Autocoro 288, automated rotor spinning and winding machine made by W.Schlaforst was displayed. Speed of this spinning machine can be easily changed from, 40,000 to 130,000 rpm.

Murata Machinery exhibited an air jet type open-end spinning frame, No.802H MJS (Fig. 12). No.802H MJS has been redesigned and now called No.802H MJS which operates at the rate of 340 m/minute. This high speed is significantly faster than other spinning frames. During demonstration, Murata spun various yarns such as 100% cotton yarns and micro fiber yarns. Its features are an integrated control system which includes yarn quality control, operation control and maintenance

Fig. 12 Air-Jet open end spinning machine No. 802H MJS (Murata Machinery)

control. Yarn quality control is handled by a control system named Intelligence analyzer (IA/3), which removes slubs, and corrects yarn variances such as the thinness and thickness. Operation Control watches the machine stoppage time due to yarn breakage, etc. Maintenance Control measures doffing time. Can robot is available for full automation of this process, and was exhibited and demonstrated. It transports sliver cans to MJS's, replaces sliver cans, and performs sliver piecing, making the piecing even and manual-like. When yarn irregularity caused by sliver join should be removed, a switch is turned on to set the yarn clearer mounted on MJS to detect that part.

4. Conclusions

In the spinning process, many technological improvements were made to develop automation systems by computer control, for instance, automatic splicing of slivers, rovings, and yarns which requires originally a lot of man power. In the field of innovative spinning frames including pre-spinning frames, however, there were no new models using new methods, although all manufacturers of machines and accessories were trying to improve efficiency in mechanical engineering, production control and other technological means.

Various makers are putting effort into accomplishing the ideal spinning plant, i.e. comfortable working environment, high cost performance, noise reduction,

dust free and easy maintenance. Such a plant will be realized in the near future by newly developed excellent technology. Future developments of new machines are eagerly wanted by many people concerned in the world.

Weaving Machinery and its Related Machinery

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1. Outline of Weaving Machines Exhibited

The weaving machines exhibited at the 5th OTEMAS were 84 looms from 15 loom makers as shown in Table 1. Table 2 shows a comparison of the exhibits with the previous OTEMAS. From this, it is found that the feature of the 5th OTEMAS are as follows.

- 1) The number of looms exhibited increased, on the other hand the number of loom makers decreased.
- 2) The number of air-jet looms (AJL) and AJL makers still increased.
- 3) On the contrary, from the 3rd OTEMAS as the top of wave, the number of rapier looms (RL) and RL makers was inclined to decrease.
- 4) The number of water-jet looms (WJL) and projectile looms (PL) makers have been limited.
- 5) The first income of the triaxial loom. Table 3 shows some technical data of the looms exhibited at the 5th OTEMAS.

2. Increase of Productivity

High-speed competition among looms exhibited has still been continued. The highest demonstrating speed of exhibited looms has been increased at every previous OTEMAS, so the high speed looms which exceed previous ones were exhibited at 5th OTEMAS. AJL demonstrated by Tsudakoma accomplished 3,040m/min in weft insertion rate. Its weft insertion rate exceeded the fastest one of WJLs (2,700m/min) for the first time. This indicates high potentiality of AJL.

The higher speed looms run, the larger noise they produce. When looms started running all together in the 5th OTEMAS, it was impossible to have a conversation. Low noise level had been one of the advantages of shuttleless looms, but it was over the limits of tolerance. From this point of view, the environmental AJL demonstrated by Nissan attracted visitors' attention. It was said that the sound-proofing covers could decrease 6 ~8dB(A) in noise level at the cloth fell.

As aforementioned, high-speed loom running comes to be realized because of the following various factors

Table 1 Number of the looms at the 5th OTEMAS

Maker	AJL	WJL	FRL	RRL	PL/TL	Total
Ih-Ching	1		1			2
Ishikawa	2		3			5
Iwama	1					1
Sulzer Ruti	1		3		5	9
Somet	1		6			8
Tsudakoma	11	3	2			16
Dornier	1			2		3
Toyoda	10					10
Nissan	6	2				8
Nuovo Pignone	1		4			5
Yamatex			6			6
Van de Wiele				1		1
Picanol	4		2			6
Hiraiwa	1		2			3
Howa					1	1
Total(Loom)	41	5	29	3	5	84
Total(Maker)	12	2	9	2	1	15

Table 2 Comparison with the previous OTEMAS

Type	1st(1976)	2nd(1981)	3rd(1985)	4th(1989)	5th(1993)
A J L	2 (1)	16 (3)	23 (5)	34(10)	41(12)
W J L	7 (3)	5 (2)	6 (2)	5 (2)	5 (2)
F R L	9 (4)	18 (7)	34(11)	33(11)	29 (9)
R R L	1 (1)	8 (5)	8 (5)	5 (4)	3 (2)
P L	6 (3)	5 (1)	3 (1)	4 (1)	5 (1)
T L	-	-	-	-	1 (1)
S L	7 (4)	6 (6)	1 (1)	-	-
Total	32(13)	58(15)	75(19)	81(18)	84(15)

such as the research and development of mechanical structure of loom, materials applied and finishing accuracy done by loom manufacturers. In addition risen level of technology of peripheral makers of related parts like looming and shedding mechanism including computer is also another remarkable factor.

Since now the positive application of these technologies can be expected to such purposes as the versatility, improving the quality of woven fabrics, solving the environmental problems, saving energy and factory automation besides high-speed running of looms.

3. Versatility of AJL

Although it had been said that the feature of jet looms is high productivity and that of rapier looms is wide versatility, the difference in versatility between RLs and AJLs appeared to become very small at 5th OTEMAS because of the expansion of variety of fabrics woven by AJLs.

The first feature of AJL was the increase of filament fabrics as shown in Table 3, i.e. 10 AJLs from 5 makers demonstrated weaving the filament fabrics. The shingosen, the hard twist weft yarn and the heavy industrial fabrics for the air-bag were especially

noteworthy. It is difficult even for WJL to weave such fabrics creditably. AJL would take the place of WJL, if the energy cost of AJL decreases by reducing air consumption.

The second feature of AJL was that 7 AJLs from 6 makers were with jacquards. In this OTEMAS especially, mechanical dobbies and jacquards inclined to disappeared, so electronic shedding devices were the mainstream. As the electronic jacquard which needs no needle was simplified in construction, it brought not only higher speed weaving but also larger number of hooks. The merit of the electronic jacquard with large number of hooks was at the ITMA 91 to have attracted visitors' attention. Big advantage is that it does not need any exchange of harness cords, and that it can weave valuable fabrics with the only one pattern for the whole reed width.

There were 5 AJLs weaving wool fabrics as the third feature of AJL. When the wool fabric was woven by AJL, the weft yarn break by the air blow had occurred frequently. As one of the countermeasures, Nissan demonstrated a new picking device which was the application of Vincent's picking mechanism. The weft yarn is accelerated and carried out with the use of a main nozzle and a pair of rollers in this method. A pair of rollers are placed between the measuring devices and the main nozzle and they were rotated at high speed simultaneously with the picking speed of the weft yarn. The maker said that this device could decrease the unwinding tension of weft yarn, so that it enabled to pick a weak weft yarn.

Wide versatility of AJL was also shown in the picking devices for multi-color yarn. Iwama introduced AJL equipped with 8 color selecting devices for the first time. This was the fourth feature of AJL at 5th OTEMAS.

On the other hand, 28 RLs among 32 RLs demonstrated at 5th OTEMAS were with dobbies or jacquards to show their wider versatility. They can weave a variety of fabrics with the use of various kinds of weft yarn such as nep yarn, flat yarn and so on.

4. Automation and FA

The center of attention at the 5th OTEMAS was the demonstration of the technology for automation and the system aimed to FA introduced by the loom makers. The most significant developments were as follows;

1) Quick style change system (QSC)

Quick style change (QSC) system was demonstrated by 6 loom makers, i.e. Sulzer Ruti, Somet, Tsudakoma, Dornier, Nissan and Picanol for processing the preparatory system outside the loom. The basic technology of this system was introduced at ITMA 91 by Dornier. Picanol and two others introduced the Warplink system offered by Zellweger Uster into QSC at

Table 3 Technical data of the looms at the 5th OTEMAS

Type of loom	Air-jet looms				
Maker	Ih-Ching	Ishikawa		Iwama	Sulzer Ruti
Model	IC-966	ZL-111-ND-6C-190	ZL-111-TD-2C-190	TERRY	LS200S190 N2SNTE
Width(cm)	190(161)	190(165.5)	190(162)	241(234)	190(170)
Speed(ppm)	1,000	600	800	550	750
Left insertion(mpm)	1,900(1,610)	1,140(993)	1,520(1,296)	1,326(1,287)	1,425(1,275)
Color selection	2	6	2	6	2
Warp shedding method	Crank	Electronic negative dobby	Positive cam	Electronic jacquard	Electronic dobby
Fabric	Lining cloth	Men's wear(3/1)	Denim(3/1)	Bath towel	Fancy filament
Yarns Warp Weft	N 75D E 150D/36f	W Nm2/48 W Nm2/48	C 6 C 6	C 30/2 C 30/2	N 70D N/E 210D
Density/in(warpxweft)	62×60	55×55	62×44	30.2×30.2	157.5×67.8

Type of loom	Air-jet looms				
Maker	Somet		Tsudakoma		
Model	STAR15 1900	STAR15 1900	ZA110i-170-2C-4S	ZA209i-190-2C-D16	ZA209i-190-2C-C6
Width(cm)	190(168)	190(170)	170(149.5)	190(168)	190(162.7)
Speed(ppm)	1,200	920	1,400	850	900
Left insertion(mpm)	2,280(2,016)	1,748(1,564)	2,380(2,093)	1,615(1,428)	1,710(1,464)
Color selection	4	2	2(1×1)	2(1×1)	2(1×1)
Warp shedding method	Positive cam	Positive cam	Crank	Electronic negative dobby	Positive cam
Fabric	Sports wear	Shirting	Acetate taffeta	Satin crape	14.5oz Denim
Yarns Warp Weft	N 60D N taslan 200dtx	C 50/1 C 50/1	AC 75D AC 100D	E 50D E 75D SZ2500T/m	C 7/1 C 6/1
Density/in(warpxweft)	101.6×68.6	122×62.2	102×75	200×90	66×45

Type of loom	Air-jet looms				
Maker	Tsudakoma				
Model	ZAX-390-2C-C7	ZAX-190-2C-4S	ZAX-280-2C-C4	ZA207Ti-280-6C-J	ZA209i-190-2C-C4
Width(cm)	390(360)	190(170)	280(265)	280(255.5)	190(167.5)
Speed(ppm)	630	1,600	800	600	1,200
Left insertion(mpm)	2,457(1,166)	3,040(2,720)	2,240(2,120)	1,680(1,533)	2,457(1,166)
Color selection	2(1×1)	2(1×1)	2(1×1)	6	2(1×1)
Warp shedding method	Positive cam	Crank	Positive cam	Electronic jacquard	Negative cam
Fabric	Downproof	Pinpoint oxford	Sheeting	Sport towel	Downproof
Yarns Warp Weft	CM 40/1 CM 40/1	CM 80/2 CM 80/2	E/C 37/1 E/C 34/1	(P),(G):C 40/2 C 20/1,(B):C 30/2	CM 50/1 CM 50/1
Density/in(warpxweft)	120×110	160×60	95×80	73×55	140×120

Type of loom	Air-jet looms				
Maker	Tsudakoma			Toyoda	
Model	ZA205i-190-4C-D16	ZA205i-230-4C-J	ZA205i-190-2C-E6	JA2F-150CS-WF-T600	JA2SF-190TN-WF-T600
Width(cm)	190(172.5)	230(214)	190(175)	150(130)	190(157)
Speed(ppm)	750	700	700	1,500	760
Left insertion(mpm)	1,425(1,294)	1,610(1,498)	1,330(1,225)	2,250(1,950)	1,444(1,193)
Color selection	4	4	2(1×1)	Mixing	2
Warp shedding method	Electronic negative dobby	Electronic jacquard	Electronic shedding (ECM)	Crank	Negative cam
Fabric	Worsted suiting	Interior cloth	① (QSC)	Lining cloth	Ladies formal wear
Yarns Warp Weft	W 2/60 W 1/30	E 150D E 40/2	②	AC 75D/20f AC 100D/25f	Shingosen 50D/36f E 75D/72f 3000T/m
Density/in(warpxweft)	77×72	135×114	③	104.5×67	199×87

Type of loom	Air-jet looms				
Maker	Toyota				
Model	JA1SF-190TN-WF-T600	JA2S-190TN-WF-T600	JA2SF-190TN-WF-T600	JA2S-190TP-WF-T600	JA6S-190DE-EF-T600
Width(cm)	190(161)	190(177)	190(160)	190(164)	190(168)
Speed(ppm)	670	1.100	1.500	850	670
Weft insertion(mpm)	1.273(1.079)	2.090(1.947)	2.850(2.400)	1.615(1.394)	1.273(1.126)
Color selection	1	2	2	2	6
Warp shedding method	Negative cam	Negative cam	Negative cam	Positive cam	Electronic dobby
Fabric	Industrials	Downproof	Men's shirting	Denim	Handkerchief
Yarns Warp Weft	N 420D/68f N 420D/68f	CM 40 CM 40	EW 150D EW 75D	C 7 C 6	CM 30. CM 60 CM 30. CM 60
Density/in(warpxweft)	56×55	120×110	110×90	65×45	④

Type of loom	Air-jet looms				
Maker	Toyota			Dornier	Nissan
Model	JA4W-190DE-ET-T600	JA4T-280JE-EH-T600	JA2S-336CM-WT-T600	DLW Model LTNF6/J	LA51A-2MY6-190
Width(cm)	190(176)	280(238)	336(300)	260(248)	190(170)
Speed(ppm)	750	600	750	580	900
Weft insertion(mpm)	1.425(1.320)	1.680(1.428)	2.520(2.250)	1.508(1.438)	1.710(1.530)
Color selection	4	4	Mixing	6	2
Warp shedding method	Electronic negative dobby	Electronic jacquard	Asymmetric crank	Electronic jacquard	Crank
Fabric	Wool suiting	Terry sport wear	Bed sheeting	Terry cloth	Conjugated yarn fabric
Yarns Warp Weft	Twisted union yarn ▼ 1/60 Twisted union yarn ▼ 1/60	(P):C 30/2.(G):C 40/2 (P):C 20/1.(B):C 30/2	E/C 34 E/C 34	⑤	Mixed spun yarn Conjugated yarn (spun & filament)
Density/in(warpxweft)	100×88	67×55.180	92×77	⑥	104×66

Type of loom	Air-jet looms				
Maker	Nissan				
Model	LA51A-2MEB16-190	LA51A-2MY6-190	LA51A-2M4-190	LA51A-2MH4-280	LA51A-6WEJ-190
Width(cm)	190(178)	190(166)	190(164)	280(261)	190(158)
Speed(ppm)	800	850	1.500	730	810
Weft insertion(mpm)	1.520(1.424)	1.615(1.411)	2.850(2.460)	2.044(1.905)	1.539(1.280)
Color selection	2	2	2	2	6
Warp shedding method	Electronic negative dobby	Crank	Crank	Exclusive plain weave cam	Electronic jacquard
Fabric	⑦ (QSC)	14.5oz Denim	Pinpoint oxford	Sheeting	Women's working
Yarns Warp Weft	⑧	C 7/1 C 6/1	CM 80/2 CM 40/1	CM 30/1 CM 30/1	R 30/2 R 20/2. R 30/2 R 40/2
Density/in(warpxweft)	⑨	62×43	152×60	92×55	60×72

Type of loom	Air-jet looms				
Maker	Nuovo Pignone	Hiraiwa	Picanol		
Model	TAJ622	HJT70 TOWEL	DELTA	DELTA	OWNI
Width(cm)	220(180)	218(68.6×3)	190(171)	190(170)	190(180.3)
Speed(ppm)	550	510	820	910	900
Weft insertion(mpm)	1.210(990)	1.112(1.050)	1.558(1.402)	1.729(1.547)	1.710(1.623)
Color selection	2	8	2	2	4
Warp shedding method	Electronic rotary dobby	Electronic jacquard	Crank	Negative cam	Electronic negative dobby
Fabric	Terry towel	Bath towel	Viscose crepe	Downproof	⑩ (QSC)
Yarns Warp Weft	(G):C9.5/1.(P):C14/1 (G):C12/1 (B):C12/1 & C9.5/2	(G):C 40/2 (P):C 30/2 C 20/1	·R 110dtex/40f R 35 S.2	C 40 C 40	⑪
Density/in(warpxweft)	33×45.112.5	67×50	111.7×72	120×110	⑫

Type of loom	Air-jet looms		Water-jet looms		
Maker	Picanol	Tsudakoma			Nissan
Model	OMNI	ZW315X-150-1C-4S	ZW305-190-2C-6S	ZW305-190-1C-C8	LW542-4-140
Width(cm)	280(266.7)	150(133.4)	190(170)	190(165)	140(120)
Speed(ppm)	900	1.800	1.000	1.000	1.710
Left insertion(mpm)	2.520(2.400)	2.700(2.401)	1.900(1.700)	1.900(1.650)	2.394(2.052)
Color selection	2	1	2(2×2)	1	1
Warp shedding method	Crank	Crank	Crank	Positive cam	Crank
Fabric	Percale sheeting	Nylon taffeta	Faille	Shingosen twill	Nylon taffeta
Yarns Warp Weft	E/C 50:50. C36/1 E/C 50:50. C36/1	N 70D N 70D	E 75D E 150D SZ1500T/m	E 60D E 100D SI1000T/m	N 70D/12f N 70D/18f
Density/in(warpxweft)	92×83	96.5×77	144.8×65	194×77	112×83

Type of loom	Water-jet looms		Flexible repier looms		
Maker	Nissan	Ih-Ching	Ishikawa		
Model	LW541-2M6-190	TP600	1001-Π-PDU-200	1001-Π-PTX-180	1001-Π-PDU-190
Width(cm)	190(175)	195(163)	200(160)	180(160)	190(166)
Speed(ppm)	900	400	500	550	600
Left insertion(mpm)	1.710(1.575)	780(652)	1.000(800)	990(880)	1.140(996)
Color selection	2	4	4	2(1×1)	6
Warp shedding method	Crank	Electronic dobby	Electronic rotary dobby	Positive tappet	Electronic rotary dobby
Fabric	Flat crepe	—	Yarn dyed seersucker	Denim(3/1)	Women's wear
Yarns Warp Weft	Singosen 90D/36f Singosen 90D/72f	E 40/2 E 40/2	EW 150D/30f EW 75D/36f EW 150D/30f	C 5.5 C 5.5	Singosen 150D/48f Singosen 150D/48f
Density/in(warpxweft)	119×85	62×60	96×76	62×43	118×78

Type of loom	Flexible repier looms				
Maker	Sulzer Ruti			Somet	
Model	G6200W190 N8SP	G6200B190 N4EP	G6200B1900 F8J	Themalle 2100	Themalle 2100
Width(cm)	190(167)	190(166.2)	190(43.6×4)	210(202.5)	210(174)
Speed(ppm)	550	615	500	450	560
Left insertion(mpm)	1.045(919)	1.169(1.022)	950(872)	945(911)	1.176(974)
Color selection	8	4	8	2	2
Warp shedding method	Electronic rotary dobby	Cam	Electronic jacquard	Electronic rotary dobby	Electronic rotary dobby
Fabric	Ladies outerwear (QSC)	shirting/gingham	Terry-towel	Air bag	Apparel(microfiber)
Yarns Warp Weft	W Nm2/64 W Nm1/60	C 80/1 C 80/1	(G):C 40/2,(P):C 30/2 C 16/1	N 420D N 420D	E 165D/2 E 165D/2
Density/in(warpxweft)	100.6×76.2	127×101.6	63.0×50.8	44.5×49	70×57

Type of loom	Flexible repier looms				
Maker	Somet				Tsudakoma
Model	Themalle 1900	Themalle 2100	Themalle 1900	Themalle 3600	R300-190-6C-D16
Width(cm)	190(181)	210(185)	190(155.2)	360(167.8×2)	190(170)
Speed(ppm)	600	520	500	380	415
Left insertion(mpm)	1.140(1.086)	1.092(962)	950(776)	1.368(1.275)	798(714)
Color selection	5	4	6	2	6
Warp shedding method	Electronic rotary dobby	Electronic rotary dobby	Electronic jacquard	Positive cam	Positive dobby
Fabric	Pure linen shirting	Men's outerwear(QSC)	Jacquard fabric	Denim	Fancy fabric
Yarns Warp Weft	Linen N150 Linen N150	W Nm2/40 W Nm2/40	E 45D E 135D, R 100D, W 2/12 Lurex 100D, C 46	C 5.5 C 5	C40/2 C40/2, Chenille 1/2 EW150D/2, Siub 6/1
Density/in(warpxweft)	48.3×45.7	45.7×45.7	203.2×114.3~127	59.4×38.1	100×56

Type of loom	Flexible repier looms				
Maker	Tsudakoma	Nuovo Pignone			
Mode	FR001-210-6C-D12	TPS626	FAST3.2	FAST2.0	FAST2.0
Width(cm)	210(172.1)	260(248.6)	320(300)	200(169.2)	200(161.2)
Speed(ppm)	600	350	380	520	550
Wft insertion(mpm)	1.260(1.032)	910(870)	1.216(1.140)	1.040(880)	1.100(887)
Color selection	6	6	4	8	4
Warp shedding method	Electronic positive dobby	Electronic jacquard	Electronic rotary dobby	Electronic rotary dobby	Electronic rotary dobby
Fabric	Shingosen venetian	Terry towel	Upholstery	Apparel for man	Bielastic apparel
Yarns Warp Weft	E 180D S1000T/m E 180D SZ2200T/m	(G):C 30/2.(P):C 24/2 (G):C 16/1	E 90D/48f C 50/2	W Nm2/56 W Nm2/56	N 195dtex/46f N 192dtex/102f
Density/in(warpxweft)	102×70	30.5×45.7	162.6×55.9	50.8×49.5	101.6×73.6

Type of loom	Flexible repier looms				
Maker	Vamatex				
Mode	SPI151 H=2600	9000Plus H=2100	P1001e H=2100	9000Plus H=2300	P1001e H=2100
Width(cm)	260(210)	210(170)	210(160)	230(217)	210(175)
Speed(ppm)	360	450	600	430	510
Wft insertion(mpm)	936(756)	945(765)	1.260(960)	989(933)	1.071(893)
Color selection	6	5	4	6	4
Warp shedding method	Electronic jacquard	Electronic rotary dobby	Rotary dobby	Electronic rotary dobby	Rotary dobby
Fabric	Terry	Fantasy	Sports clothing	Curtain fabric	Wool clothing
Yarns Warp Weft	C 30/2.C 24/2 C 16/1	C 24/2 C 24/2. Acrylic Nm2/30	E 40D/96f E 150D/272f	E 50/2 E 30/1. Fantasy 24/1	W Nm2/70 W Nm1/35
Density/in(warpxweft)	62.2×45.7	61×38.1	122×191	50.8×50.8	66×66

Type of loom	Flexible repier looms				
Maker	Vamatex	Hiraiwa		Picanol	
Mode	P1001e H=3600	HUA21	HSA60	GTM-AS	GTM-AS
Width(cm)	360(166.7×2)	200(186)	200(178)	190(174)	190(162.6)
Speed(ppm)	410	230	500	525	600
Wft insertion(mpm)	1.476(1367)	460(428)	1.000(890)	998(914)	1.140(976)
Color selection	3	6	8	6	4
Warp shedding method	Cam	Positive dobby	Electronic rotary dobby	Electronic rotary dobby	Electronic rotary dobby
Fabric	16oz Denim	Ladies goods	Men's jacket	Ladies outerwear	Ladies outerwear
Yarns Warp Weft	C 6.3/1 C 4.6/1	W Nm2/72 W Nm2/72	W Nm2/60 W Nm2/60	W Nm2/70 W Nm2/70	E 50dtex/24f C 40. C 26/2 E 74dtex/24
Density/in(warpxweft)	57.2×40.6	56×56	72×70	75.6×74.9	99×108.9

Type of loom	Rigid rapier looms			Projectile looms	
Maker	Dornier		Van de Viele	Sulzer Ruti	
Mode	HS Model HTVS8/SD	HS Model HTVS8/J	VM22-175	P7200B360 F4SPD1	P7200B390 N2EPK3
Width(cm)	200(170)	180(145.5)	175(155)	360(71.8×5)	390(191.7×2)
Speed(ppm)	500	500	355	335	420
Wft insertion(mpm)	1.000(850)	900(725)	621(550)	1.206(1.203)	1.638(1.610)
Color selection	8	8	8	4	2
Warp shedding method	Electronic rotary dobby	Electronic jacquard	Electronic rotary dobby	Electronic rotary dobby	Tappet
Fabric	⑬ (QSC)	Heavy upholstery	Car seat	Bath towel	Poplin
Yarns Warp Weft	⑭	⑮	(G):R 2×50tex (P):R 2×30tex (G):R 2×30tex	(G):C 27/2.(P):C 20 C 16	C 40/2 C 40/2
Density/in(warpxweft)	⑯	⑰	42.7×43.9	112×45.7	87.4×53.3

air suction. EL-M used cotton yarn which enabled drawing-in easily as seed yarn. After drawing this seed yarn in dropper wires, harnesses and reed, it was tied with the yarn unwound from the warp beam. In this new system, drawing-in operation could be started as soon as the fabric was decided, because it was unnecessary to wait preparing the warp beam.

Many makers demonstrated heald frames made of carbon fiber composite materials to correspond to higher speed running of looms. Carbon frames appeared to have such advantages that they decreased wear of the heald wires and damage of warp yarn because they were lighter and could absorb vibrations better. More developments might be required for generally using of carbon frames due to from 3 to 5 times cost compared with aluminum frames at the present condition. Healds also have a lot of subjects in quality and durability to endure higher speed weaving. Rapid solution is anticipated due to full-scale participation of the domestic maker (Kiji) to the healds' market for JL.

6. Conclusions

The the first application of computers to weaving

machinery was demonstrated at the ITMA in 1979. Those enabled AJL to control the ejection timing of air-jet easily through the series of solenoid valves. Now, 14 years later, the technology to control the loom using micro-computers has become common. The performance of AJL has made rapid progress and this has influenced RL, PL and further preparatory machines. Devices to systematize the whole weaving mill has been developed and there are some systems considering the scale of the factory. For most of them, however, it is difficult to introduce into existing looms and factories. In order to answer more efficient production on the basis of "many items of small lot" system, more practical systems should be developed.

In addition, this report was based on the results investigated by the weaving machinery studying group in this society and the industrial research institute of Ishikawa prefecture and thanks for their assistance.