



US00D918413S

(12) **United States Design Patent** (10) **Patent No.:** **US D918,413 S**
Banes et al. (45) **Date of Patent:** **** May 4, 2021**

(54) **APPARATUS FOR PATTERNING CELLS**

FOREIGN PATENT DOCUMENTS

(71) Applicant: **MedTrain Technologies, LLC**,
Burlington, NC (US)

GB 2155948 A 10/1985

(72) Inventors: **Albert J. Banes**, Hillsborough, NC
(US); **Colin Patrick Frazier**, Raleigh,
NC (US); **Christopher James**
Wimmer, Raleigh, NC (US)

OTHER PUBLICATIONS

Andarawis-Puri et al., "Rotator cuff tendon strain correlates with
tear propagation", Journal of Biomechanics, 2009, pp. 158-163, vol.
42, No. 2.

(Continued)

(73) Assignee: **MedTrain Technologies, LLC**,
Burlington, NC (US)

Primary Examiner — Vy N Koenig

(**) Term: **15 Years**

(74) *Attorney, Agent, or Firm* — The Webb Law Firm

(21) Appl. No.: **29/727,514**

(57) **CLAIM**

The ornamental design for an apparatus for patterning cells,
as shown and described.

(22) Filed: **Mar. 11, 2020**

DESCRIPTION

Related U.S. Application Data

(60) Division of application No. 29/607,853, filed on Jun.
16, 2017, now Pat. No. Des. 880,721, which is a
(Continued)

(51) **LOC (13) Cl.** **24-02**

(52) **U.S. Cl.**
USPC **D24/224**

(58) **Field of Classification Search**
USPC D24/107, 121, 133, 183, 184, 224-225,
D24/227, 233; D6/596, 601; D9/523,
D9/547, 549, 550, 724, 732
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,521,475 A	9/1950	Nickolas	
D239,548 S *	4/1976	Schiff et al.	D24/225
4,087,327 A	5/1978	Feder et al.	
4,228,243 A	10/1980	Iizuka	
4,623,355 A	11/1986	Sawruk	
4,642,220 A	2/1987	Bjorkman	

(Continued)

FIG. 1 shows a top view of an apparatus for patterning cells
showing our new design, according to a clover leaf embodi-
ment of the present invention.

FIG. 2 shows a top perspective view thereof.

FIG. 3 shows a bottom view thereof.

FIG. 4 shows a bottom perspective view thereof.

FIG. 5 shows a top view of an apparatus for patterning cells
showing our new design according to a butterfly embodi-
ment of the present invention.

FIG. 6 shows a top perspective view thereof.

FIG. 7 shows a bottom view thereof.

FIG. 8 shows a bottom perspective view thereof.

FIG. 9 shows a top view of an apparatus for patterning cells
showing our new design according to a three-arm propeller
embodiment of the present invention.

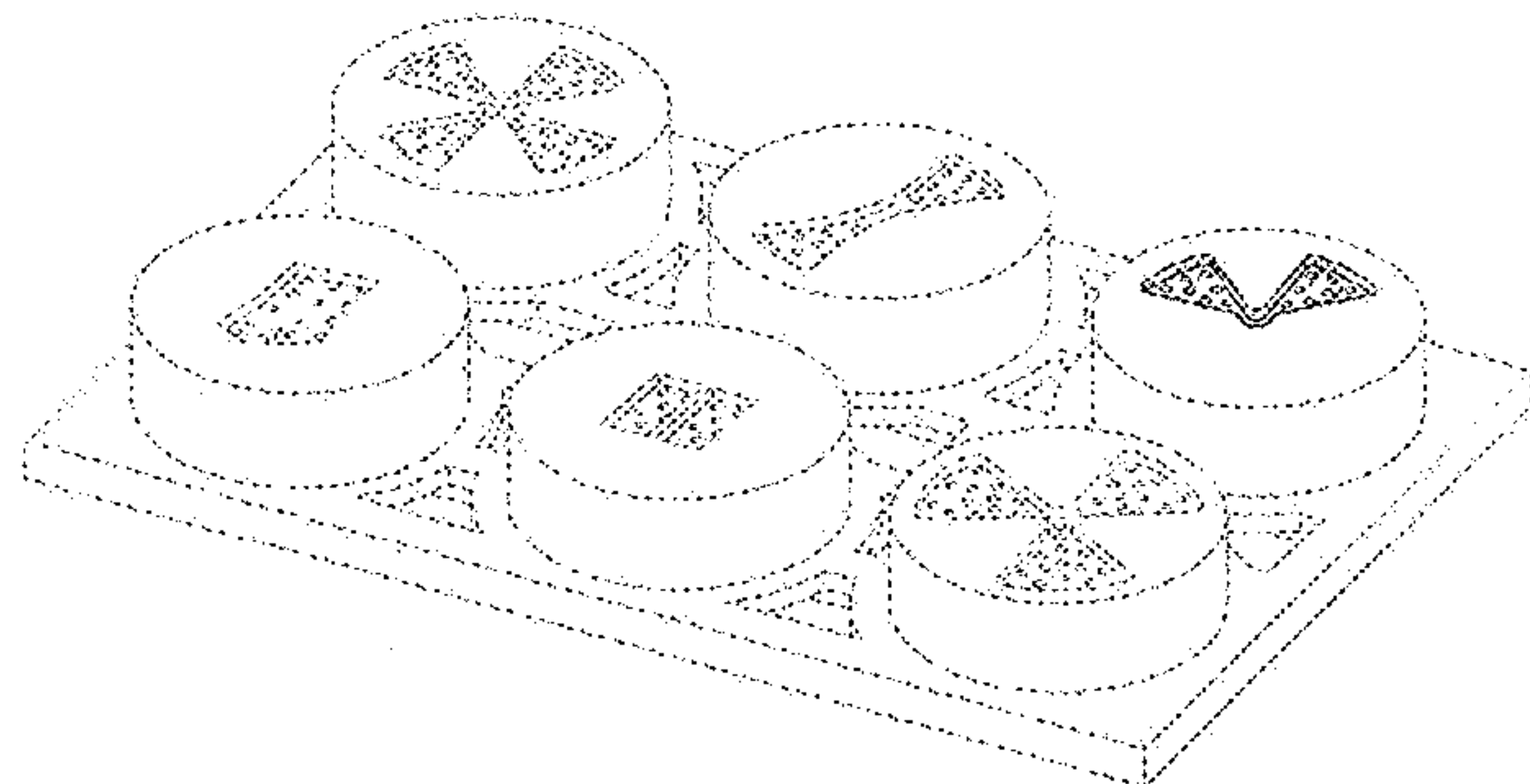
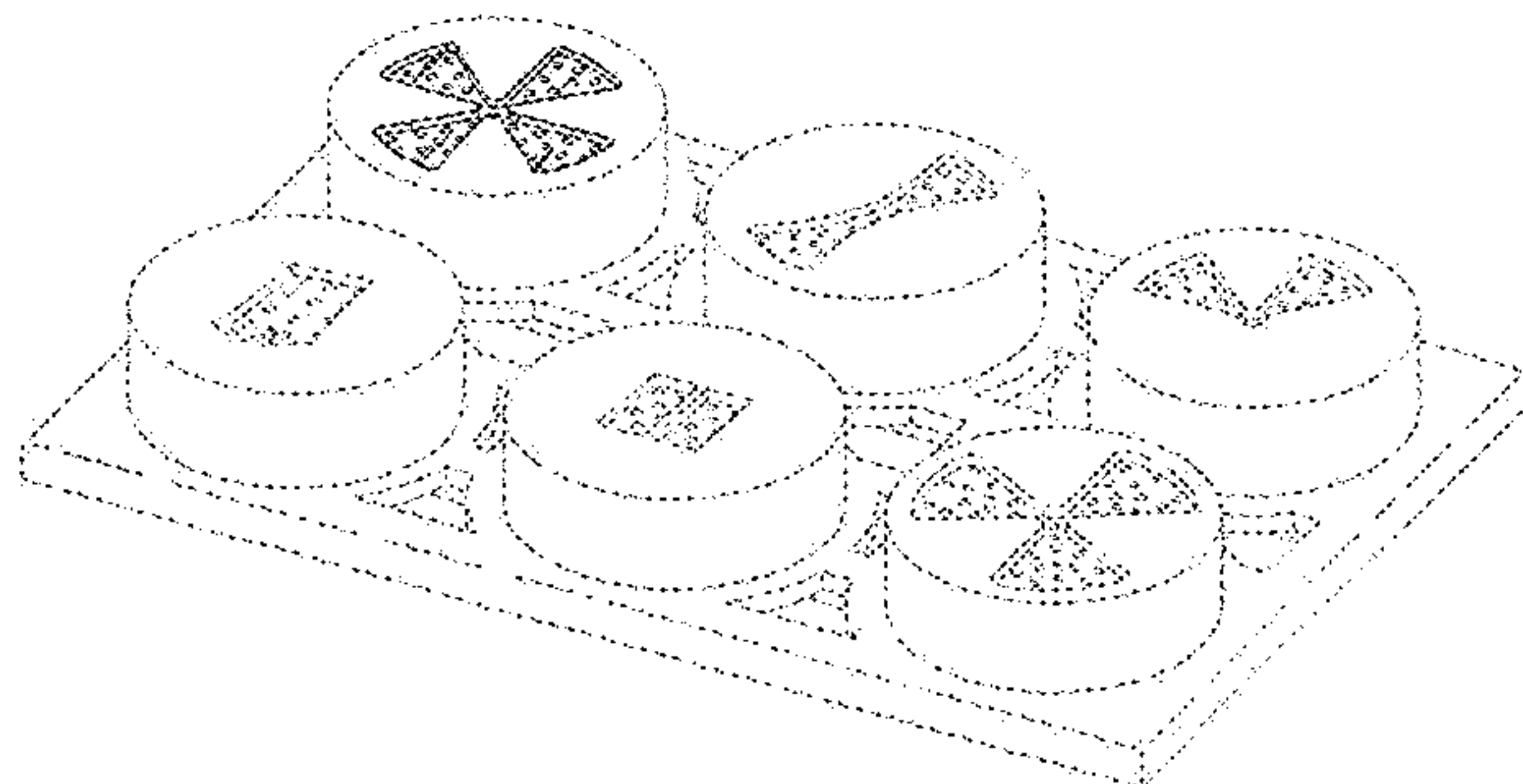
FIG. 10 shows a top perspective view thereof.

FIG. 11 shows a bottom view hereof; and,

FIG. 12 shows a bottom perspective view thereof.

The broken lines in FIGS. 1-12 show portions of the
invention which form no part of the claimed design. The
broken lines in FIGS. 1-12 are environmental only and are
not part of the claimed design.

1 Claim, 6 Drawing Sheets



Related U.S. Application Data

continuation of application No. 13/921,887, filed on Jun. 19, 2013, now abandoned.

(58) Field of Classification Search

CPC A61G 1/04-048; A61G 5/12-128; B01L 3/00

See application file for complete search history.

(56) References Cited**U.S. PATENT DOCUMENTS**

4,695,547	A	9/1987	Hilliard et al.	
4,789,601	A *	12/1988	Banes	A61L 27/18
				428/116
4,822,741	A *	4/1989	Banes	A61L 27/18
				427/2.24
4,831,869	A	5/1989	Fowler et al.	
4,839,280	A	6/1989	Banes	
4,839,292	A	6/1989	Cremonese	
4,851,354	A	7/1989	Winston et al.	
4,908,319	A	3/1990	Smyczek et al.	
4,940,853	A	7/1990	Vandenburgh	
4,974,952	A	12/1990	Focht	
5,153,136	A	10/1992	Vandenburgh	
5,240,854	A	8/1993	Berry et al.	
5,273,905	A	12/1993	Muller et al.	
5,348,879	A	9/1994	Shapiro et al.	
5,414,556	A	5/1995	Focht	
5,460,945	A	10/1995	Springer et al.	
5,496,697	A	3/1996	Parce et al.	
5,518,909	A	5/1996	Banes	
5,686,303	A	11/1997	Korman	
5,843,766	A	12/1998	Applegate et al.	
D411,308	S	6/1999	Pandey et al.	
5,958,760	A	9/1999	Freeman	
6,015,590	A	1/2000	Suntola et al.	
6,037,141	A	3/2000	Banes	
6,048,723	A	4/2000	Banes	
6,207,451	B1	3/2001	Dennis et al.	
6,218,178	B1	4/2001	Banes	
6,472,202	B1	10/2002	Banes	
6,586,235	B1	7/2003	Banes	
6,645,759	B2	11/2003	Banes	
D500,426	S *	1/2005	Newman	D7/357
6,998,265	B2	2/2006	Banes	
D522,145	S	5/2006	Best et al.	
7,186,548	B2	3/2007	Li	
7,738,682	B2	6/2010	Banes et al.	
D632,386	S	2/2011	Chang	
D650,295	S *	12/2011	Schmitz	D9/732
D651,524	S *	1/2012	Kerr	D9/732
D688,570	S *	8/2013	Logue	D9/732
D697,073	S	1/2014	Andersson et al.	
D708,760	S	7/2014	Smeja	
8,777,013	B1 *	7/2014	Jalindre	B65D 75/327
				206/534
D720,844	S	1/2015	Wells	
D736,403	S	8/2015	Hudson et al.	
D754,840	S	4/2016	Waldman et al.	
D767,163	S	9/2016	Schimmel et al.	
D793,258	S	8/2017	Buber	
D828,122	S	9/2018	Levine	
D873,660	S *	1/2020	Akana	D9/436
2004/0142411	A1	7/2004	Kirk et al.	
2005/0153273	A1	7/2005	Wikswow et al.	
2006/0270023	A1	11/2006	LeDuc et al.	
2007/0077653	A1	4/2007	Banes et al.	
2013/0337565	A1	12/2013	Banes et al.	

OTHER PUBLICATIONS

Banes et al., “Mechanical forces and signaling in connective tissue cells: cellular mechanisms of detection, transduction, and responses to mechanical deformation”, *Current Opinion in Orthopaedics*, 2001, pp. 389-396, vol. 12, No. 5.

Clark et al., “Integrins and Signal Transduction Pathways: The Road Taken”, *Science*, 1995, pp. 233-239, vol. 268, No. 5208.

Di Carlo et al., “Single-Cell Enzyme Concentrations, Kinetics, and Inhibition Analysis Using High-Density Hydrodynamic Cell Isolation Arrays”, *Analytical Chemistry*, 2006, pp. 4925-4930, vol. 78, No. 14.

Discher et al., “Tissue Cells Feel and Respond to the Stiffness of Their Substrate”, *Science*, 2005, pp. 1139-1143, vol. 310, No. 5751.

Duncan et al., “Mechanotransduction and the Functional Response of Bone to Mechanical Strain”, *Calcified Tissue International*, 1995, pp. 344-358, vol. 57.

Howard et al., “Mechanoelectrical Transduction by Hair Cells”, *Annual Reviews of Biophysics and Biophysical Chemistry*, 1988, pp. 99-124, vol. 17.

Hellmich et al., “Single cell manipulation, analytics and label-free protein detection in microfluidic devices for systems nanobiology”, *Electrophoresis*, 2005, pp. 3689-3696, vol. 26, No. 19.

Irimia et al., “Single-Cell Chemical Lysis in Picoliter-Scale Closed Volumes Using a Microfabricated Device”, *Analytical Chemistry*, 2004, pp. 6137-6143, vol. 76, No. 20.

Irimia et al., “Cell Handling using microstructured membranes”, *Lab on a Chip*, 2006, pp. 345-352, vol. 6, No. 3.

Li et al., “Biology on a chip: Microfabrication for Studying the Behavior of Cultured Cells”, *Critical Reviews in Biomedical Engineering*, 2003, pp. 423-488, vol. 31, Nos. 5 & 6.

Long et al., “Low magnitude of tensile strain inhibits IL-1 β -dependent induction of pro-inflammatory cytokines and induces synthesis of IL-10 in human periodontal ligament cells in vitro”, *Journal of Dental Research*, 2001, pp. 1416-1420, vol. 80, No. 5.

Long et al., “Tumor Necrosis Factor α -dependent Proinflammatory Gene Induction Is Inhibited by Cyclic Tensile Strain in Articular Chondrocytes In Vitro”, *Arthritis & Rheumatism*, 2001, pp. 2311-2319, vol. 44, No. 10.

Martini et al., “Systems Nanobiology: From Quantitative Single Molecule Biophysics to Microfluidic-based Single Cell Analysis”, *Sub-cellular Biochemistry*, 2007, Chapter 14, pp. 301-321.

McClain et al., “Microfluidic Devices for the High-Throughput Chemical Analysis of Cells”, *Analytical Chemistry*, 2003, pp. 5646-5655, vol. 75, No. 21.

Mijatovic et al., “Technologies for nanofluidic systems: top-down vs. bottom-up—a review”, *Lab on a Chip*, 2005, pp. 492-500, vol. 5, No. 5.

Munce et al., “Microfabricated System for Parallel Single-Cell Capillary Electrophoresis”, *Analytical Chemistry*, 2004, pp. 4983-4989, vol. 76, No. 17.

Muñoz-Pinedo et al., “Confocal restricted-height imaging of suspension cells (CRISC) in a PDMS microdevice during apoptosis”, *Lab on a Chip*, 2005, pp. 628-633, vol. 5, No. 6.

Nevill et al., “Integrated microfluidic cell culture and lysis on a chip”, *Lab on a Chip*, 2007, pp. 1689-1695, vol. 7, No. 12.

Ostuni et al., “Patterning Mammalian Cells Using Elastomeric Membranes”, *Langmuir*, 2000, pp. 7811-7819, vol. 16.

Quake et al., “From Micro- to Nanofabrication with Soft Materials”, *Science*, 2000, pp. 1536-1540, vol. 290, No. 5496.

Reyes et al., “Micro Total Analysis Systems. 1. Introduction, Theory, and Technology”, *Analytical Chemistry*, 2002, pp. 2623-2636, vol. 74, No. 12.

Riveline et al., “Focal Contacts as Mechanosensors: Externally Applied Local Mechanical Force Induces Growth of Focal Contacts by an mDia1-dependent and ROCK-independent Mechanism”, *Journal of Cell Biology*, 2001, pp. 1175-1185, vol. 153, No. 6.

Ros et al., “Bioanalysis in structured microfluidic systems”, *Electrophoresis*, 2006, pp. 2651-2658, vol. 27, No. 13.

Sims et al., “Analysis of single mammalian cells on-chip”, *Lab on a Chip*, 2007, pp. 423-440, vol. 7 No. 4.

Svahn et al., “Single cells or large populations?”, *Lab on a Chip*, 2007, 544-546, vol. 7, No. 5.

Tourovskaya et al., “Differentiation-on-a-chip: A microfluidic platform for long-term cell culture studies”, *Lab on a Chip*, 2005, pp. 14-19, vol. 5, No. 1.

Unger et al., “Monolithic Microfabricated Valves and Pumps by Multilayer Soft Lithography”, *Science*, 2000, pp. 113-116, vol. 288, No. 5463.

(56)

References Cited

OTHER PUBLICATIONS

Voleti et al., "Tendon healing: repair and regeneration", Annual Review of Biomedical Engineering, 2012, pp. 47-71, vol. 14.

Wall et al., "Comparison of cellular strain with applied substrate strain in vitro", Journal of Biomechanics, 2007, pp. 173-181, vol. 40, No. 1.

Wheeler et al., "Microfluidic Device for Single-Cell Analysis", Analytical Chemistry, 2003, pp. 3581-3586, vol. 75, No. 14.

Whitesides et al., "Soft Lithography in Biology and Biochemistry", Annual Review of Biomedical Engineering, 2001, pp. 335-373, vol. 3.

Yang et al., "Hydrodynamic simulation of cell docking in microfluidic channels with different dam structures", Lab on a Chip, 2004, pp. 53-59, vol. 4, No. 1.

Yang et al., "Cell Docking and On-Chip Monitoring of Cellular Reactions with a Controlled Concentration Gradient on a Microfluidic Device", Analytical Chemistry, 2002, pp. 3991-4001, vol. 74, No. 16.

* cited by examiner

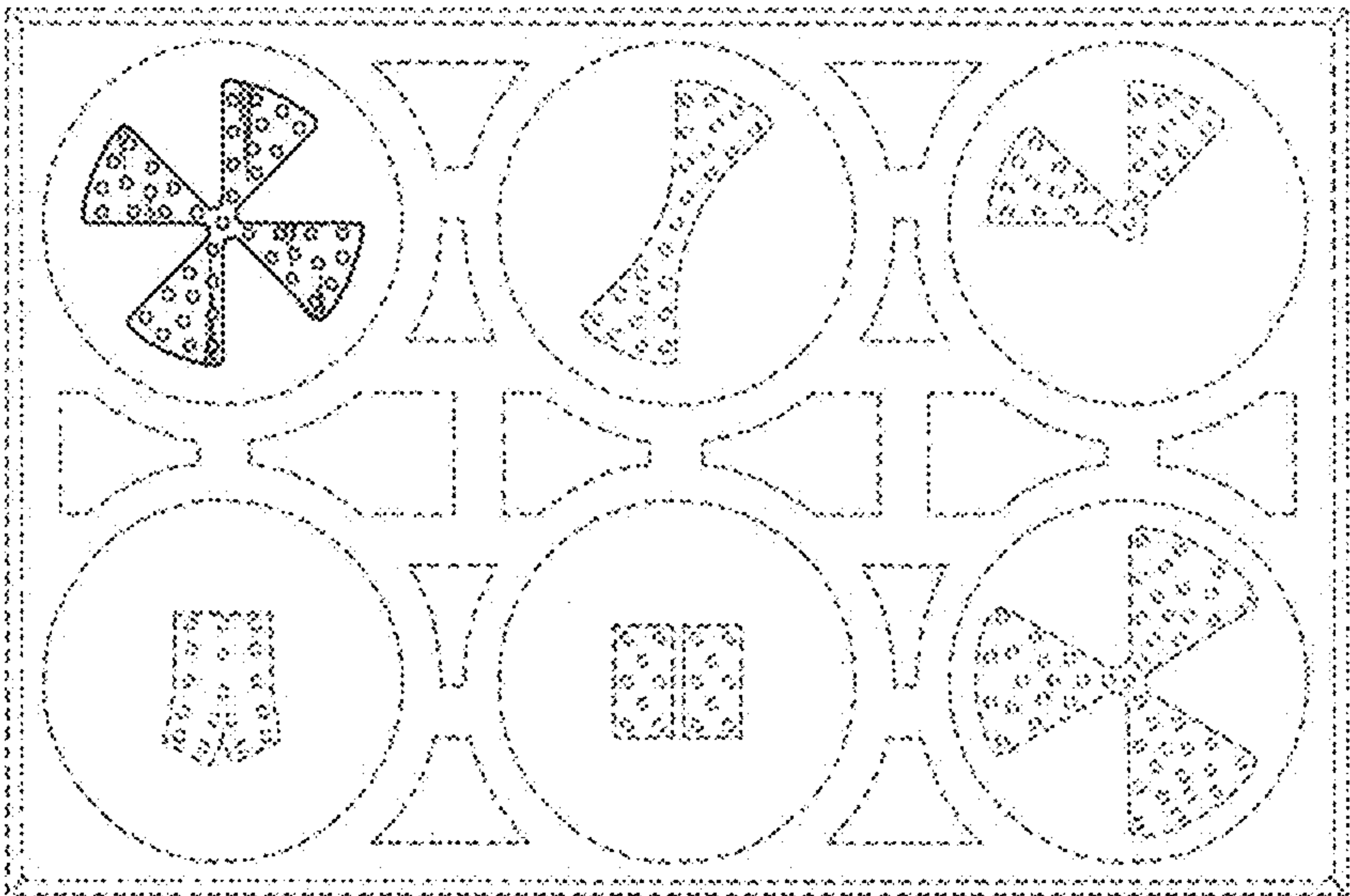


FIG.1

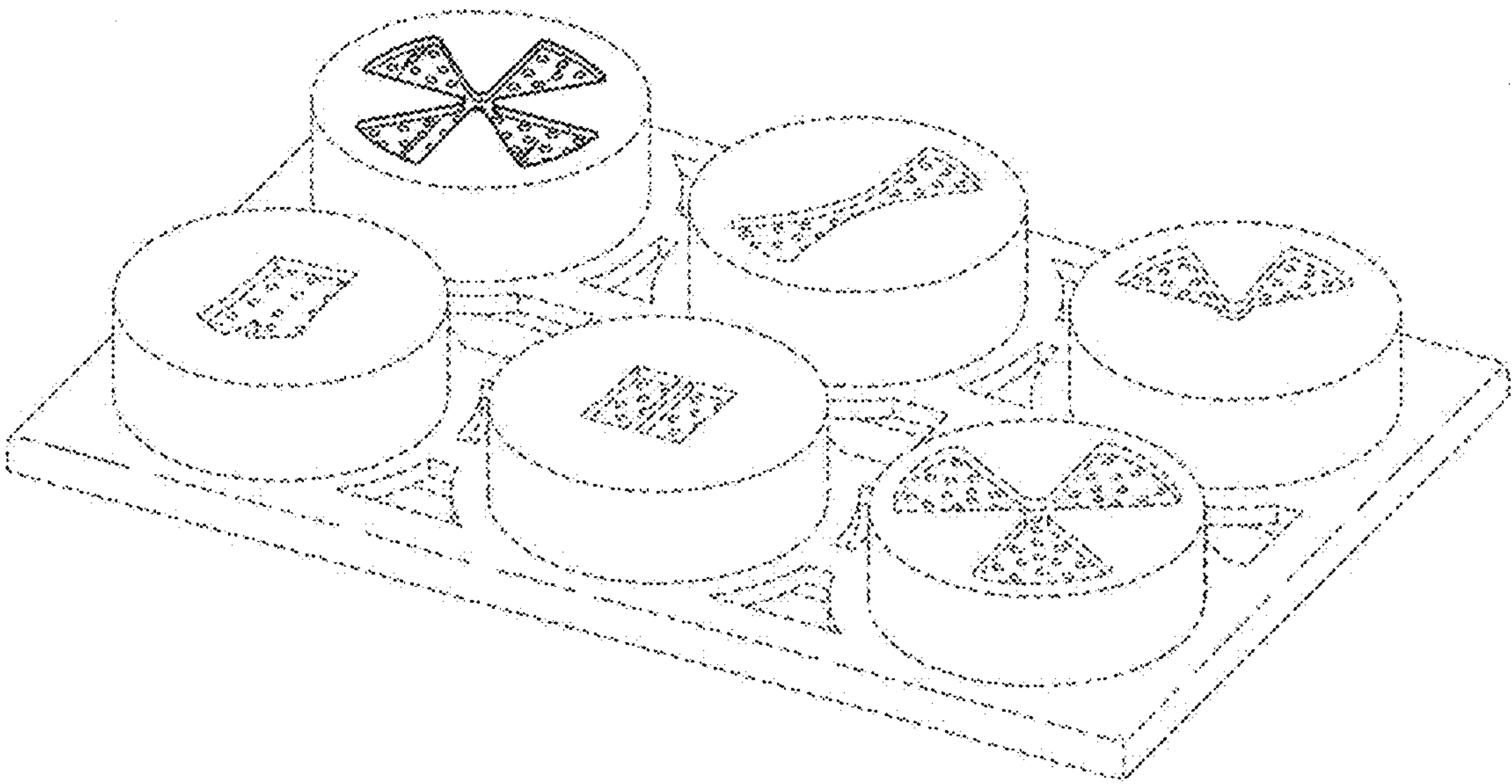


FIG.2

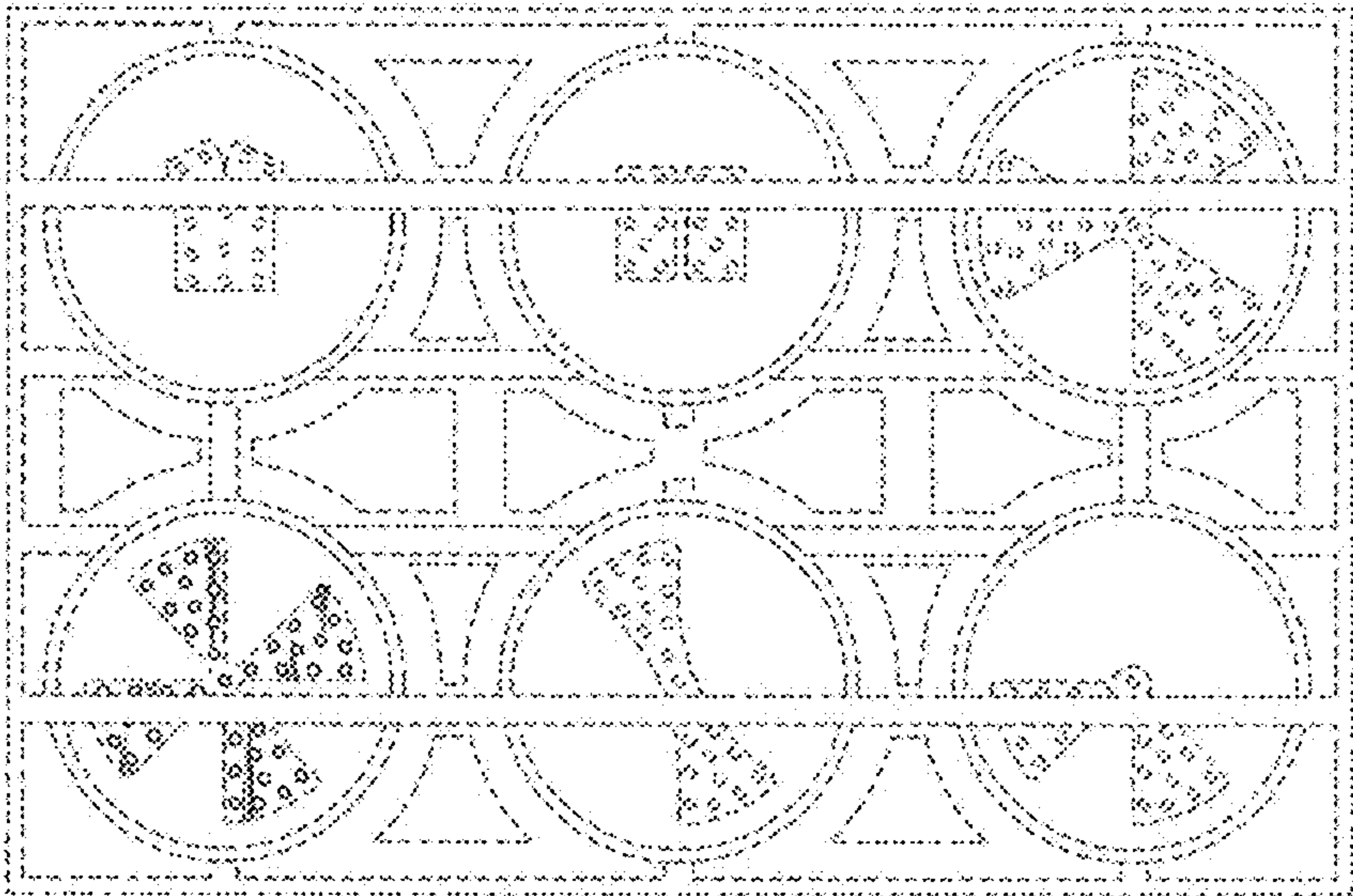


FIG. 3

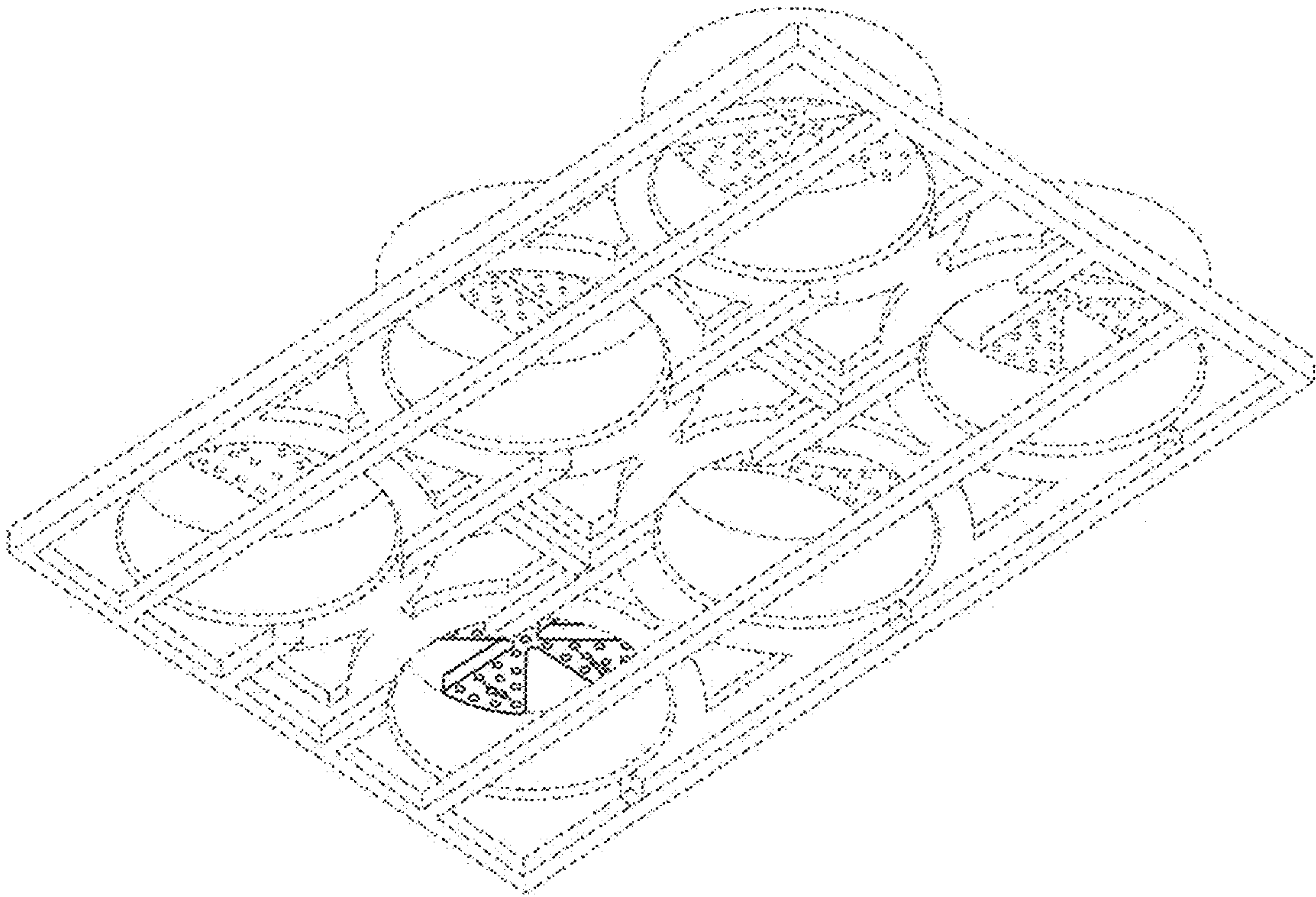


FIG. 4

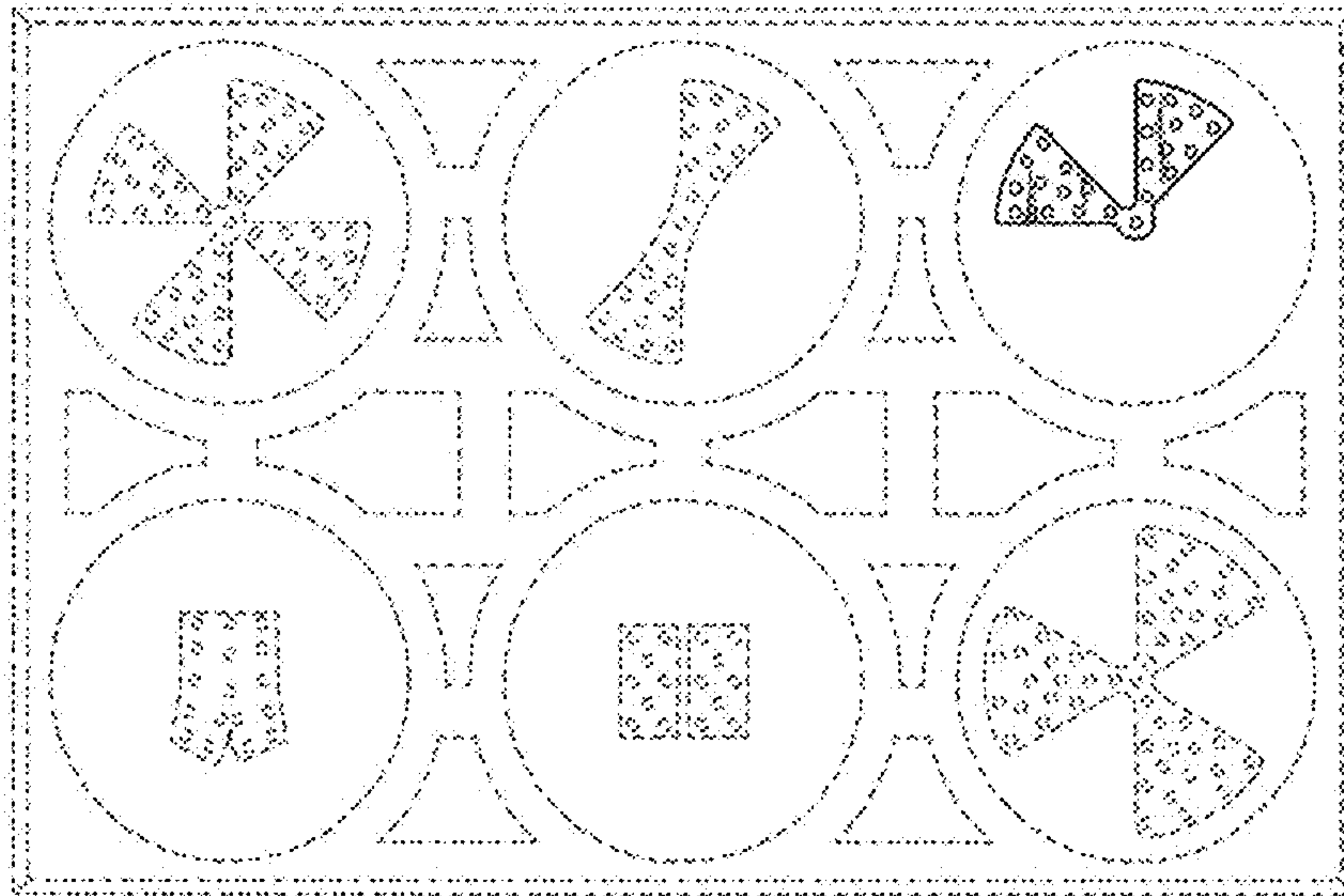


FIG. 5

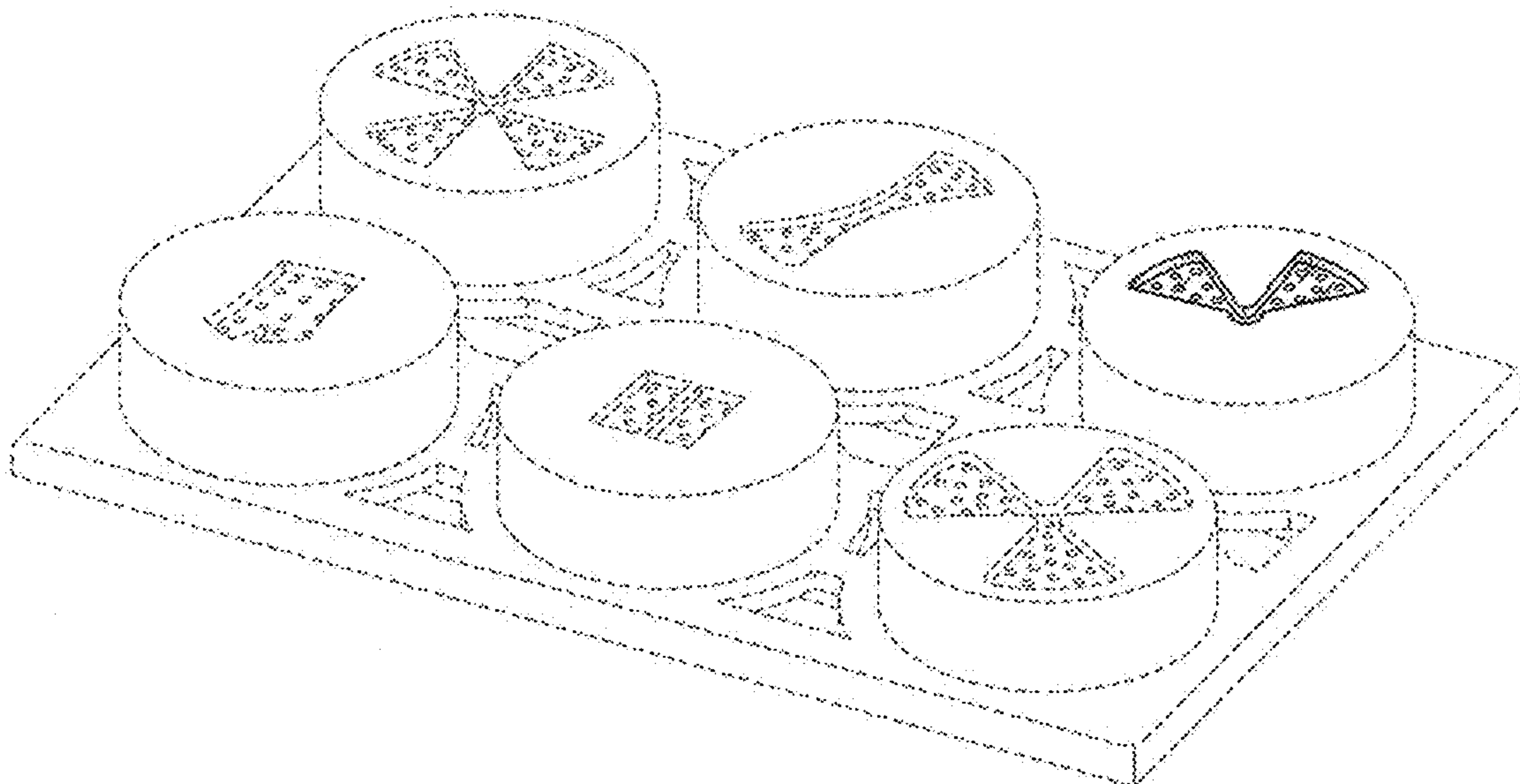


FIG. 6

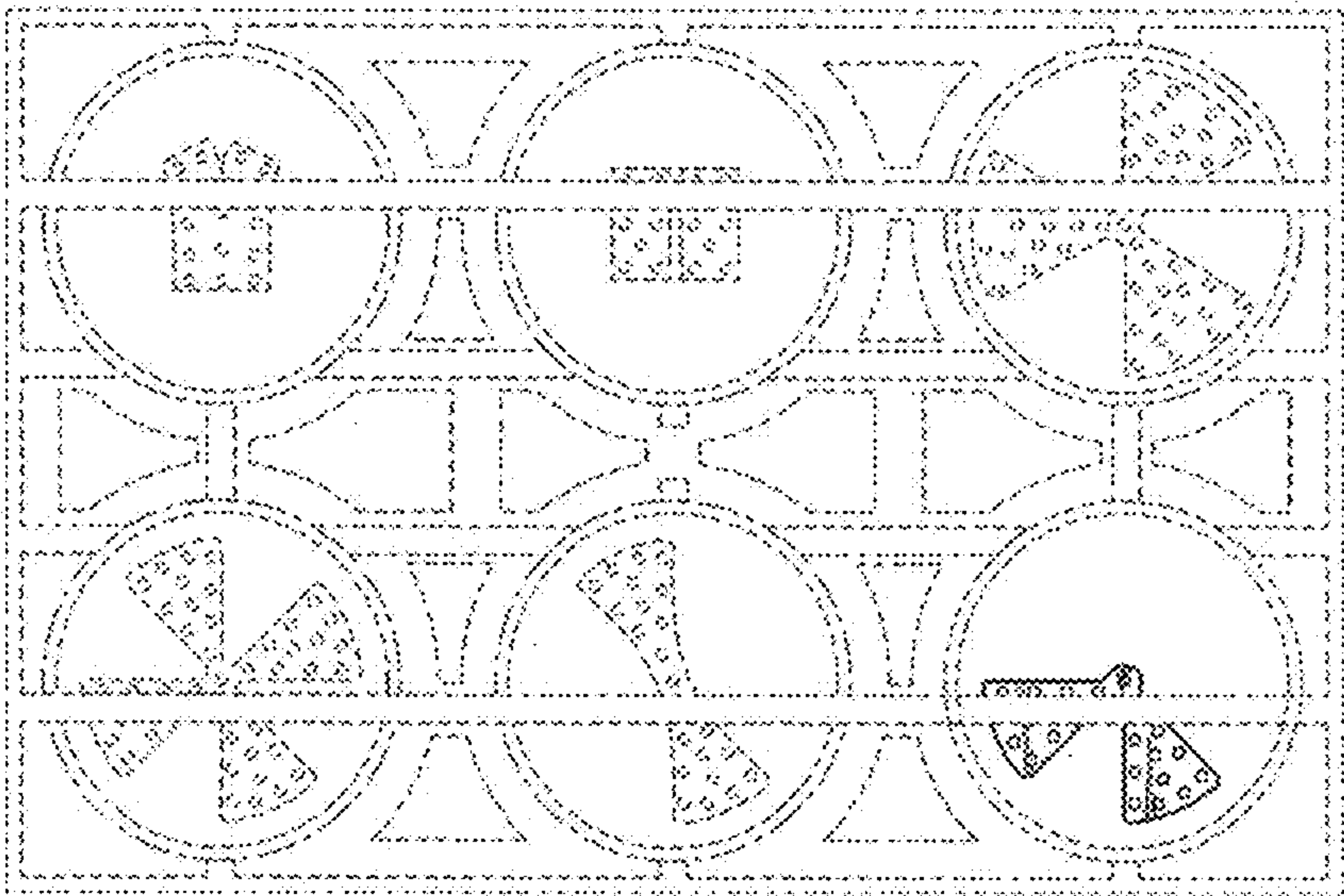


FIG. 7

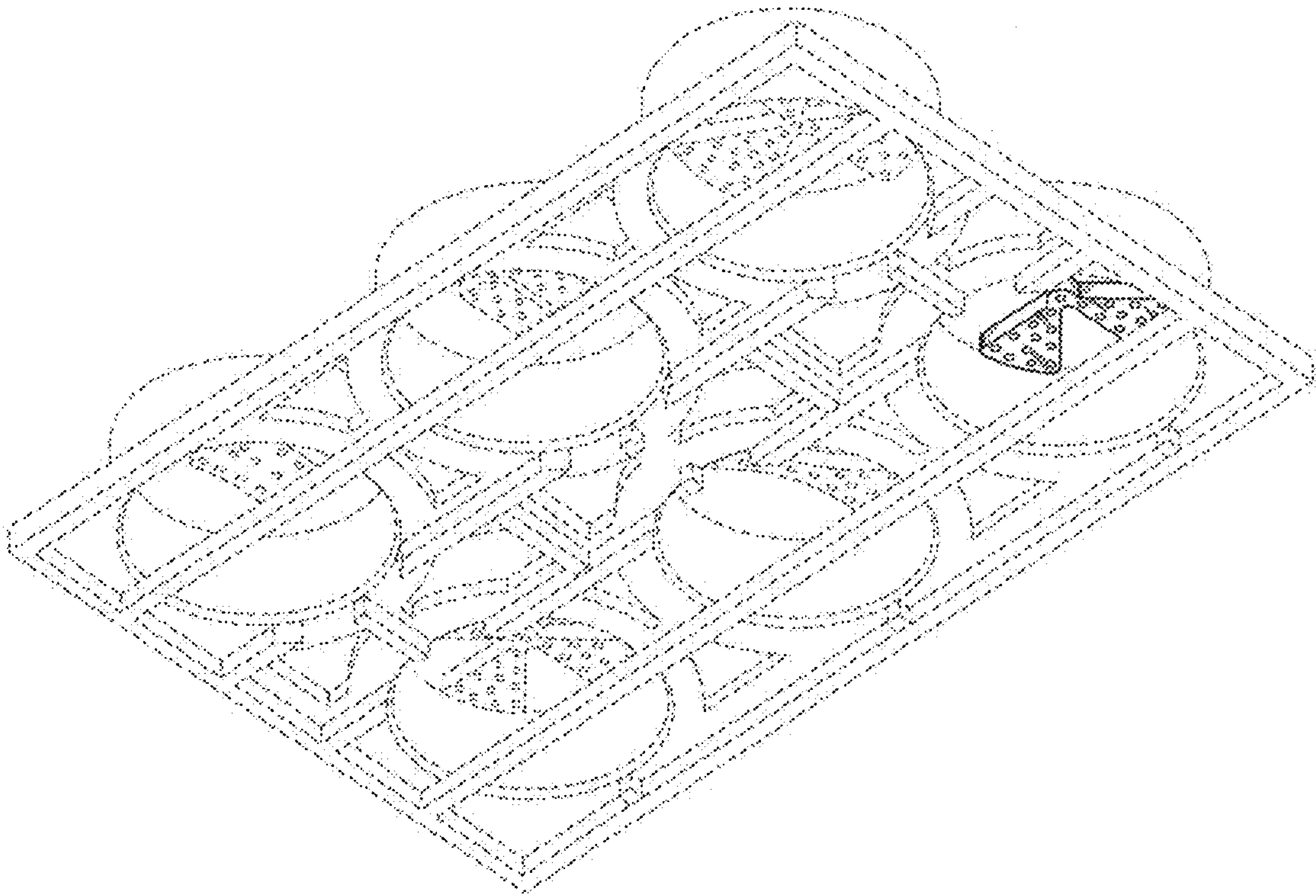


FIG. 8

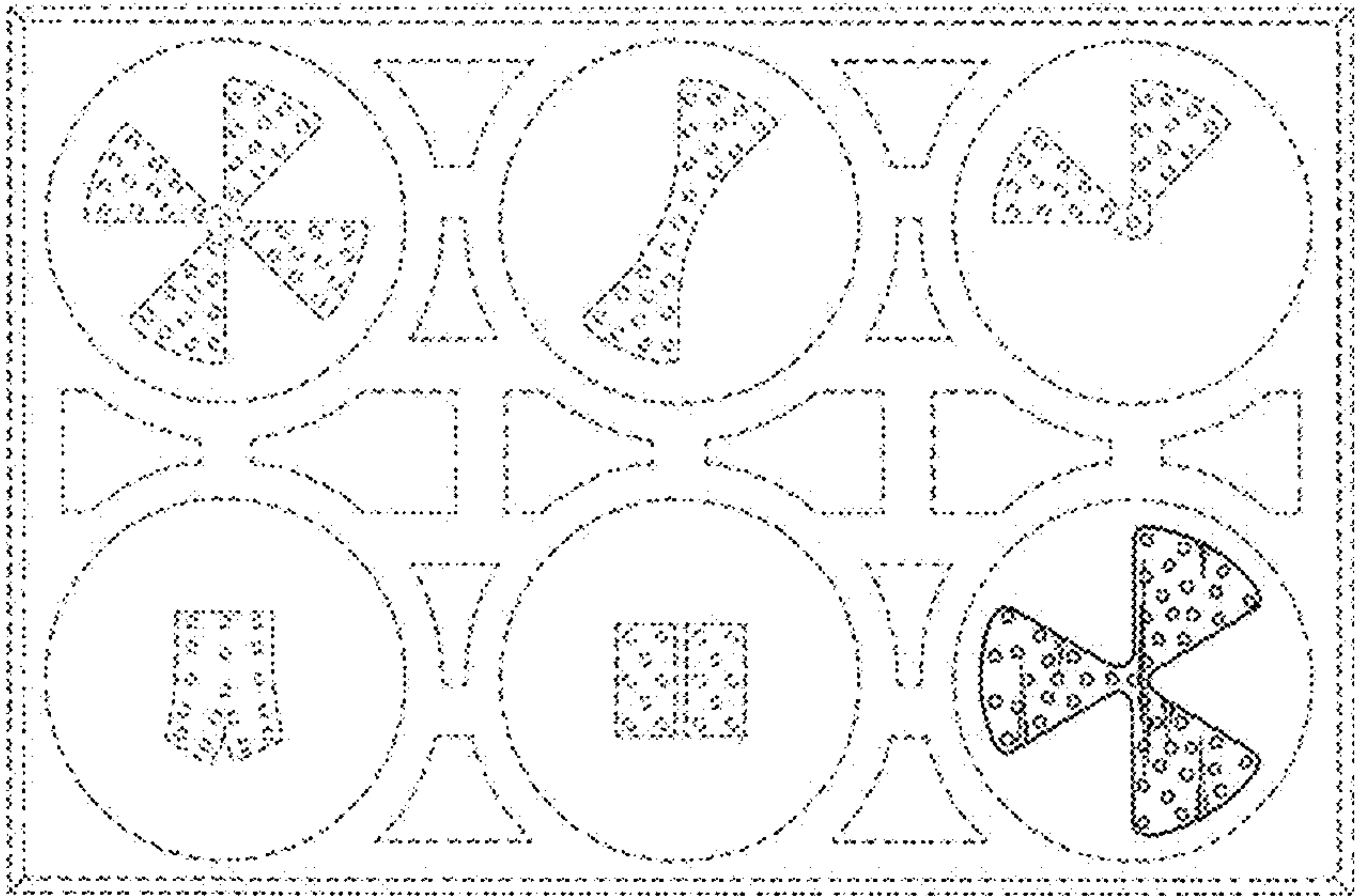


FIG. 9

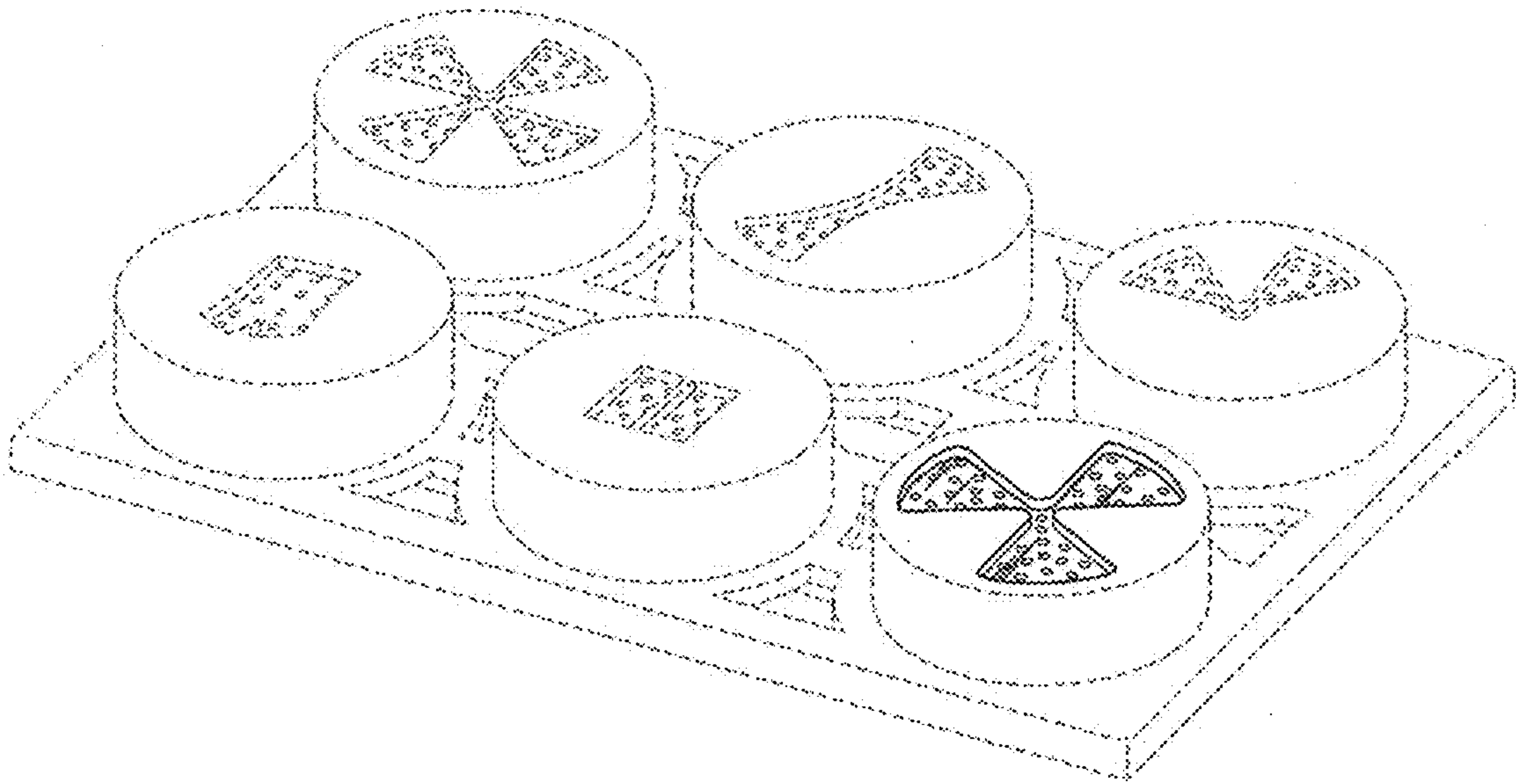


FIG. 10

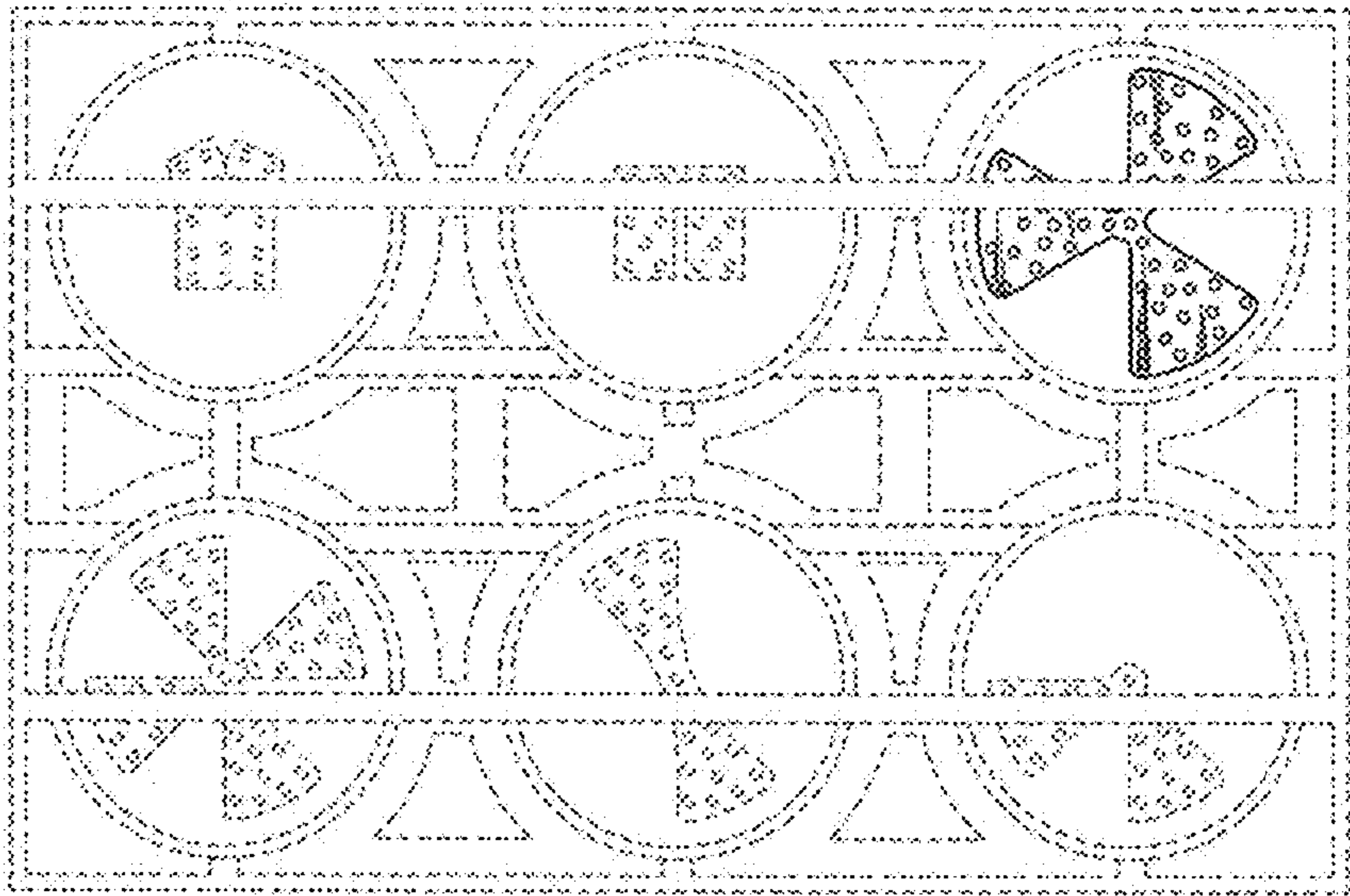


FIG. 11

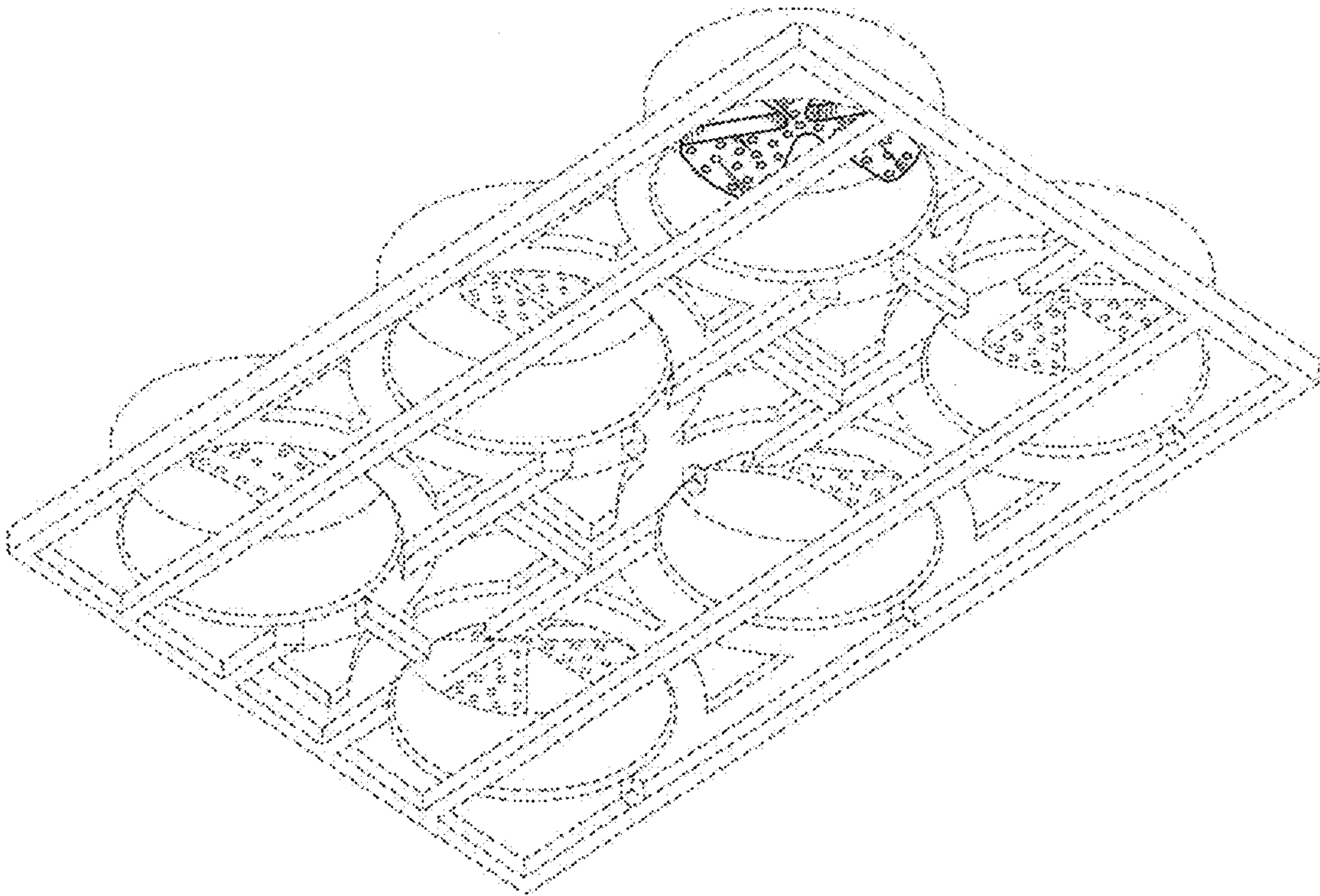


FIG. 12