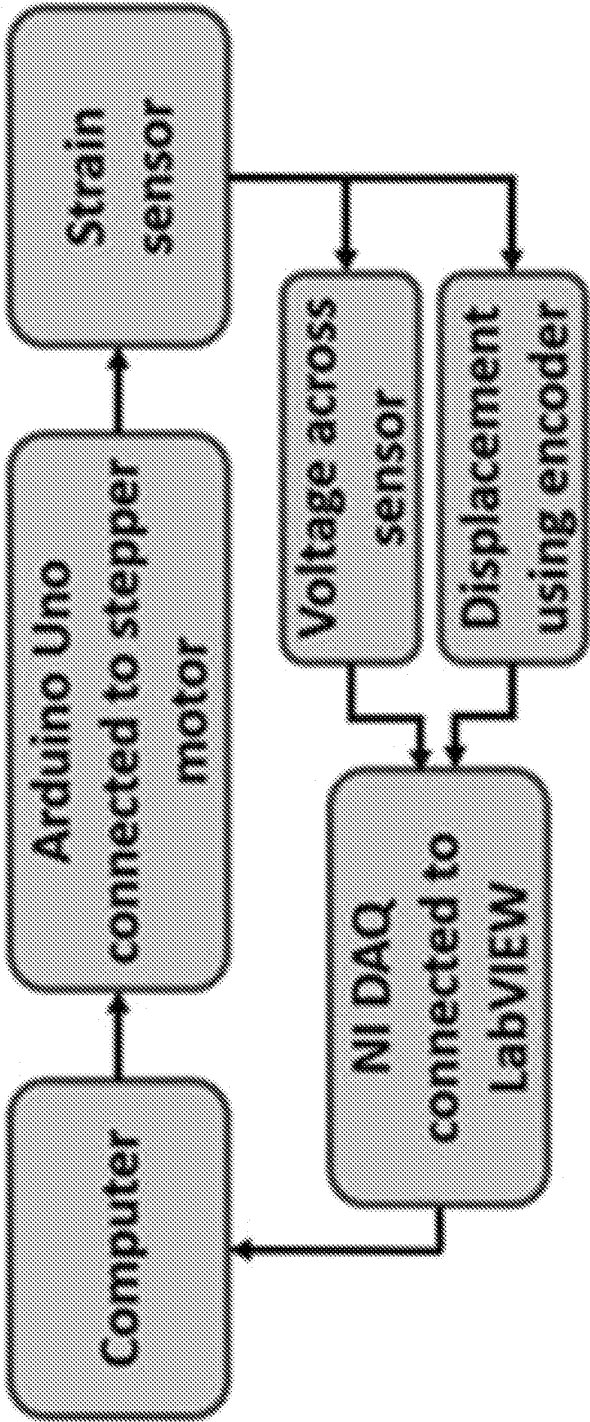


FIG. 34D

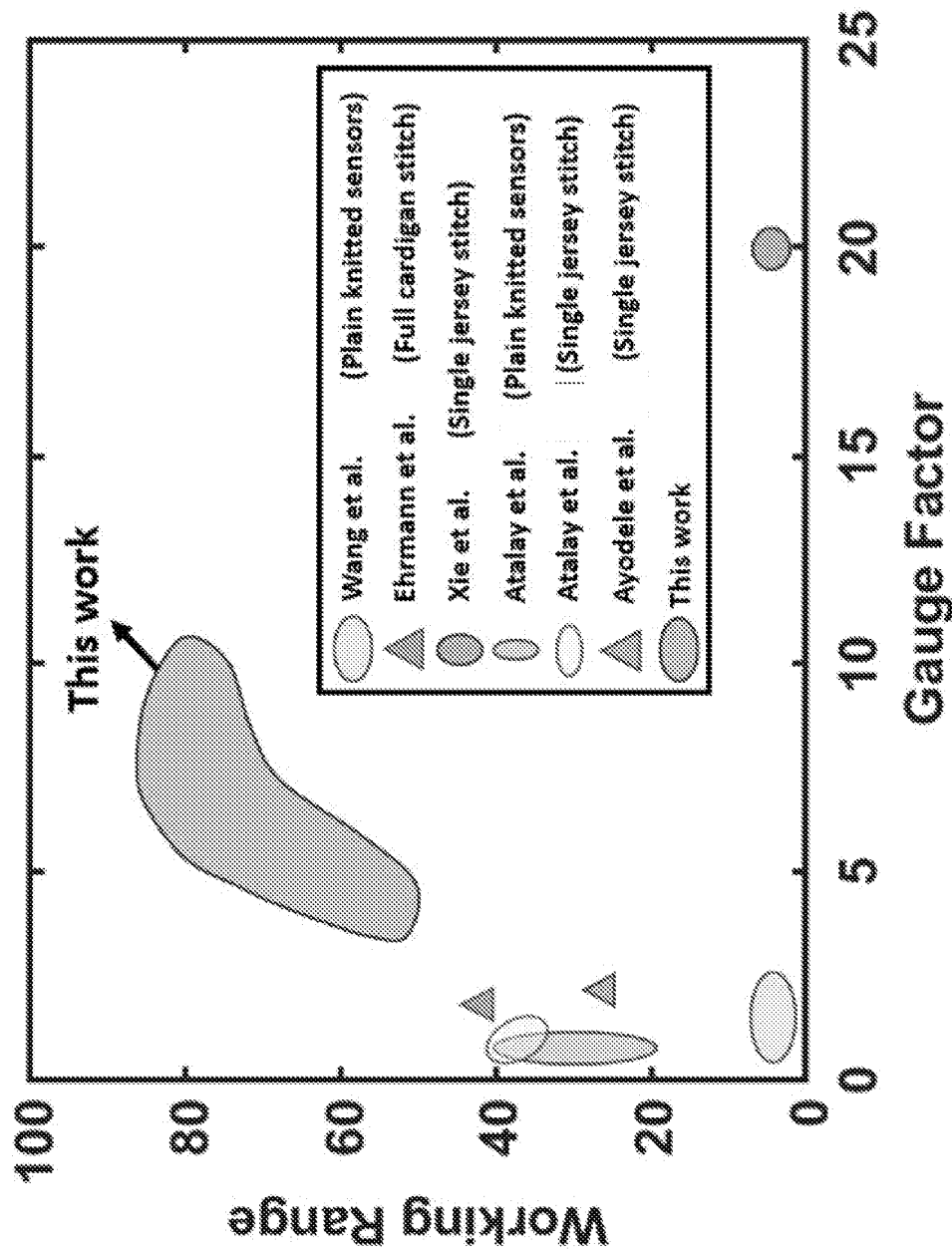


FIG. 35A

Existing works on knitted strain sensors		
Design of sensor	Sensitivity (GF)	Working range
Wang et al. focused on developing a theoretical model to study the resistance dependence of single jersey knitted structures. Later, they studied the strain sensitivity of circular plain knitted sensors varying the unit width of structure and loop length.	2.51 for 2% WR 0.89-0.97	2%-5%
Ehrmann et al. studied stretch sensors of Double jersey and Full Cardigan stitch pattern. Full cardigan was found to be more sensitive. They further studied the effect of loop length and stretching direction (0 to 90 degrees) on the sensitivity of knitted sensor.	Best 2.25 (Full cardigan stretched at 30 degree)	42%
Xie et al. compared course wise (CW) and wale wise (WW) knitted sensors of single jersey stitch pattern using a conductive yarn made of cotton fiber mixed with fine stainless steel.	CW (3.7), WW (20)	0-5%
Atalay et al. studied plain knitted sensors for all conductive (OC) and elastic-conductive (EC) yarns.	Plain OC (0.38), Plain EC (1.05)	Plain OC (20), Plain EC (40)
Ou et al. proposed strain sensors with conductive pleated structures knitted on a spandex base. As the spandex base is stretched, the pleated structures move away from each other changing the resistance.	N/A	N/A
Atalay et al. developed fabric strain sensors of single jersey stitch pattern consisting of conductive courses separated by elastomeric yarns. They varied the linear density of the elastomeric yarn and the input tension on the elastomeric yarn and studied its effect on the performance of the sensor.	2.1 (Best case)	34%
Atalay et al. studied the effect of conductive yarn input tension and the number of courses on the performance of single jersey knitted sensors.	1.7 (Best case)	40%
Raji et al. investigated the effect of conductive area and profile design of the single jersey knitted sensor on its performance.	0.51-1.32	N/A
Ayodele et al. developed electromechanical models for single jersey knits with miss and tuck stitches and studied the effect of varying amount of miss and tuck stitches on the performance of the knitted sensor.	3.3 (Best)	25%

FIG. 35B

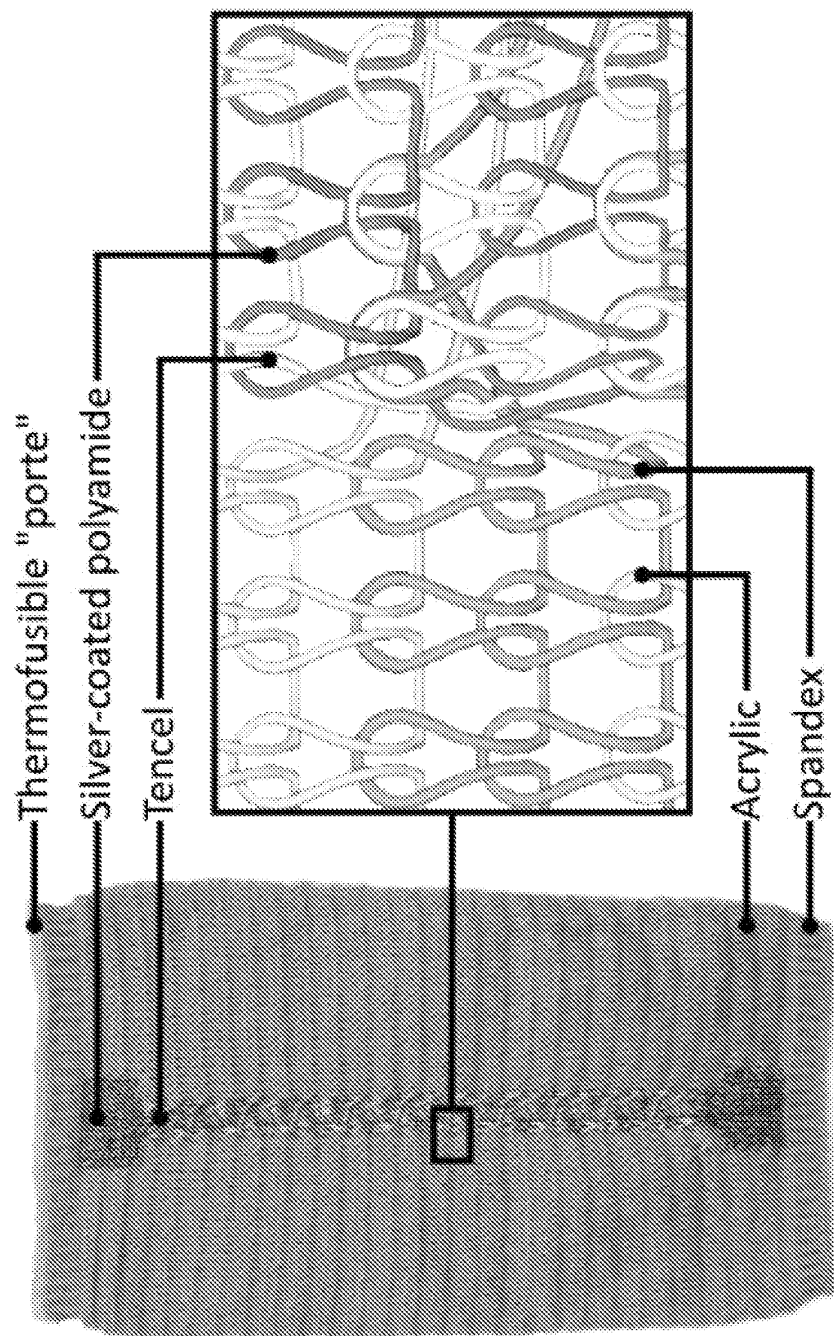


FIG. 36

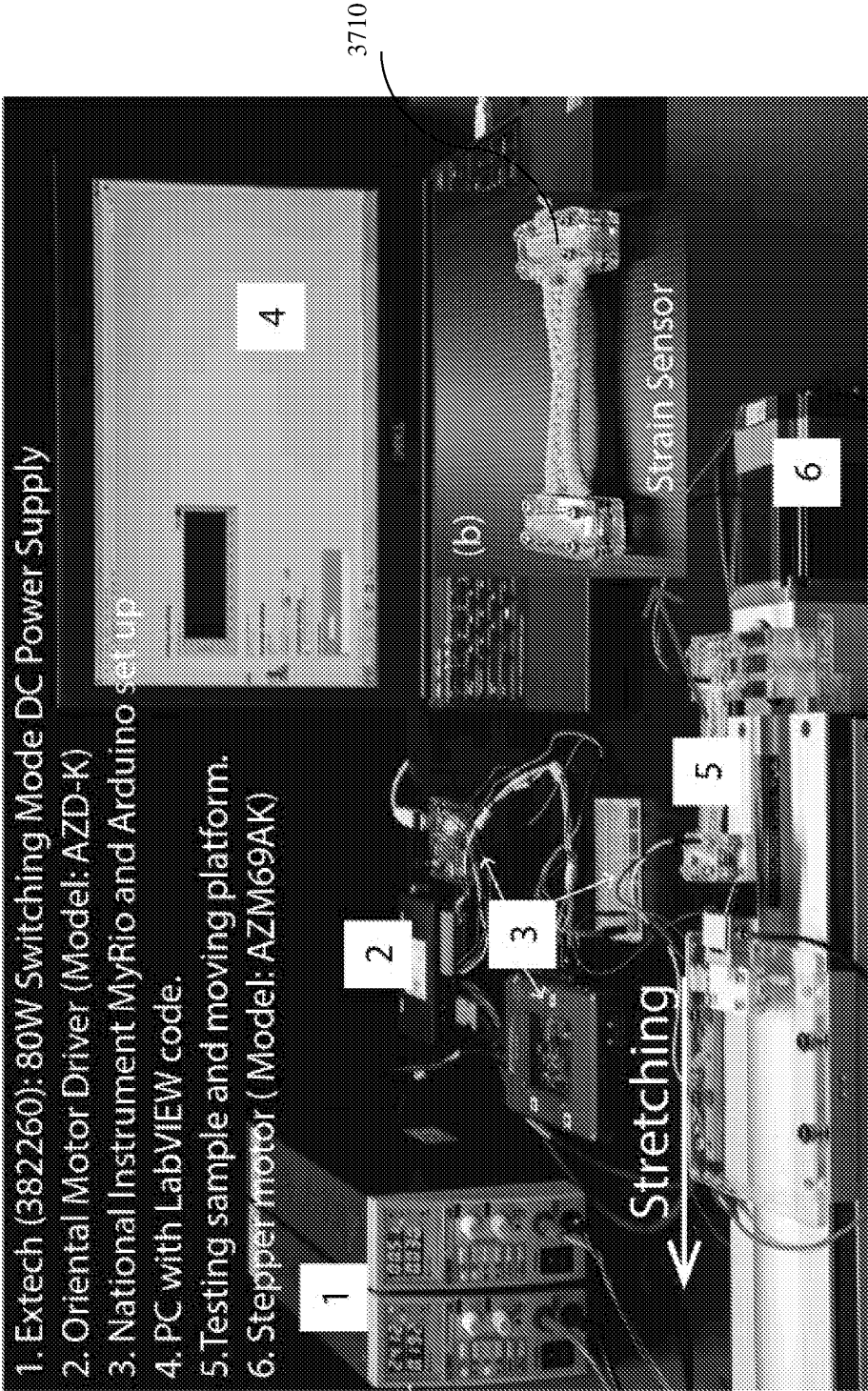


FIG. 37

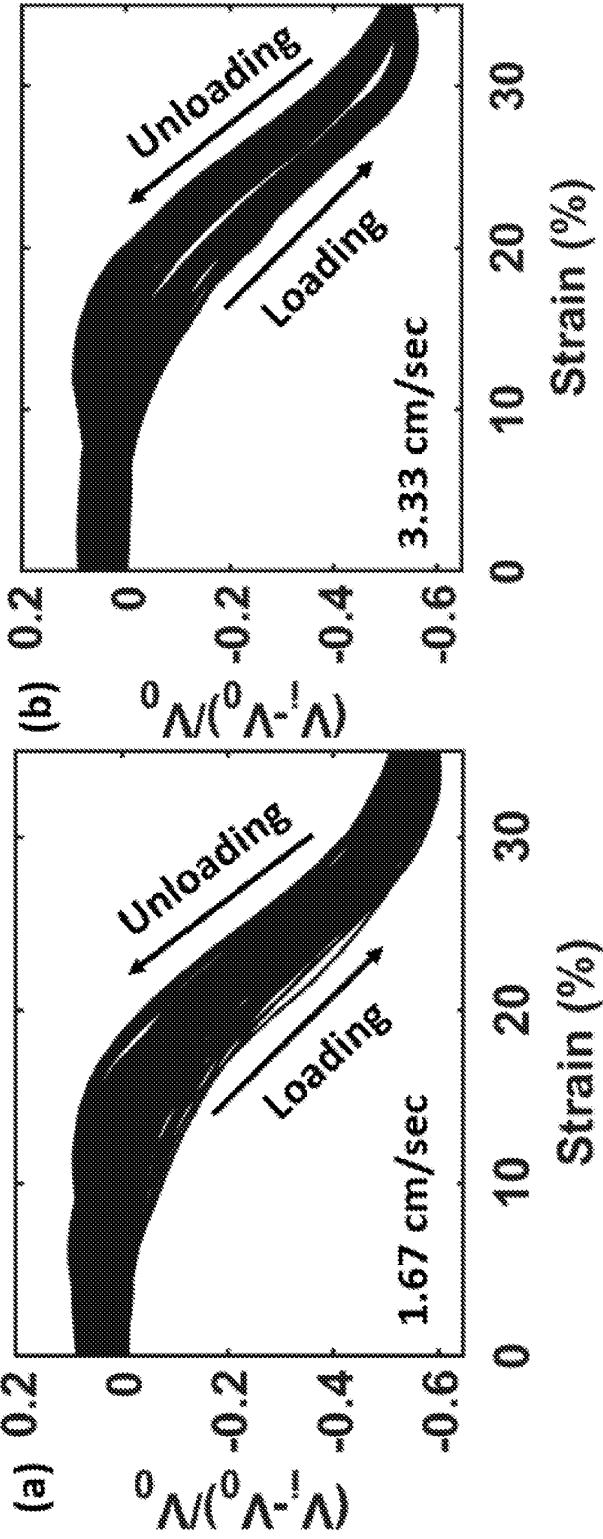


FIG. 38B

FIG. 38A

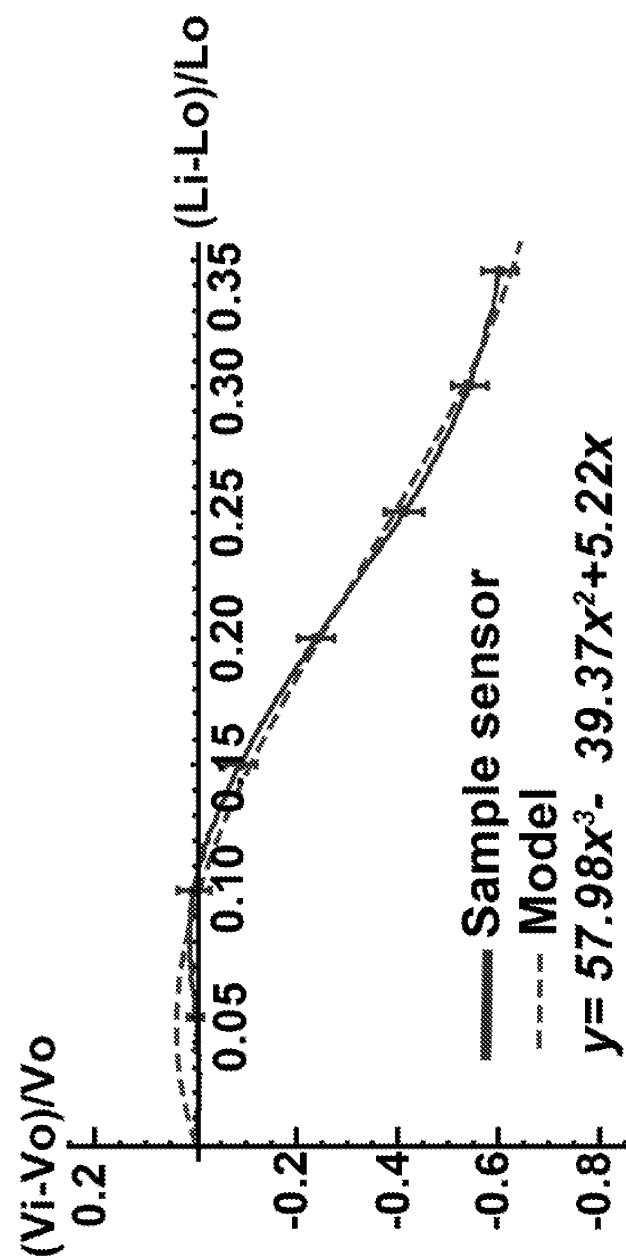


FIG. 39

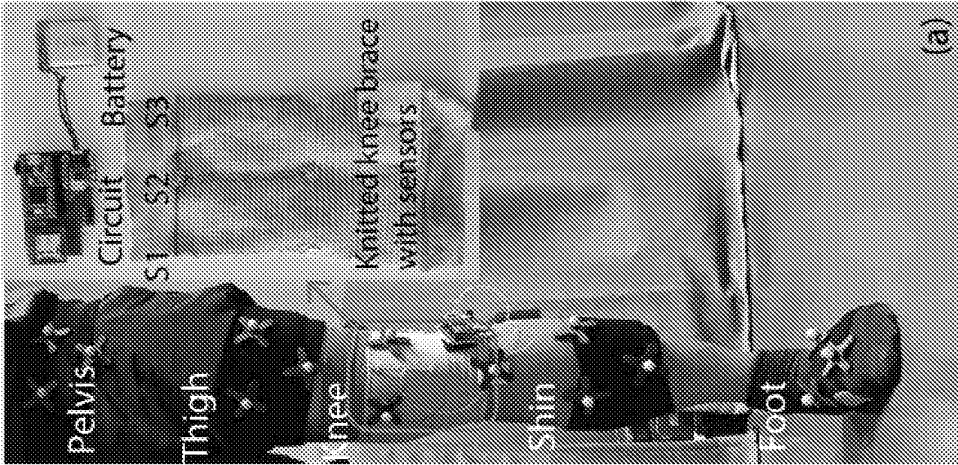


FIG. 40A

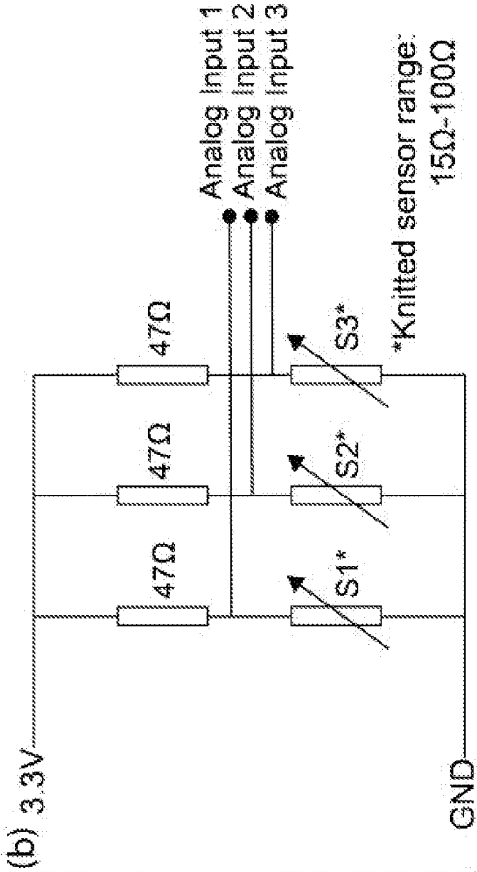


FIG. 40B

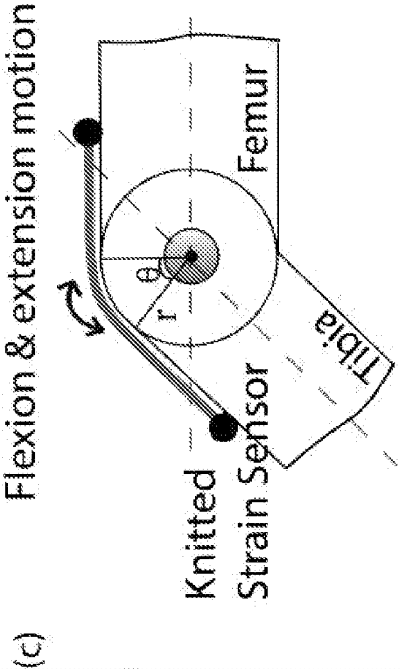
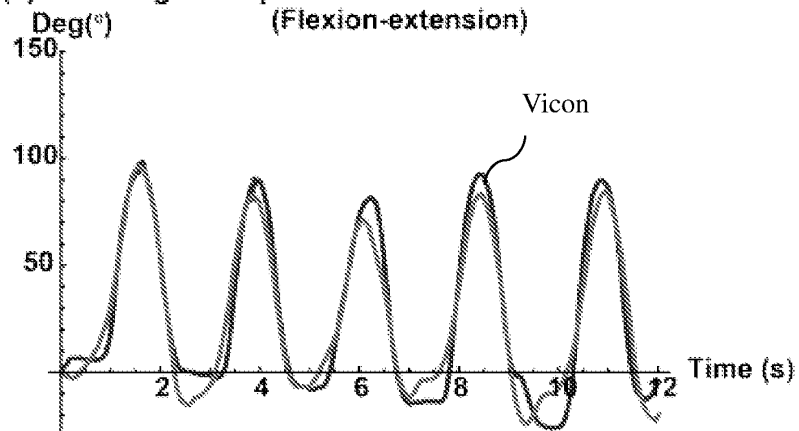
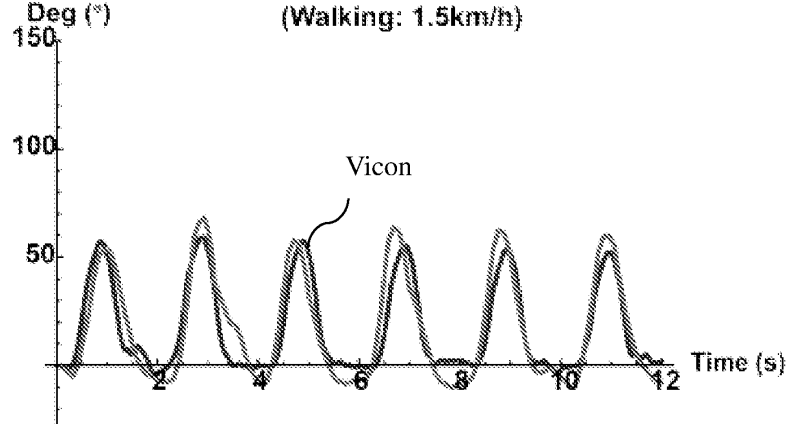


FIG. 40C

(a) Knee angle comparison between vicon & knitted sensor
(Flexion-extension)



(b) Knee angle comparison between vicon & knitted sensor
(Walking: 1.5km/h)



(c) Knee angle comparison between vicon & knitted sensor
(Jogging: 5km/h)

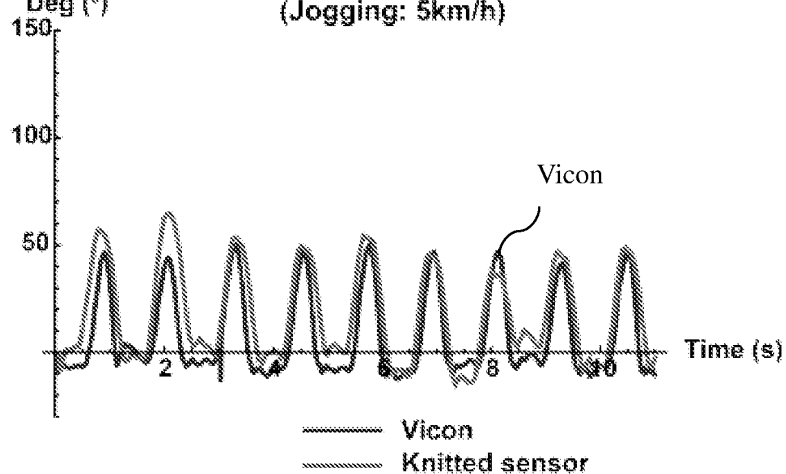


FIG. 41

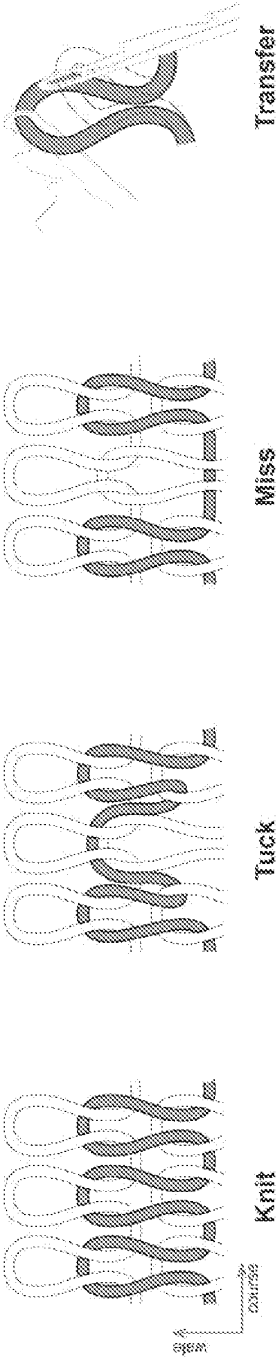
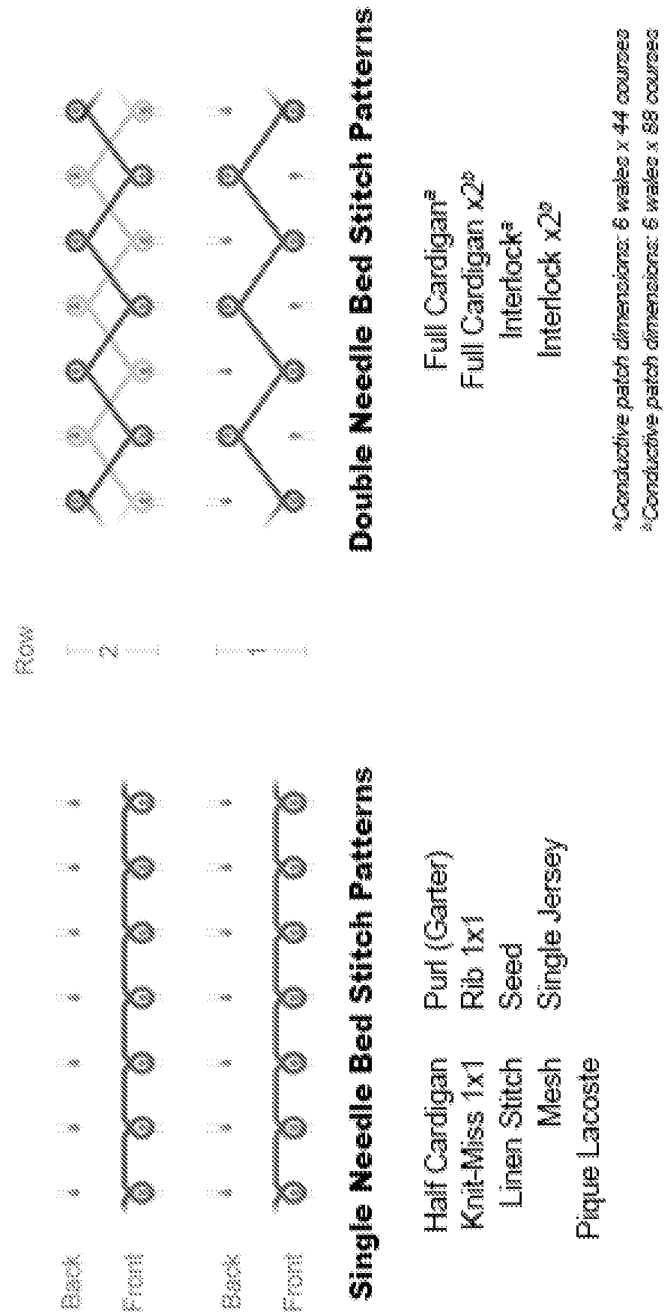


FIG. 42



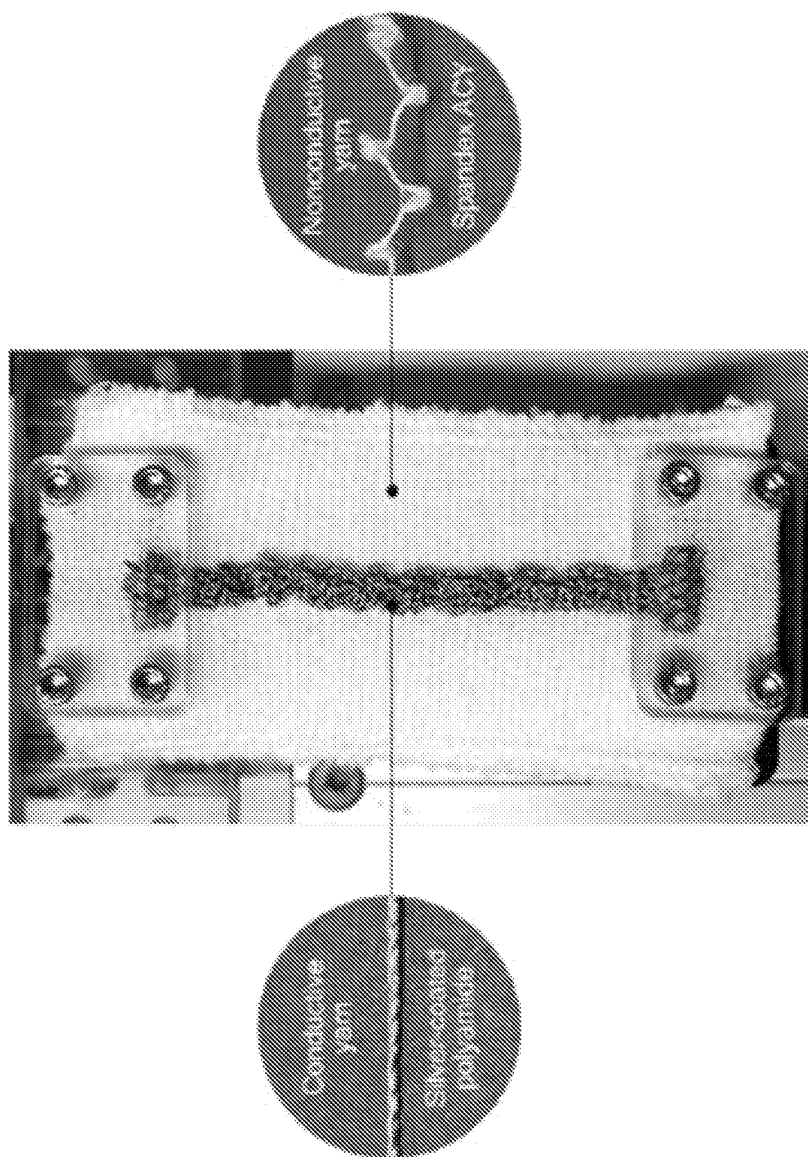


FIG. 44

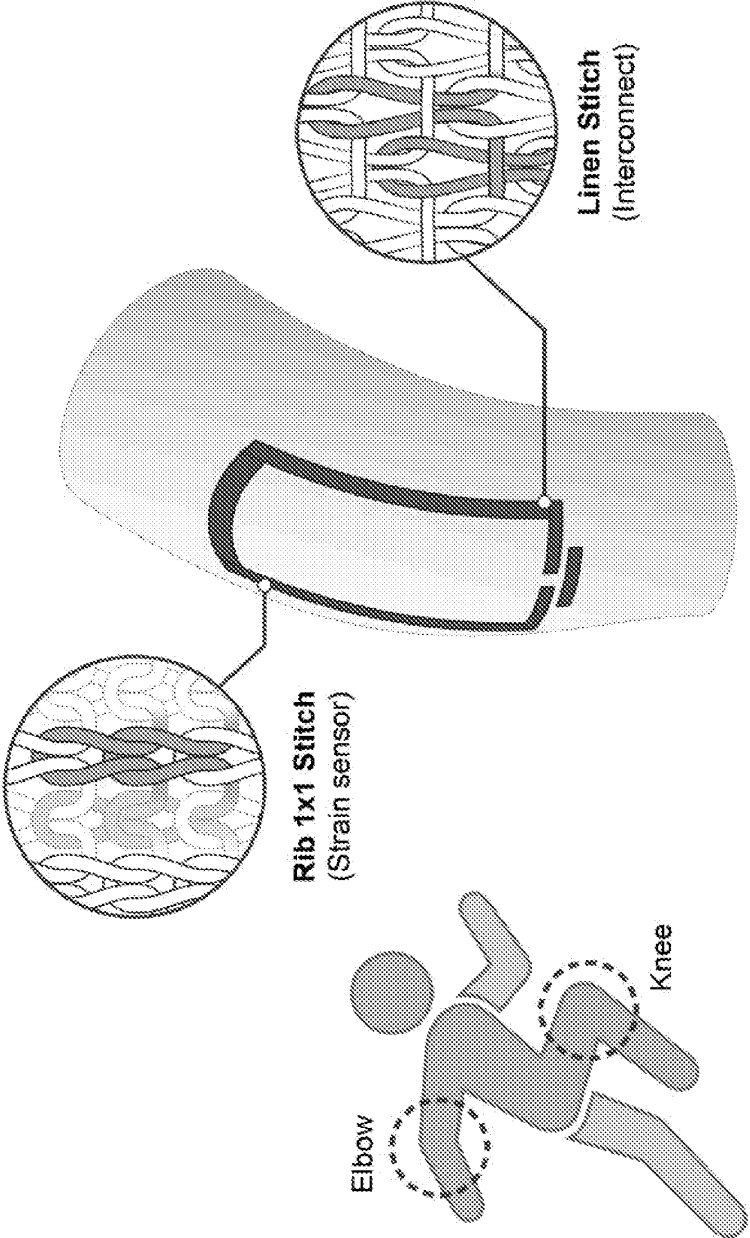


FIG. 45

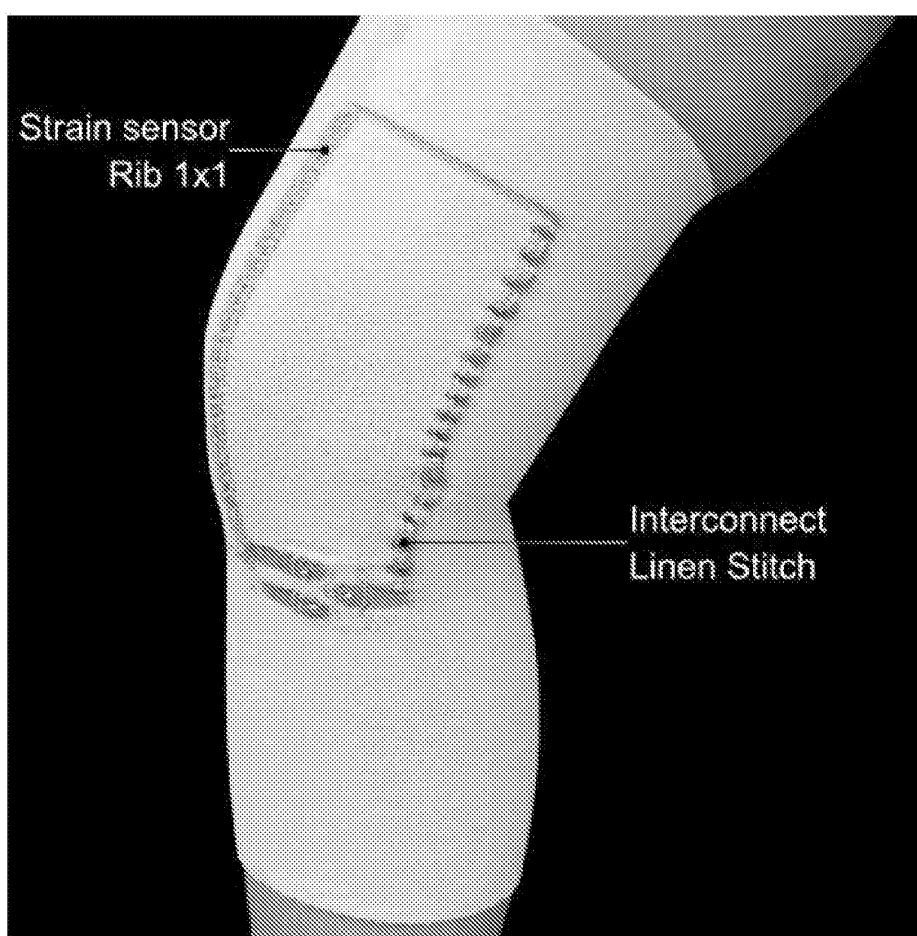


FIG. 46