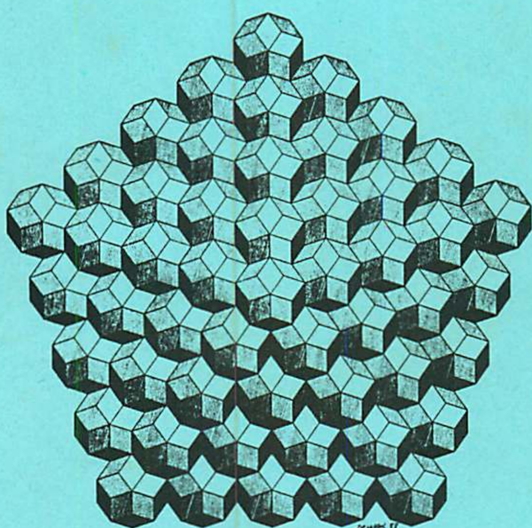
Symmetry of STRUCTURE

an interdisciplinary Symposium

Abstracts

I.



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On the world of forms of Wilhelm Ostwald

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1. Who was Wilhelm Ostwald?

From his curriculum vitae.

1853	September 2, born in Riga
1872-1875	Student of chemistry
1878	Doctor promotion at the age of 25 years
1881-1887	Full professor of chemistry at the Polytechnicum in Riga
1887-1906	Full professor of physical chemistry at the university of Leipzig
1906-1932	free working in Großbothen
1909	Nobel prize for chemistry for his investigation in catalysis

He wrote several widespreaded books. Some are devoted to his color theory. Beside his color theory he developed a theory of forms which has not been taken into account. We will analyse his world of forms.

2. The symmetry concept in Ostwald's approach to ornamentics (Ostwald pattern)

Still as a student he was interested in antique ornaments. In 1922 he published a procedure to get the most symmetrically plane filling pattern. The starting point is the point lattice of the trigonal or the quadratic or the hexagonal mosaic. The order of the point lattice dependes of the size of the edges.
Two types of Ostwald pattern can be built up for each of the 3 point lattices: reflection type and rotation type. We explain the procedure in modern mathematical language. Consider the symmetry group S of the fundamental pattern of order n or the rotation group R of the pattern.
Now Ostwald takes an arbitrary segment s joining any two chosen vertices. The Ostwald pattern composed by this "line of theme" s will be the orbit

$orb_S(s)$ resp. $orb_R(s)$ in the plane.

3. Ostwald pattern from a cristallographic point of view. Each Ostwald pattern has its symmetry group. This is one of the 17 Fedorov's Groups or wall paper groups. For the reflection type pattern there occur only the groups W_6^1 or W_4^1. (In the notation of the groups we follow [5]). For the rotation type pattern can be the groups W_6 or W_6^1 and W_4 or W_4^1.

4. Ostwald pattern generated by computer. The groups S and R are finitely generated. Therefore the Ostwald pattern can be given by a computer program.

5. How many Ostwald pattern there exist? Application of Polya's counting theory tells us the number of Ostwald pattern.

6. About Ostwald colored pattern. What are the symmetry groups? Many colored pattern could be found in the unpublished work of Ostwald. We will report on the answer to the mentioned question.

Literature

[1] Ostwald, W.: Die Harmonie der Formen. Leipzig 1922.

[2] Ostwald, W.: Die Welt der Formen. Entwicklung und Ordnung der gesetzlich-schönen Gebilde. (Mappen 1 u. 2) 1922, (Mappen 3 u. 4) 1923, 1925.

[3] Ostwald, W.: Unpublished papers. Zentralarchiv der Akademie der Wissenschaften DDR und Ostwald Gedenkstätte in Großbothen.

[4] Coxeter, H.S.M.: Unvergängliche Geometrie. Basel, Stuttgart 1963.

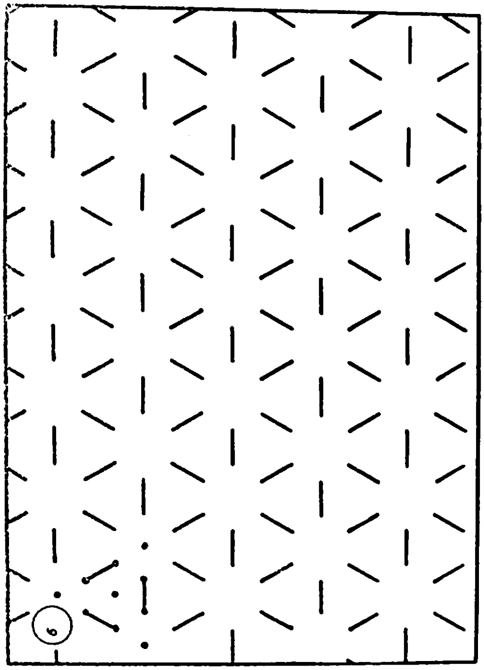
[5] Fejes Toth, L.: Reguläre Figuren. Leipzig 1965.

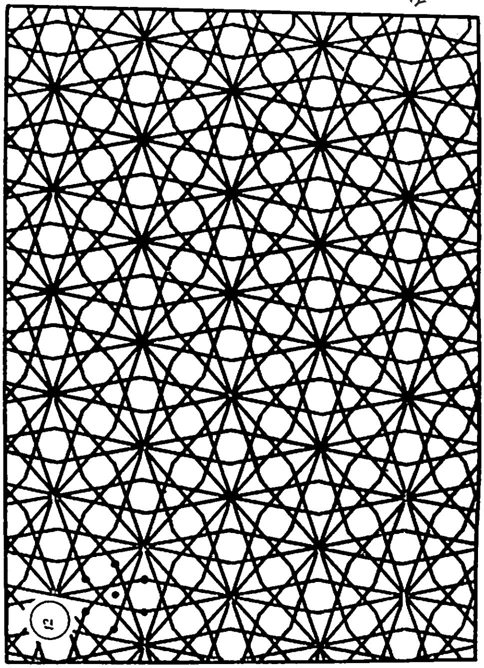
[6] Polya, G.: Über die Analogie der Kristallsymmetrie in der Ebene. Zeitschrift f. Kristallogr. 60, 1924.

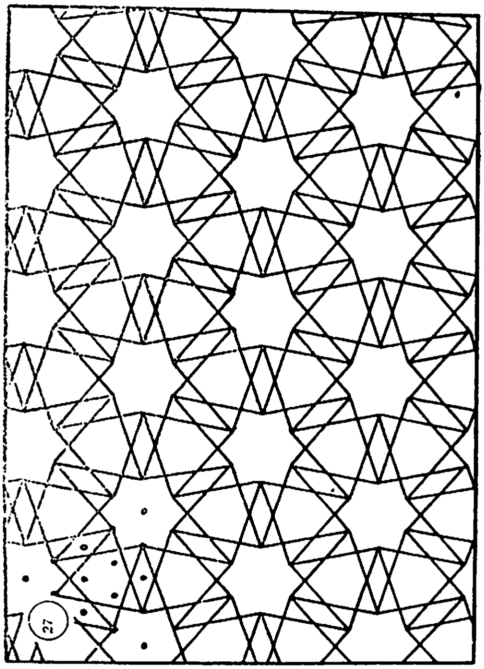
[7] Flachsmeyer, J.: Geometrische Aspekte der Formenwelt von Wilhelm Ostwald. Wissenschaftliche Beiträge der Ernst-Moritz-Arndt-Universität Greifswald, submitted.

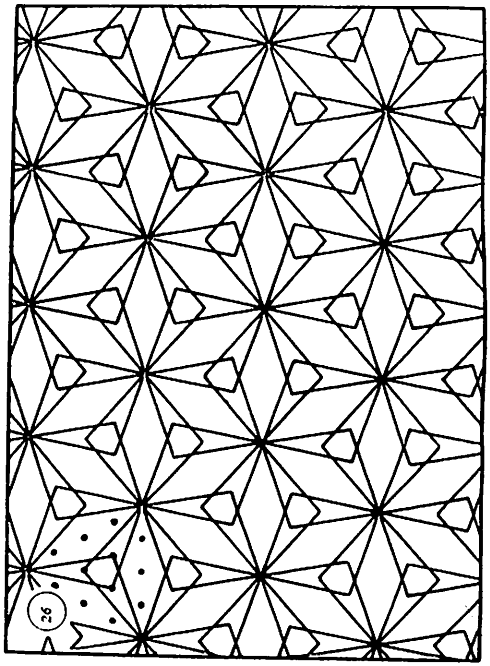
[8] Flachsmeyer, J.: Die geometrisch-ästhetische Formenwelt von Wilhelm Ostwald. Wissenschaft und Fortschritt 7, 1989.

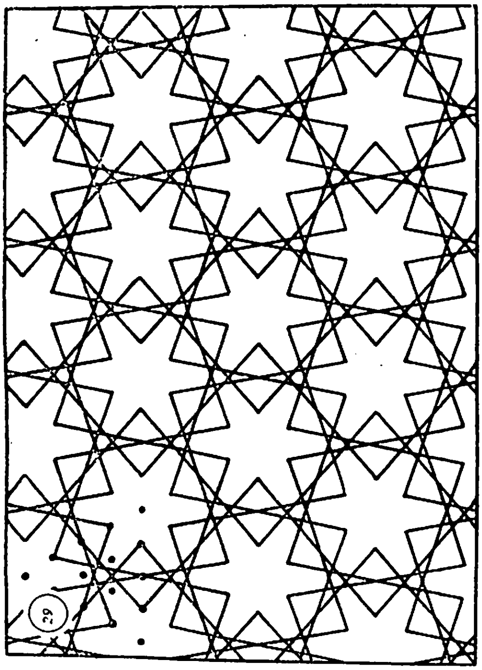
[9] Flachsmeyer, J.: Symmetrien Ostwaldscher Muster. Alpha, Heft 2, 1989.







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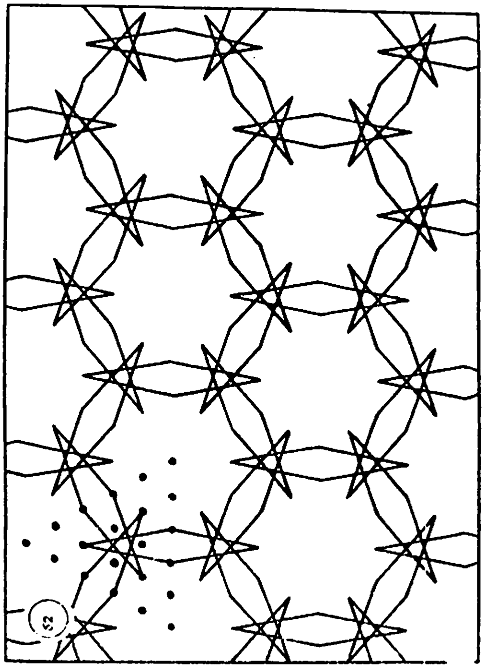
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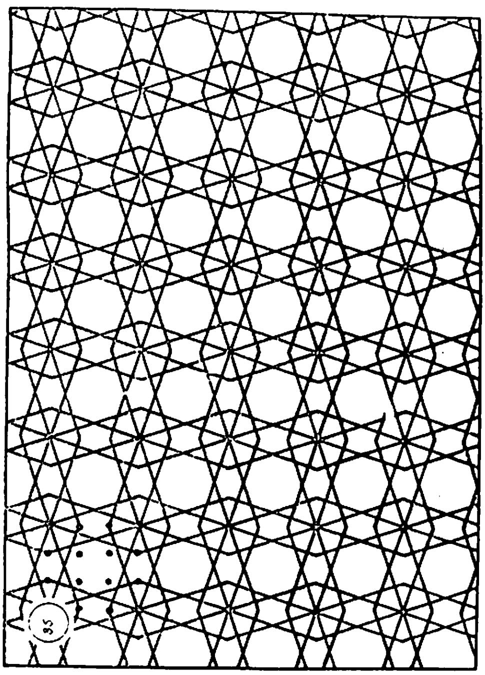
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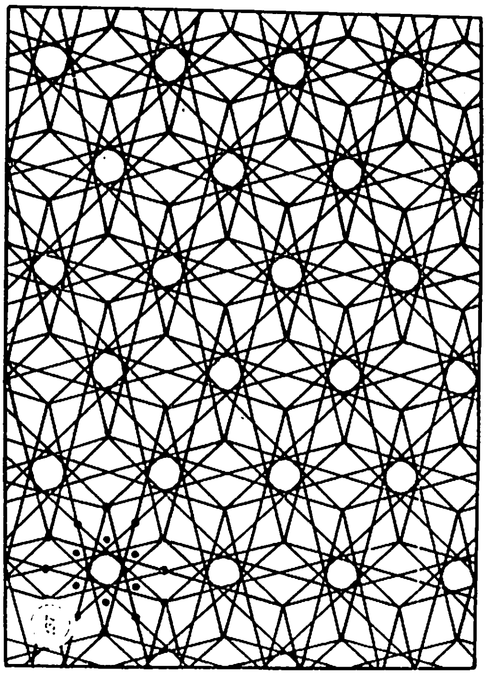
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DOME WITH CYLINDER VAULTS

Authors deal with a double-layers grid structure. A double layer grid structure has an external layer which constitutes a triangular grid and an external layer which is a triangular grid as well but with a four times greater number of triangles. The both layers are connected with stiffenig rods in such a manner that six rods converge in every vertex of the internal grid. These rods are connected, in turn, with six vertices of the hexagon external mother grid. The mother grid /fig.2/ is created from the triangular grid reduced to triangles and hexagons, in such a way, that every side of a triangle constitutes a common side with a hexagon, but neither triangles nor hexagons of this grid have common sides. The external grid is made from the icosahedron closed with twenty equilateral triangles in such position that the axis connecting the polyhedron opposite vertices is vertical. Let us draw an equilateral triangle on each face of the icosahedron, by connecting the sides centres. Those céntres are the apices of a semi-regular 32-hedron closed with 20 equilateral triangles and 12 regular pentagons. Drawing on each pentagon a regular pyramid with apex lying on a sphere described on a 32-hedron, we obtain an 80-hedron /fig.1/.

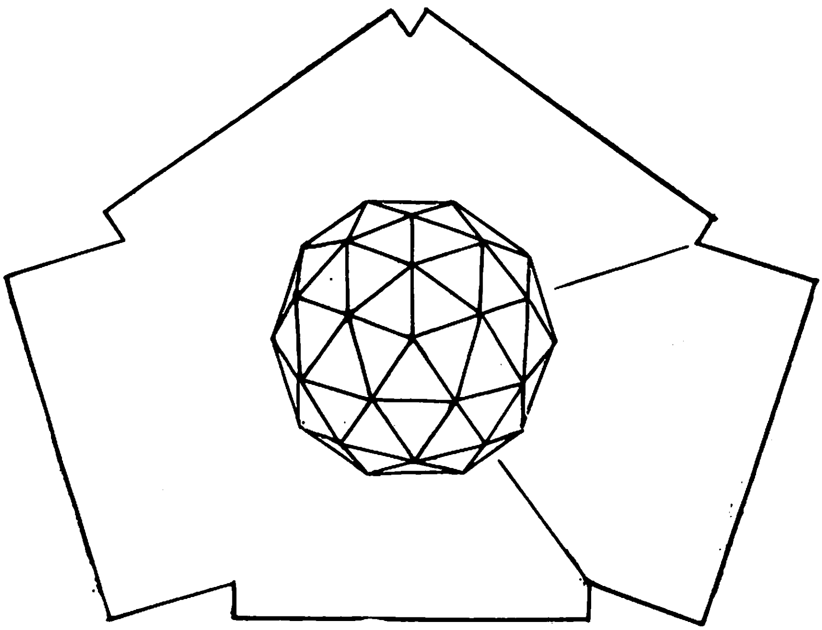

Fig.1

Let us consider a pyramid with a vertical height and pentagonal base, its five lateral faces constitute 1/16 part of an 80-hedron. The side of pyramid base measured in the angle between the radii of the 80-hedron sphere is 36°. The pyramid lateral side,measured in the same way, is equal to one half of the angle corresponding to icosahedron side i.e. 31°43'03". So the dome will be formed from five isosceles spherical triangles with bases equal to 36° and sides 31°43'03".

Let us now divide this spherical triangle into 400 spherical triangles. To do so we divide the triangle sides into 20 equal parts and we draw 19 big spherical circles, by corresponding points of division and by centre of the sphere. We divide these circles into 19, 18, 17, 16,... equal parts. So described grid apices are symmetrical collections of points with regards to the spherical triangle height. Thus, it is enough to take into consideration only one half of the spherical triangle. In this way we can fix position not only of the external spherical grid apices but also of the internal grid because every second apex will correspond to the internal grid apex and in this spherical triangle we obtain a four times smaller number of the internal grid triangles

At first let us designate angular coordinates of this collection of points. To calculate them we must find bases of the spherical grid triangles and their heights. Horizontal and vertical angular coordinates of the spherical grid apices are calculated on the respective tables. Having already angular coordinates,cartesian coordinates are calculated in tables for external and internal

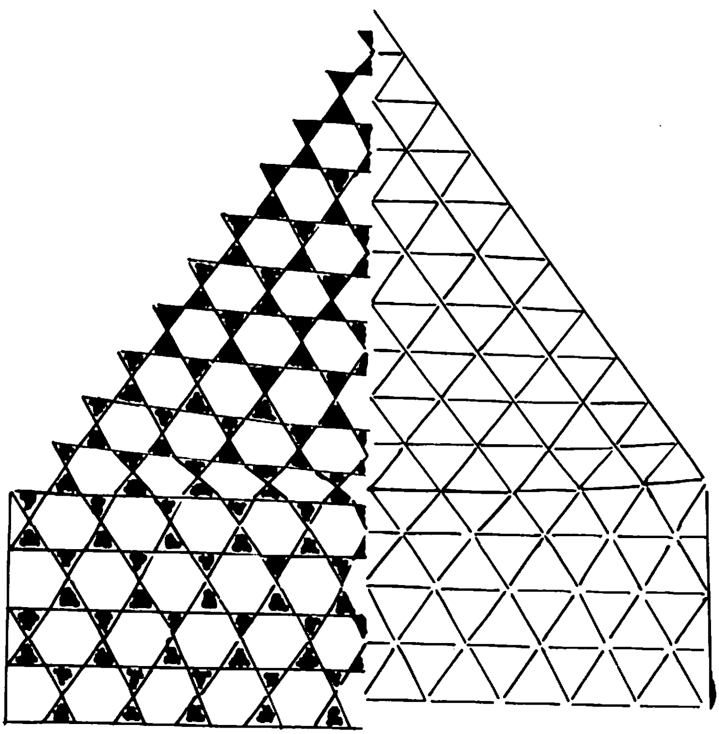

Fig.2

layer respectively. Thus we receive data to calculate length of the external and internal grid rods as well as rods connecting these two grids. These lengths are calculated on respective tables and are inscribed into the schemes of the 1/10 part of the dome. Grids on the cylinder vaults are designated in the following way. Let us consider one of the five arcs of the lowest circumference of the internal grid namely an isosceles triangle designated by points of support and the highest point of this arc. This triangle is leaned towards the level creating an acute angle. The base of this triangle is now the base of an isosceles vertical triangle with an apex having its ordinate equal to ordinate of the preceding triangle. Circumference circumscribed on this triangle is a cross section of the internal vault. The grid made of equilateral triangles is designed on the internal vault, taking as an example division of the lowest circumference of the spherical grid. Circumference having the same centre as the previous one but with radius longer respectively, being a cross section of the external vault depends also on the height of the highest apex of the external spherical grid lowest arc.
Analogically like in the equilateral grid, introducing additional meridians to the external vault we get an external isosceles grid with a four times greater number of triangles having a common axis with the internal grid. Then we calculate rectangular coordinates and lenghts of rods on the respective tables. Lenghts of rods are presented on schemes of 1/10 part of the structure.