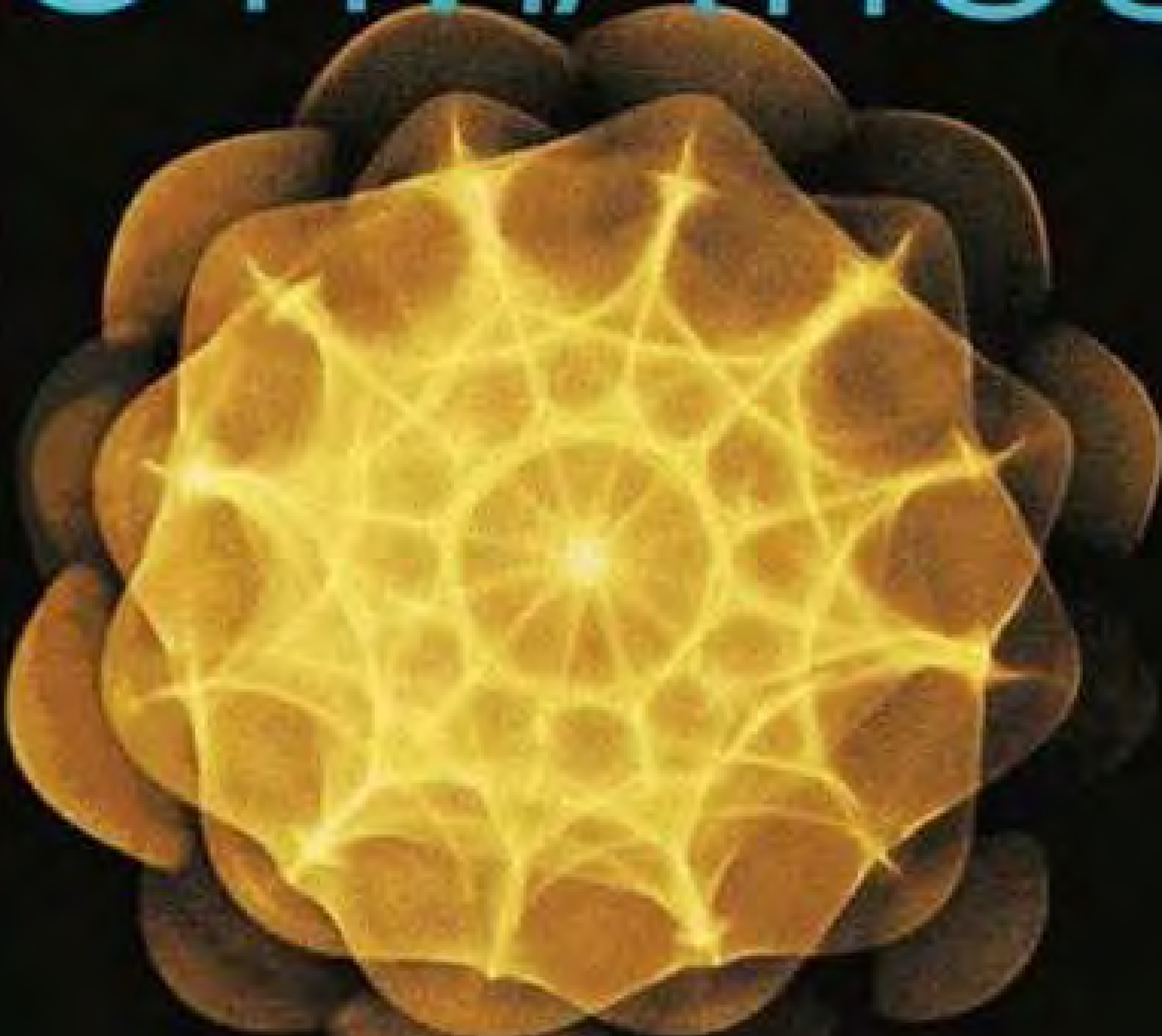
CYMATICS



Hans Jenny

CYMATICS

A Study of Wave Phenomena and Vibration

A complete compilation of the original two volumes by Hans Jenny.

Volume 1, 1967
The structure and dynamics of waves and vibrations.

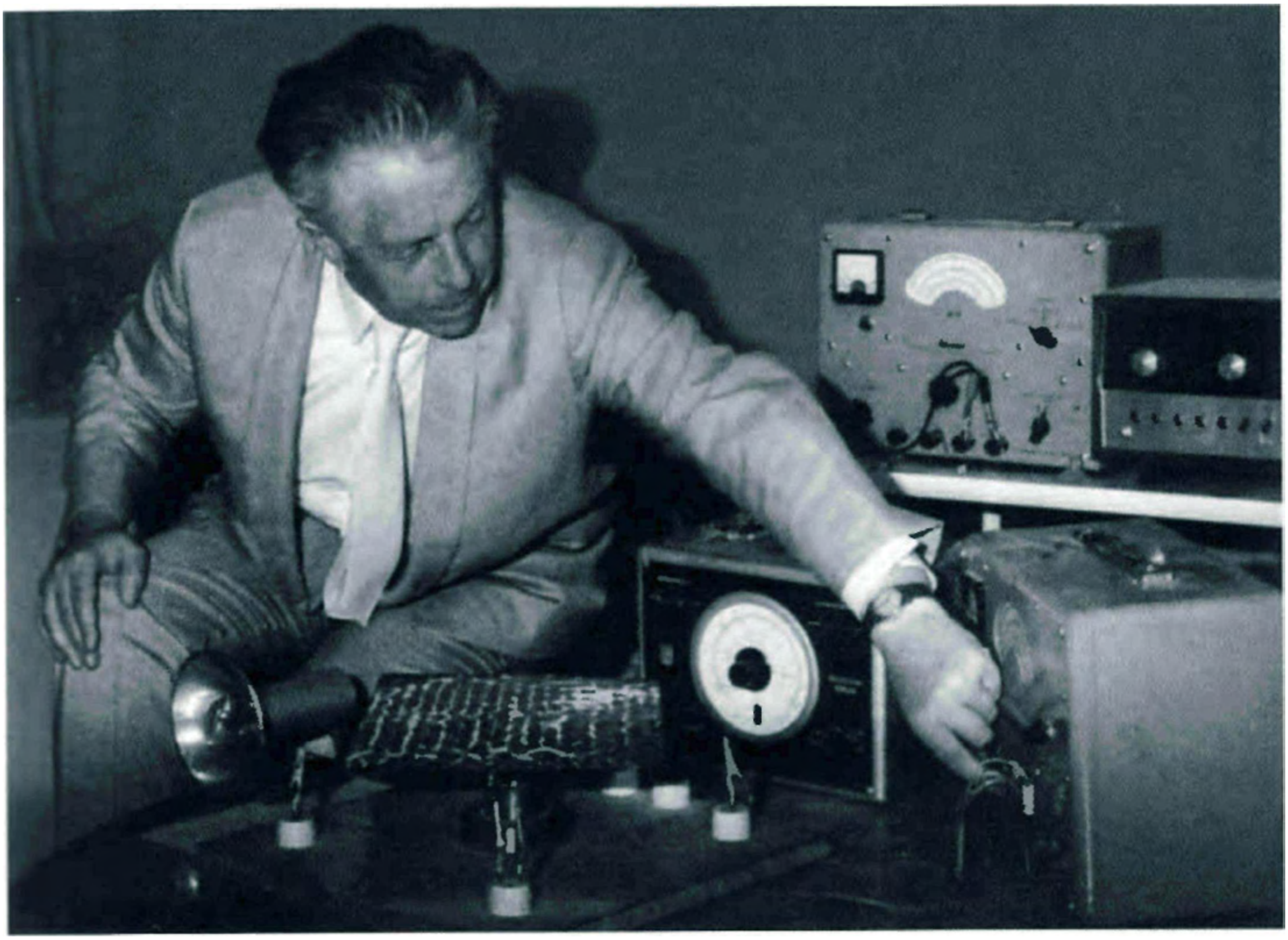
Volume 2, 1974
Wave phenomena, vibrational effects and harmonic oscillations
with their structure, kinetics and dynamics.

Dedicated to the memory and research of Rudolf Steiner

Dedication: Revised Edition, 2001

With gratitute to Maria and Ea Jenny, A. Koster, and especially Max Savin.

To the Sound which unifies all phenomena, generating the vast world of form in its "triadic" nature.



Hans Jenny (1904-1972)

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Publisher's Confession

Although I never met him, I hold Dr. Jenny in the highest esteem — so please don't expect these introductory notes to be as objective as were his experiments! My purpose in re-publishing these two volumes, which document his meticulous research into oscillation and its various manifestations, is to make sure that Hans Jenny's unique perspective does not fade into obscurity.

One might well ask "what's so fascinating about watching a bunch of pastes, powders and liquids being bounced, prodded and jiggled around?" And why has interest in this obscure branch of phenomenology continued to grow even though the books have long since gone out of print, the publisher gone out of business, and the author passed away nearly thirty years ago!?!

As you will see in these pages, not only was Dr. Jenny uncompromising in his methodology, but also in his discipline of always inquiring anew, of maintaining his "questing eye" unconstrained by doctrine, scientific or otherwise. A keen observer whose hawk-like intensity of focus was unclouded by the need to prove a theory, he, like Goethe whom he so greatly admired, learned by "pure observation" of Nature. This was not a technique, but an essential aspect of his character. Further insights into this remarkable man are provided in the Foreword by his long-time friend and associate, Christiaan Stuten.

Because Jenny's experiments were so thorough and exacting, and so well documented, this body of work, which he named Cymatics after the Greek ta kymatika, "matters pertaining to waves," could easily be applied to other fields. In fact, the principle underlying Cymatics, that of periodicity, is so ubiquitous in nature (and in Nature), that it is found in all manner of phenomena.

So here we have documentation of the highest caliber, of one of the most fundamental phenomena of matter — vibration, or from the perspective of the life sciences, pulsation. Relevance to the medical profession is obvious, as all physiological processes exhibit this quality of periodicity. It is for this reason that I have included a commentary by John Beaulieu, N.D., Ph.D., which relates the relevance of Cymatics to the field of vibrational medicine.

Personally, I am grateful to have had this opportunity to prepare these works for re-publication. What a gift it has been to pore over both volumes word by word, correcting misprints and searching for the perfect nuance to convey the intended meaning in what was sometimes overly complex syntax, or perhaps a little-too-literal translation from the original German. It is more than a bit ironic that over the past 15 years or so, I have sold thousands of the Cymatics books (Vol. II), and this without ever having read the book in its entirety!

It was 1983 when I got my first glimpse into the world of Cymatics, My introduction came via a video clip of one of the films which Dr. Jenny had made documenting some of the very experiments detailed in this volume. Even though this video was barely legible, I was immediately awestruck. I was particularly fascinated by one astonishing image of what appeared to be a snake, slowly undulating on screen, but stripped right down to its vertebrae. What was so amazing was that this was neither a reptile, nor was it even alive. What I was witnessing was a small pool of glycerin being "animated" by sound! The imaginary snake was actually light reflecting off a series of wave trains creating this delicate, flowing form in the vibrating liquid.

There were other images which mirrored biological forms and natural processes, as well as flowers, mandalas and intricate geometric designs — all this the result of audible vibration. These experiments seemed to reveal the hidden nature of creation, to lay bare the very principle through which matter coalesces into form.

It is no wonder to me that today, Dr. Jenny's experiments with cymatics are finding a wider and more enthusiastic audience than ever before. It is easy to look at the pictures, read a few captions, and let the imagination run witd. This is one approach that I know well. But there is also much to be gained in really studying the principles which underlie this body of exploration, and in contemplating what might well be Dr. Jenny's greatest legacy: that while the phenomenal world has much to teach, one must strive to penetrate the surface level of appearance, and not be too quick to judge as "cause" that which is merely "effect".

Jeff Volk, January, 2001
Newmarket, New Hampshire, USA

We are slaves to what we do not know, and of what we do know, we are masters,
- Sri Gary Olsen

A Commentary on Cymatics

John Beaulieu, N.D., Ph.D.

The purpose of this commentary is to inspire you to take the time to actually read this book — to devote the necessary attention to develop an understanding and respect for Dr. Jenny's profound scientific perspective. This takes some deliberate and focused concentration, but in even flipping through these pages you will quickly see that the experiments portrayed herein, as well as Dr. Jennys depth and breadth of understanding, more than merit the effort!

I also wish to acknowledge the enormous contribution which Dr. Jenny has made to the emerging fields of "Sound Healing" and "Energy Medicine." Although he was a medical doctor, it was never his intention that this work be applied therapeutically. Rather, he wished to demonstrate the primacy of vibration and its ever-present effects throughout the entirety of nature. Through his painstaking experimentation and acute observation, he was able to articulate a conceptual basis which may very well prove fundamental throughout the broad reach of scientific endeavor.

I first became aware of Dr. Jenny's work in 1974 when I was working at Bellevue Psychiatric Hospital in New York City as Supervisor of Music Therapy. A fellow therapist placed a copy of Cymatics, Vol. I on my desk. I remember the joy of looking at the cymatic sound patterns, and the wonderful sense of "Yes!" that rippled through my being. Each picture was worth at least a thousand words and I felt as though I were reading volumes in just a few minutes.

As I read the Cymatics book. I realized that Dr. Jenny was a dedicated systems researcher and I found his writing just as exciting as the cymatic images! My graduate studies and work at Bellevue Hospital were based on applied systems theory. I also studied mathematical music composition with Innas Xenakis and a systems approach to therapeutic program planning. I will say more about Dr. Jenny's systems approach later.

Having shared and taught Cymatics for over twenty five years I know that many who are attracted to Dr. Jenny's work are artistic and "right brain" by nature. They are immediately inspired by the beauty of his cymatic pictures and can sense instantly what they mean. Using their imaginative capacities; they are able to extrapolate broad implications to his research.

Yet Dr. Jenny's writings are pure "left brain" science. He sets forth a thorough phenomenological study of vibration befitting an accomplished physicist and systems researcher. From a scientific perspective Dr. Jenny's written words form a beautiful mosaic which is just as profound as his cymatic pictures. His cymatic writings are embedded in rigor and clarity and supported by exacting methodology and procedure. He is constantly seeking to observe the integrity of the whole, and to document its behavior through phenomenological categories.

I remember when I first showed Dr. Jenny's work to a group of New York composers and musicians. I started by explaining how the pictures were made, in about two minutes, which was their right brain theory time limit before they became restless. Next, we viewed slides of cymatic photographs. Everyone said words like "wow", "far out", "yeah", "ummm". After the presentation I asked for questions. Everyone just sat there in what I took to be an appreciative silence. No one had any questions, and then they went home.

This was my first "Music and Sound in the Healing Arts" class and I didn't know what to think, so I just went along with the energy. To my surprise I came home to an answering machine filled with questions. I continued to get questions for the rest of the week, and to this day I occasionally get questions about Dr. Jenny's work from students of that very class! Sooner or later the other side of our brain says "what about me?" and wants to know. So twenty-five years of hearing "wows" followed by "hows" has inspired me to write this commentary.

It is my intention to attempt to communicate the essence of Dr. Jenny's work based on years of "right brain-students' questions. I am not seeking scientific precision. If you are scientific by nature and want science, I suggest that you dive right into Dr. Jenny's research. My goal is to heip artists and creative people not versed in science and systems theory to come to a better understanding of this material. Through this understanding, it is my hope that they will have an even greater and more balanced appreciation of what Dr. Jenny has given us.

Dr. Jenny's Cymatic Experiments

Dr. Jenny performed many of his experiments by putting substances such as sand, fluids, and powders on a metal plate. The plate was attached to an oscillator and the oscillator was controlled by a frequency generator capable of producing a broad range of vibrations. Through turning a dial on the frequency generator Dr. Jenny would cause the plate to vibrate at different frequencies. (See photo of Dr. Jenny at work, on page 6.) Let me explain.

Oscillators are devices which produce vibrations. They are often called "vibrators" in the popular market place. A massage device is a simple oscillator. Imagine any popular electric massage device or go to most any department store and ask to see their massagers. Turn it on and it will vibrate or oscillate. Next place the massager on a bone. Feel how the vibrations are amplified over your body. Touching the rnassager to your bone is like Dr. Jenny attaching his oscillator to a metal plate. The plate, like your bones, amplifies the vibrations of the oscillator.

A simple massage device creates only one vibration which can be heard as a hum. The hum you hear with your ears and vibration you feel from the massager are the same. In contrast to a massage device which is capable of only one vibration/sound, Dr. Jenny's oscillator hooked to a frequency generator was capable of thousands of different vibrations/sounds.

Dr. Jenny could turn a dial and instantly change the vibrations moving through the plate. He could observe the effect of different vibrations on different substances. When Dr. Jenny watched the sand or other substances on the metal plate organize into different patterns, he could also hear the sound produced by the oscillator. If he were to lightly touch the plate he would feel the vibration in his fingertips.

Dr. Jenny observed three fundamental principles at work in the vibratory field on the plate. He wrote, "Since the various aspects of these phenomena are due to vibration, we are confronted with a spectrum which reveals a patterned, figurative formation at one pole and kinetic-dynamic processes at the other, the whole being generated and sustained by its essential periodicity."

What Dr. Jenny is saying is that one can hear the sound as a wave; he calls this the pole of kinetic-dynamic process. One can see the pattern the sound creates in the plate; he calls this the pole of "patterned-figurative formation". And if Dr. Jenny were to touch the plate and feel it's vibration, he would call this the generating pole of "essential periodicicity".

[Editor's Note: Although the example given here involves three of our senses, Dr. Jenny stated that his objective was to make these effects visible, since our sense of sight is the most discriminating. He was emphatic that this "triadic nature" of vibration referenced above, comprised three essential aspects, or three ways of viewing, a unitary phenomenon.]

Dr. Jenny's Scientific Approach

Systems Theory unites science and art in a quest for holistic vision. It is a discipline where objectivity and intuition meet, for one can not see the whole without this kind of vision. Dr. Jenny always sought to observe the whole and to understand the behavior of parts in relationship to the whole. He says, "What is the status of the parts, the details, the single pieces, the fragments? In the vibrational field it can be shown that every part is, in the true sense, implicated in the whole."

A basic systems law is that the whole is greater then the sum total of its parts. A common metaphor used to illustrate this systems law is that of a team of scientists studying an elephant. The problem is that the scientists have no idea they are working on an elephant. One scientist is measuring the behavior of the foot, another scientist is measuring the velocity in which the tail wags, and another is observing the chemical composition of one toenail, etc. These views are fragmented. Each is one publishing separate papers in prestigious scientific journals in different disciplines, yet they have no idea that their work is remotely related.

One day a scientist comes along and accidentally "sees" the whole. She calls the whole an "elephant". She sees the relationship of the parts to the whole and how they move together. Everyone thinks she is crazy and the specialists begin to fight over her idea of an "elephant". More and more people begin to see "the elephant" until one day "there is an elephant" and many isolated areas of research are explained in a larger context.

Throughout his writings Dr. Jenny is always requesting that we focus on the whole and not get distracted by the behavior of the parts. "The three fields, the periodic as the fundamental field with the two poles of figure and dynamic, invariably appear as one. They are inconceivable without each other. It is quite out of the question to take away the one or the other; nothing can be abstracted without the whole ceasing to exist. We cannot therefore number them one, two, three, but can only say they are threefold in appearance and yet unitary; that they appear as one and yet are threefold."

Cymatics and "Vibrational Medicine"

Cymatics research is a "sound" example of the principles underlying vibrational medicine. If you were to be present during a cymatics experiment you would hear a sound and simultaneously see a pattern forming in a substance which had been placed on a vibrating membrane or perhaps a steel plate. What started out as an inert "blob" of sand or water, without movement, form, or pulse, would instantly transform into an animated, pulsating form as soon as the plate or membrane was excited by vibration. All this would be generated by the vibrational field created by the oscillator.

Now let us assume that for some reason you could only "see" the static aspect of the form and therefore understood it to be solid. The idea of the form being generated by a vibrational field and making a sound would seem preposterous. Now let's imagine that someone unknowingly brushes the sand on the plate and the shape is disturbed, but then in a matter of a few seconds it returns to its original shape. How would you explain it?

The above example illustrates the basic differences between conventional, materialistic medicine and energetic healing. Let me explain. "Energy medicine" seeks to understand people as unified energy fields or in Dr. Jenny's words, "as wholes". Metaphorically, our physical body, emotions, and thought processes are like cymatic forms which are organized by underlying vibrational fields, the densest (the physical), being animated by the subtler vibrations (emotions and thoughts).

In energy medicine, the underlying vibrational field is called an energy field. The health practitioner seeks to perceive, evaluate, and support the energy field rather than focus on a specific symptom. The practitioner's goal is to use therapeutic modalities such as music, sound, touch, homeopathics, acupuncture, tuning forks, voice, and color, to effect and change the energy field. As the person shifts into resonance with a more coherent field, their array of symptoms may disappear as a more harmonious pattern emerges.

The idea of energy fields is both new and ancient. Physicists have sought to explain the strange behavior of quantum particles through the existence of a unified field. "We may therefore regard matter as being constituted by the regions of Space in which the field is extremely intense....There is no place in this new kind of physics both for the field and matter, for the field is the only reality." (Albert Einstein)

Dr. Jenny used phenomenology and systems theory as research vehicles to observe the effects of whole vibrational fields. He wanted students of Cymatics to understand that the phenomena witnessed on the vibrating surface were always the product of a larger field, and that any change in the frequency of the vibrational field would immediately alter the phenomena being observed.

In the latter chapters of Cymatics, Vol. II, Dr. Jenny sought to illustrate a connection between cymatic vibrational fields and the behaviors of biological, weather and social systems. I believe that Dr. Jenny was not saying that Cymatics was the cause — rather he was saying "look at the whole and you will come to new understandings. Let these cymatic experiments inspire your imagination to deeper insights into the universal principles of Nature."

The current environment within the healing arts is one of specialization and compartmentalization. In contrast, energy medicine takes a more generalized approach to healing, based on the understanding of energy fields. When the energy medicine practitioner evaluates the energy field, he/she can recommend "vibrational therapies" such as music, sounds, movements, colors, etc., to support a shift in the field. The result will be a new energetic field in which the old symptoms can no longer exist.

This is a "transformation" as opposed to "fixing a part." The old energy field will still be available, yet we will now have developed the ability to shift into a newfield. Ultimately we learn that we have the freedom to create and choose different fields. Ideally we would find ourselves in a continuum of fields, always observing and entering into a greater whole, a greater experience of wholeness!

As I mentioned before, a fundamental tenet of systems theory is that "the whole is greater then the sum total of its parts." Observation of the "whole picture" is a discipline to which Dr. Jenny dedicated himself, as documented in Cymatics, Vols. I and II, We can learn from his dedication. We can be inspired to see ourselves as "wholes" with the capability to shift into different vibrational fields at any time. Cymatics, from its widest purview, ultimately teaches us that we are limitless beings with immense creative and healing powers. Dr Jenny exhibited this in his own life — may you be so moved to experience this yourself, as you explore the vast implications of his work.

Foreword by Christiaan Stuten

As a life-long friend of Dr. Jenny, until his death in 1972, including 14 years assisting him with the fascinating experiments portrayed in these pages, it is with great joy that I introduce this combined edition of his two books on Cymatics, the study of wave formations. Hans Jenny was indeed a Renaissance man, his diverse callings woven together by his dynamic personality which was characterized by great intensity and a profound sense of competency in all thai he undertook.

As a youngster, his affinity for music and skill at the piano made a career in music seem likely. His father held various positions in the evangelical church, and throughout grammar school Hans would play organ for church services. His tastes, however, were as broad as his talents and he was equally at ease improvising jazz as performing a piano sonata. His musical aptitude overshadowed an indifference for church religion, although he did gain a thorough knowledge of the bible during this time. He also developed a life-long interest, and formidable command of both classical and modem history, as well as becoming proficient in Greek and Latin.

His love of the arts was evidenced by continuous study of the works of Leonardo da Vinci and Raphael, music through the works of Mozart and Wagner (as well as jazz), and philosophy via Plato, Aristotle, Heraclitus and Nietsche. The scientific approach of Goethe was also a powerful influence upon him. He was a tireless observer of the natural world, especially animals. In later life, as a scientist and lecturer his travels took him all over the world, and he never missed an opportunity to visit zoological gardens, whether in his hometown of Basel, Switzerland, or in some distant city. He loved to travel, and had an insatiable desire to really "know" the places he would visit. Two of his favorites were the Engardin in the town of St. Maurice in the Swiss Alps, and, quite appropriately, the town of Florence, Italy, which, in its day, was the center of the Renaissance.

He was a most entertaining man whose sharp wit was tempered with heartfelt compassion. This was to serve him greatly in what was to become his primary profession as a family physician in the village of Dornach. His practice spanned more than 30 years and ranged from making "house calls" to local farmers {occasionally even treating their animals), to seeing prominent socialites at his clinic in the nearby city of Basel. With his breadth of interest, sense of humor, and his positively magnetic personality, he could quickly develop rapport with just about anyone, and his vibrancy was so infectious that no sooner did he enter the room than his patients would feel better!

One of his most prized possessions was a pair of binoculars which his father had given him as a boy. Though nothing fancy, he always carried them with him on his many sojourns around the world. His keen eyes, schooled in the Goethean mode of observing nature, were his primary tools in his relentless pursuit of the hidden laws of life. His acute perceptivity was already evident as a schoolboy when he would go on ornithological excursions in the Swiss countryside outside of Basel. He quickly learned to recognize and identify every bird in the vicinity by both its appearance and its call! Since early childhood he had liked to draw and to paint, primarily animals and their environs. This "hobby"' grew to become an absolute inner necessity for him throughout his later life.

He painted with oils on canvas, and also on composition board, the latter being larger images often 3' x 5' or greater. He never copied nature. Rather he would absorb impressions whose motifs would then gestate within him, sometimes for years, until they emerged in a controlled explosion of creativity, color and form. Even these larger works seldom took more than an hour or two for him to complete.

Executed in a vital, expressive manner unique in the realm of "animal portraiture," his paintings captured the soul of the animal while at the same time reflecting powerful archetypes within the psyche of man. The resulting body of over two thousand paintings firmly established Jenny as a fine artist with numerous exhibits throughout Europe and as far afield as Argentina.*

It was on one of these ornithological excursions bicycling in the hills overlooking the Birs Valley near Dornach, that the 14 year-old's gaze fell upon the first Goetheanum, a unique and impressive wooden structure built under the inspiration and direction of Rudolf Steiner. The lad was fascinated by the twin-lobed structure, and as late would have it, a short time later he accompanied his parents and a small group of educators and public officials on a guided tour of what was to become the locus of Anthroposophical teaching — a tour led by none other than Rudolf Steiner himself!

Thus began his study of Anthroposophy, a spiritual science with which he found particular affinity. As with his earlier experience with religion, he didn't always relate well with "Anthroposophists", but he greatly admired Steiner and read an enormous amount of his extensive writings. It was Steiner, with his emphasis on the super-sensible spiritual dimension of life, who was to influence Jenny most profoundly, providing direction for his insatiable curiosity and a framework for his own inner strivings.

Not surprisingly, Jenny proved a good student, and was already giving lectures on Anthroposophy before he had even finished medical school. After completing his doctorate he taught science at the Rudolf Steiner School in Zurich for four years before beginning his medical practice. And even with a bustling practice, he still found time to keep up with the latest advances in the natural sciences, to travel and lecture, and of course, to experiment in a whole new field of science, Cymatics!

Dr. Jenny would frequently begin his lectures stating that he hoped that his research into Cymatics would open the eyes of others to the underlying periodic phenomena in nature, which he so clearly perceived. An earlier book, published in 1962 in German, was entitled "Das Gesetz der Wiederholung" or "The Laws of Repetition." Although those experiments were rudimentary in comparison to what is contained in Cymatics, Volumes I and II, his inner eye was already looking far ahead with daring and inspiration.

Jenny liked to quote an aphorism of Heraclitus, "'All is flow. All is in flux." More than a favorite maxim, this was a very apt and pointed characterization of the man himself. The outer form of things, their skin or surface appearance, proved no boundary for his insightful mind and penetrating gaze.

Much like the Cymatics experiments brought to light underlying principles of nature, Jenny's indefatigable spirit of inquiry, and unparalleled powers of perception revealed his ardent desire to know, to understand, to feel and be at one with the very essence of life, a force which he felt deeply within.

It was a tremendous privilege to work side by side with Dr. Jenny for those many years, and I only hope that this brief synopsis will convey some semblance of the character of this most remarkable man who was Hans Jenny.

*A deluxe edition compiling 275 full-color reproductions is entitled Tierlandschaften, or "Animal Landscapes." See color insert at the back of this book.

CYMATICS

Volume I

The structure and
dynamics of waves
and vibrations

1

Problems of Cymatics

Whenever we look in Nature, animate or inanimate, we see widespread evidence of periodic systems. These systems show a continuously repeated change from one set of conditions to another, opposite set. This repetition of polar phases occurs alike in systematized and patterned elements and in processes and series of events. A few physiological examples may be mentioned in brief. The great systems of circulation and respiration are virtually controlled by such natural periods or rhythms. Inspiration and expiration of the lungs, systole and diastole of the heart are only these basic rhythmic processes writ large. In the nervous system the impulses occur serially and may therefore be described as frequencies. Much the same applies to the active muscle system which is actually in a state of constant vibration. The more closely one examines these functions, the more evident do these recurrent sequences become. Events then, do not take place in a continuous sequence, in a straight line, but are in a continual state of constant vibration, oscillation, undulation and pulsation. This also holds true for systematized structures. On the largest and smallest scale, we find serial elements, repetitive patterns — and the number of fiber stromata, space lattices, and reticulations is legion. If we turn our eyes to the great natural domains, periodicity expands to include the ocean itself. The whole vegetable kingdom, for instance, is a gigantic example of recurrent elements, an endless formation of tissues on a macroscopic, microscopic and election microscopic scale. Indeed, there is something of a periodic nature in the very concept of a tissue. Again, periodic rhythms are a dominant feature of the animal kingdom. The metamerism of the various phyla is a case in point. It is the operation of this law that gives many worms, arthropods and vertebrates their special characteristics.

From one specific point in the development of the germ onwards, the principle of organization is repeated on a grand scale in the segments. Every system is affected: skeletal, muscular, nervous, vascular, renal system, etc. But this principle is most clearly seen in the cellular character of organisms. Organs are not homogeneous masses, but tissues of the utmost delicacy which go on developing and repeating themselves indefinitely. Linked up with this is the sequence of generations, invariably a regular sequence of alternating polar-like phases. Even conditions inside the cell — the processes of cell division and the mechanics of the gene systems — are subject to this principle of oscillation. However natural these things may seem, they are. in fact, not. It must be realized that this periodicity represents an aspect of the world, and at first its mysteriousness always inspires a feeling of the greatest astonishment. In organisms, of course, we then find pure oscillatory phenomena rising to a higher plane in the formation of sound; and language itself appears on a still higher plane within this same field. If an inventory were to be drawn up of periodic phenomena in the realm of the organic, it would have to include the whole scope of morphology and physiology, biology and histology. But we must not forget the inorganic world. In this field we shall merely mention some typical examples recalling known facts, with particular reference to physics. Here we encounter vibrations in a pure form, more specifically in waves. In the vast spectrum extending from gamma radiation, through the ultraviolet and visible light to infrared (heat rays), to electric waves (microwaves and radio waves), we have a field which may be termed periodic in the purest sense of the word. Then there are waves in the various states of matter, acoustic vibrations, ultrasound and hypersonics. Again, the lattice structures of matter in the crystalline state are also periodic. Periodic structure is a salient principle in say. the space lattices of mineralogy. What insights into vibration and periodicity have been gained in the vast range extending from the cosmic systems (rotations, pulsations, turbulences, circulations, plasma oscillations, periodicity of many kinds in both constituent elements and the whole) down to the world of atomic or even nuclear physics (shell model of nucleus; nucleon structure: organization of meson clouds)! Here again, the idea of periodicity is all-embracing. The few examples we have given here will serve as signposts. But to reveal the systematic, universal character of periodic phenomenology a great deal would, of course, have to be added: structural chemistry, colloidal chemistry, phenomena of mechanical tension such as appear in the isochromatic and isoclinic fringes of photoelasticity, and all the families of associated trajectories, to name only a few examples. Also of interest here is the problem of matter waves (L. de Broglie). Diffraction patterns have in fact been produced by material particles (atoms and molecules) in experiments. Thus these particles also display a wave-like behavior This law of periodicity is particularly evident in the fault systems of geographical formations, which affect immense areas of rock.

Solar physics is another field in which oscillatory and wave processes are prominent. Our mental picture of the sun can accommodate serial structures, actual acoustic waves, plasma oscillations, turbulences, tendencies to recurrence of many kinds, periodic dynamics, etc. Moreover, many of the systems we have mentioned are polyperiodic in character. The rhythms and vibrations interpenetrate. But in every case periodicity is constitutive of their nature; without periodicity they would not exist at all.

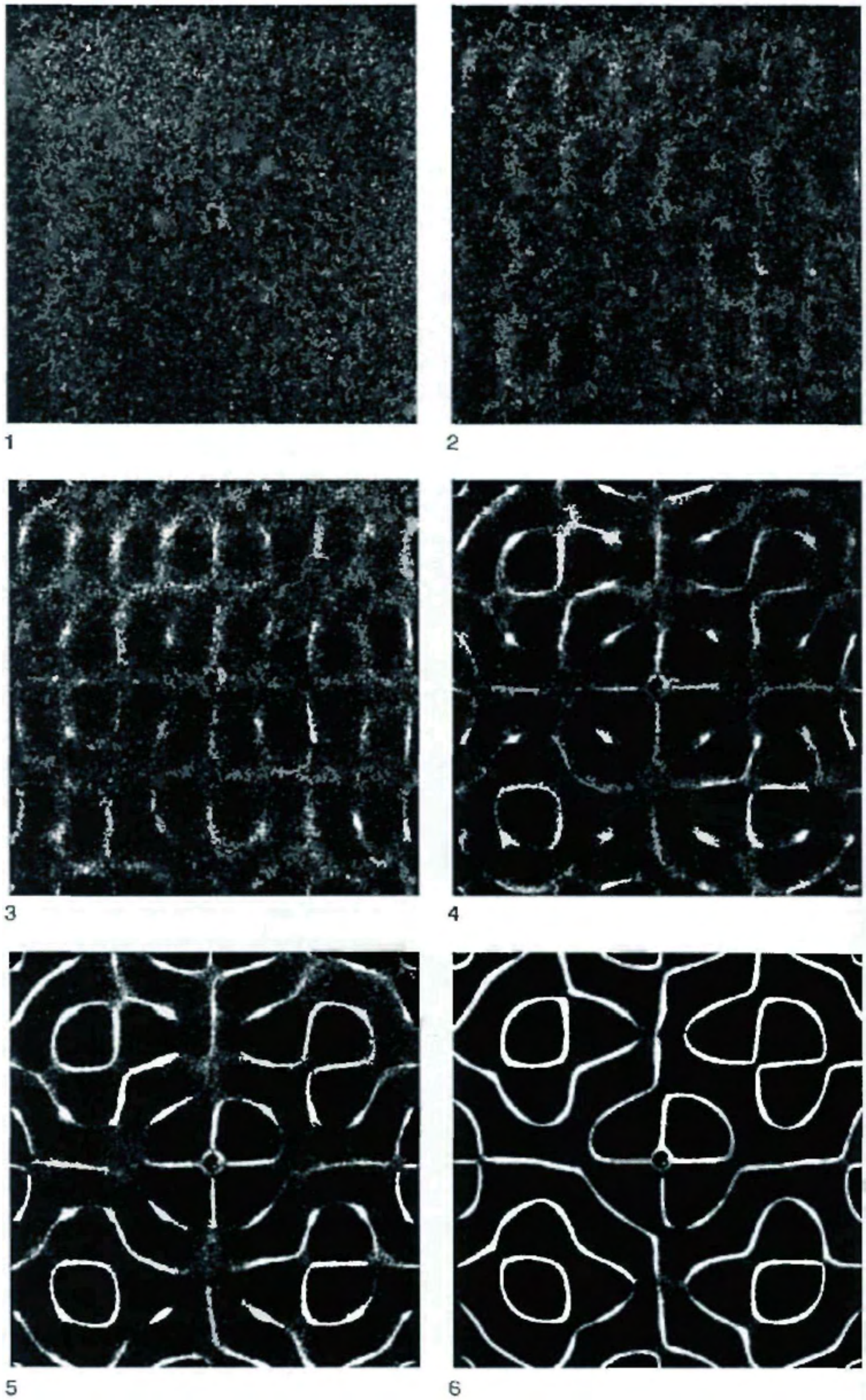
Each of the fields we have mentioned would of course require a monograph of its own if it were to be properly described from the point of view of periodicity. The brief examples given here, in which reference is made to known facts, are only intended to give some idea of the inventory which, as suggested above, might be drawn upon the basis of periodicity. Hence it might be said without hesitation that the systems available to our experience are essentially periodic and that phenomena appear to be periodic throughout. However different the objects concerned, however different their causes and functional mechanisms, they have in common rhythmicity, oscillation and seriality. Nonetheless it must be realized that this conclusion does not take us to the real heart of these rhythms and wave processes. Indeed, it is only the discovery of the ubiquitous character of waves in the world that confronts us with the precise question: How actually do these vibrations function in a particular environment. a particular medium, a particular material? Even if we know whether we are dealing with hormonal influences, neural impulses, or mechanical or chemical factors, the actual problem still remains: What is really happening in all these periodic phenomena? What actually takes place in the periodic field? Now in view of the extreme variety of things affected, the extreme variety of systems coming into consideration, we have to seek out the rhythmic or serial where it is most characteristic, study it carefully, and observe its intrinsic character. Considering, then, that the repetitive alternation of opposed phases is common to ail these phenomena, can we in this way obtain a description of periodicity which will reveal a basic phenomenon and afford a clear picture of its most fundamental nature? One example, which stands for many, will bring the problems involved into sharper focus. Let us consider the striated muscle in action. When the skeletal muscle is fully contracted, it displays what is known as tetantzation. It is then seemingly in a state of continuous contraction. Closer examination and measurement, however, reveal an entirely different picture. It has been shown that in tetanization there are in the muscle, oscillations which can be demonstrated mechanically, optically and acoustically; they correspond to the frequencies of the impulses transmitted to the muscle. The "muscle sound" audible when the muscle is contracted is due, therefore, to the rhythm or frequency of the "miniature contractions at maximum tetanus" (Reichel 1960). Whatever happens, then, in the active muscle takes place in these rhythms. Let us consider exactly what this means. The numerous and vastly complex processes in the active muscle are all subsumed in this periodicity. It is in this vibratory field that all the bioelectric, chemical, mechanical, energetic, thermal, structural, kinetic and dynamic processes take their course. What are the effects of this oscillatory process in all these sectors? What are the kinetic effects of vibration on liquid systems? How do chemical reactions take place when they are enacted in media whose processes are without exception periodic in character? These are questions which follow directly upon actual observation. As we said above, the example of muscles in action must stand for many others However this organic system involves structures of the greatest intricacy; their very complexity forbids simple discussion. And yet they are a clear invitation to explore their peculiar nature, their dynamics and kinetics, their structure and texture as revealed in their periodicity. It is these problems which are the focus of our research. What we are concerned to do then, is not to formulate hypotheses about backgrounds and final causes, but rather to press on step by step with our exploration into this field and to find methods of giving tangible expression to this phenomenology

Observation must begin, however, with relatively simple processes; many variations must be made in experimental conditions; and the object itself must be allowed to point the way from one set of experiments to another. It must be stressed that it is not a question of demonstrating the periodic and the rhythmic as such, or eliciting it from the complexities of its worid according to the criteria of wave theory. The contrary is the case. It must be detected in its own world, its own environment, so that its specific effects are discovered and its multifarious operations recognized. Only by "getting inside" the phenomena through empirical and systematic research can we gradually elicit systems in such a way that mental constructs can be created which will throw a light on the ultimate realities. For it must be stated quite categorically that we have to proceed on strictly empirical and phenomenological lines and that all interpretative or analogical thinking will be out of place. If a name is required for this field of research it might be called cymatics (to kyma, the wave; ta kymatika, matters pertaining to waves, wave matters). This underlines that we are not dealing with vibratory phenomena in the narrow sense, but rather with the effects of vibrations. Our documentation is primarily concerned with the experimental demonstration of phenomena in the acoustic and lower ultrasonic range. Examples will also be interposed showing periodic phenomena occurring without an actual vibratory field in order to afford a view of the general field of periodicity or, in other words, of cymatics in the broader sense.

2

Experimental Method

In attempting to observe the phenomena of vibration, one repeatedly feels a spontaneous urge to make the processes visible and to provide ocular evidence of their nature. For it is obvious that, by virtue of the abundance, clarity, and conscious nature of the information communicated by the eye, our mode of observation must be visual. However great the power of the ear to stir the emotions, however wide-ranging the information it receives, particularly through language, the sense of hearing cannot attain that clarity of consciousness which is native to that of sight. Who can reproduce a symphony after only one hearing, or even recall all its themes? But how many are there who, after looking at a picture, can in principle describe its main elements. It is not surprising then, that workers in experimental acoustics should have striven to make its phenomena visible during important periods of the development of the science. Special mention might be made of E. F. P. Chladni (1756-1827) who discovered the sonorous figures named after him while he was investigating Lichtenberg figures. With a violin bow he stroked metal plates sprinkled with powder and was thus able to make the vibration processes visible. The vibratory movement caused the powder to move from the antinodes to the nodal lines, and Chladni was thus enabled to lay down the experimental principles of acoustics (e.g. die Akustik, 1802). Work on this basis was not easy and, more particularly, the conditions of the experiment did not allow a sufficient range of observation since they could not be freely varied while the experiment was in progress. Thus the first necessity was to elaborate methods enabling the conditions of the experiment to be accurately fixed while still allowing free variation within these limits. One such method, which utilizes the piezoelectric effect, deserves special mention. Many crystals are distorted by electric impulses, and conversely they produce electric potentials when they are distorted. If a series of electric impulses is applied to the crystal lattice, the resulting distortions have the character of real vibrations. We will not go further here, into the complexities of vibrating crystal space lattices. Suffice it to say that these vibrating crystals afford a whole range of experimental possibilities. First of all, the number of impulses can be precisely determined with the generator exciting them. Thus we can always know the frequency (number of vibrations per second) and also the strength of the impulse (excursion or amplitude of the vibrating body). Moreover the precise site of stimulation can be known in every case. Most important of all, however, is the fact that the experiment is not limited in time. The frequency and the amplitude can both be altered during the experiment. Hence it is possible not only to produce vibration patterns and investigate the laws to which they continuously conform, but also, and more especially, to make a close study of the transitions as one figure gives way to another. The experiment can be discontinued at any stage and each phase observed. Figs. 1-6 show



1-6 The illustrations show a simple sonorous figure taking shape under the action ot crystal oscillators (piezoelectric effect). Steel plate 31x31 cm. Thickness 0.5 mm. Frequency 7560 cps. The material strewn on the plate is sand which has been calcined to purify it.


7

7-11 In figures 7 and 11 a single tone (800 cps in Fig. 7,865 cps in Fig. 11) has produced its own sonorous figure on a hexagonal steel plate. Figure 9 shows the result when both tones are sounded at the same time and at equal strength. Figures 6 and 10 show the intermediate stages.

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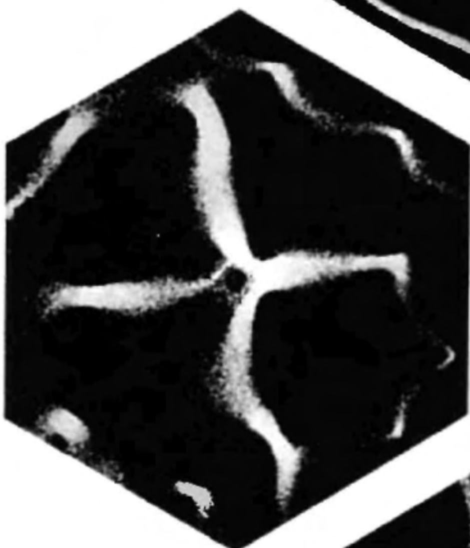

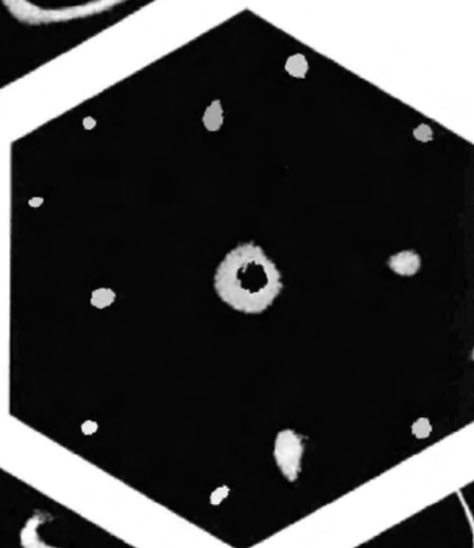
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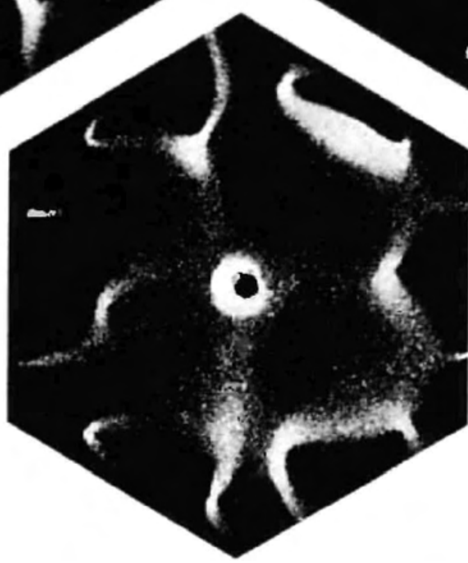
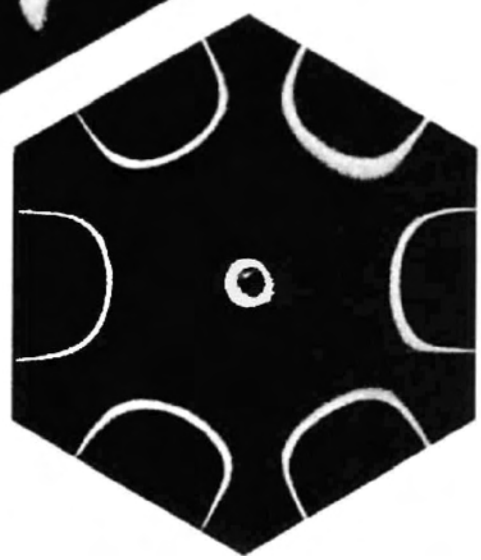



11

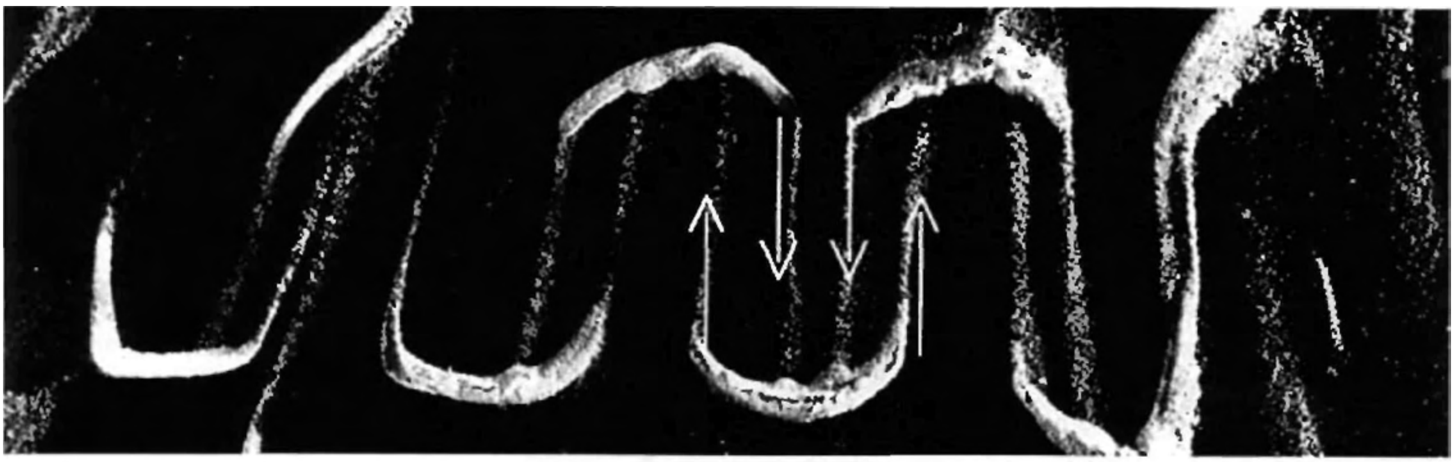
a sonorous figure forming under the piezoelectric effect of a crystal oscillator It is a steel plate (size 31x31 cm, thickness 0.5 mm), upon which calcined quartz sand has been sprinkled. The oscillator is fixed to the underside. Fig. 1 shows the situation before the exciting impulse. In Fig. 2 the impulse has started and gradually the vibrational patterns of the plate are rendered visible. In Fig. 6 the sonorous figure has formed. It must be realized that in Figs. 2-6 the whole process is also audible. The exciting note can be heard continuously throughout the various stages (frequency 7560 cps). It would be really true to say that one can hear what one sees and see what one hears. Some experiments will now be described in order to show what this method is capable of achieving.

It is of course possible to attach more than one crystal oscillator to the same body and observe the effect. Fig. 7 shows a sonorous figure (frequency 800 cps) and Fig. 11 a second figure (frequency 865 cps). Each is individually excited. In Fig. 9, however, they are simultaneously excited, i.e. both notes can be heard. The figure shows the resultants of the two vibrations. From here it is only a step to making beats (interferences) visible. They have already been demonstrated by using a plate with irregularities in its material (Zenneck). If the characteristic tones of this material were proportional to the beat, the loops could be seen to change regularly in diameter. By using crystal oscillators a great variety of interference conditions can be selected. If two notes are produced with frequencies giving rise to beats, the whole Chladni figure pulsates or moves to-and-fro. Again, the phases can be changed in the course of the experiment.

The stages arising between the actual sonorous figures are of particular interest- Currents appear. The sand is moved around as if it were fluid. Nevertheless the organization of the vibrational fields persists in as much as these currents of sand move in the same or opposite directions. Fig. 12 shows such a process; the arrows indicate the direction in which the current is moving. Fig. 24 also shows this experiment and it is seen in greater detail in Fig. 25. Naturally the sand simply serves as an indicator. The actual events in vibrating plates and diaphragms are of extraordinary complexity In the fields, for instance, areas appear which the indicator reveals to be in rotation. The powder congregates in small circular areas which continue to rotate regularly as long as the note is sounded. This rotational effect is not merely adventitious, but appears systematically throughout the vibrational field. Fig. 13 shows a plate with a number of rotating areas in which the direction of rotation of each area is contrary to that of its neighbors. The arrows show the direction of rotation. The circulation continues steadily and its course can be followed by marking with colored grains. Phases can also be demonstrated in which both currents and rotation are present The following phenomenon is then observed: a small round heap which must be imagined to rotate has sand flowing towards it

12 The arrows indicate the direction of flow of the streams of particles. The material is lycopodium. Plate 25x33 cm. Thickness 0.5 mm. Frequency 8500 cps. This picture shows a detail.

13 Numerous rotational effects. The small round areas are in constant rotation. The arrows indicate the direction of rotation. Steel plate 31x31 cm. Frequency 12,460 cps. The material is quartz sand.



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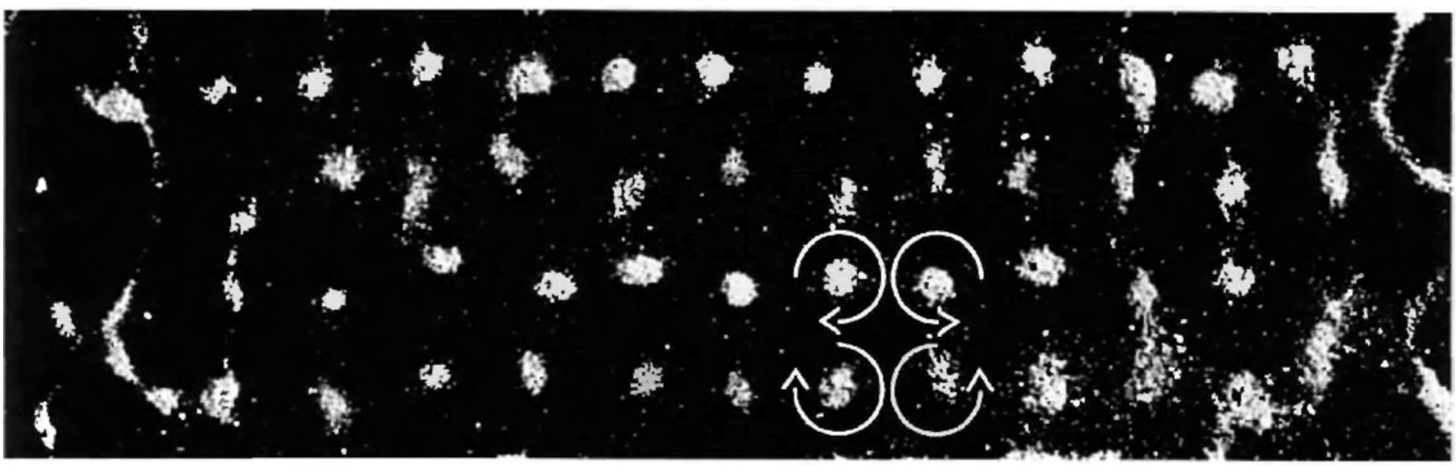

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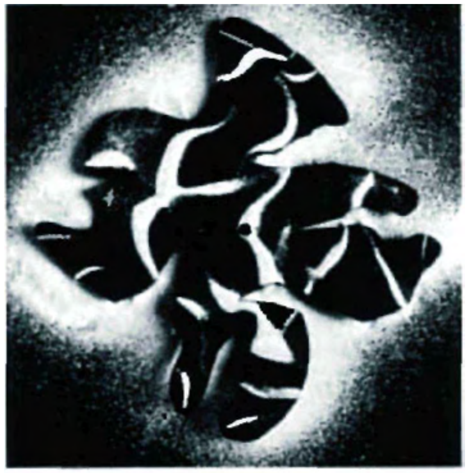
from two sides; the sand joins the heap, however, at opposite points on its circumference and is absorbed into it. Fig. 26 shows this happening. We thus have circular heaps which are joined together by bridges of flowing sand, or put another way, each circular heap has two flowing arms which move towards it, turn, and flow into it. These rotary effects can also be seen in "quite ordinary" Chladni figures. They point the way to still further investigations into the real vibratory processes in these bodies. At the same time they are a reminder that we should watch for such processes in vibrational fields. Indeed these currents, centers of rotation, revolving heaps with influent streams and connecting flows must actually be expected, and the material occupying the field will indicate the vibrational pattern prevailing there. There can be no doubt about the occurrence of these formations.

It is obvious that all these processes (interference, flows, rotation) could be more appropriately documented by cinematography; photographs can only stimulate the mind into grasping these processes imaginatively.*



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14 A steel plate deliberately cut in an irregular shape. Maximum diameter 23 cm. Thickness 0.5 mm. Frequency 4100 cps. The material is quartz sand.

15

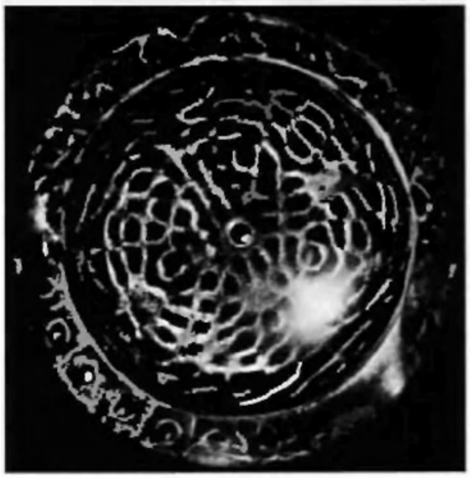
15 A symmetrical plate with complicated subdivisions. Distance across at widest part 30 cm. Length 18 cm. Frequency 21.400 cps. Excitation is from the top downwards.

*Editor's note: Dr. Jenny did make several films of his experiments, highlights of which are now available on video. See color insert at the back of this book.

16 Guitar excited by a tone of 520 cps. The sand shows the nodal lines of the mode of vibration.

17 The vibrational pattern of a brass plale. Oscillatory processes In complicated solids can be rendered visible by means of crystal oscillators. Frequency 10.400 cps. The material is lycopodium powder. Diameter of the plate 20 cm, depth 3 cm, thickness 0.3 mm.


16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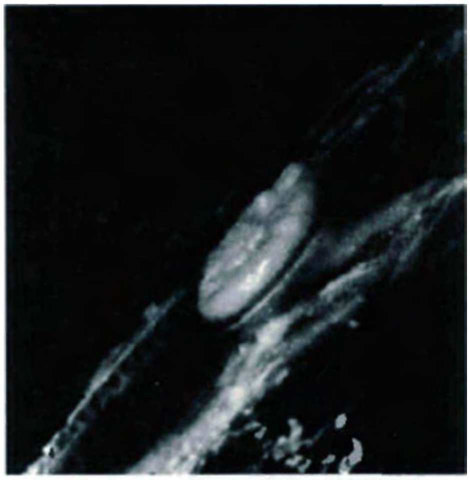
With these selected methods the vibration of complicated bodies can also be rendered visible. The vibrations of structures whose mode of vibration cannot be calculated at all, or only approximately, can in this way be made accessible to experience. Fig. 14 represents a sonorous figure on a steel plate of arbitrary shape. The conditions revealed on the variously formed lobes can be studied. Fig. 15 also reproduces a complicated figure. It is precisely in figures of this kind that symmetrical relationships between the various parts can be found. It might be mentioned in passing that in such structures as these both planar and axial symmetry enter as factors. In Fig. 16 we see a guitar energized by sound (520 cps). The indicator substance reveals the real wave events in the wooden body. If the material contains irregularities, say cracks in the wood, there are corresponding changes in the pattern of oscillation. Vibrational behavior in forms whose modes of vibration cannot be calculated can also be rendered visible in this way. In Fig. 17, a brass plate has been made to vibrate by sound and its pattern of vibration can be clearly discerned.

An interesting observation may be made at this point. The masses affected by a tone are, of course, naturally forced into the form corresponding to the vibrational effect. While the tone impulse persists, liquids and viscous masses will remain in their place if the diaphragm is tilted. or even held vertically. If the vibration is discontinued, the masses slip down under the force of gravity. If the resumption of the tone is not delayed too long, the masses return to their position, i.e. they climb up again. In a sense it would be legitimate to speak of an antigravitation effect. In Fig. 18 the vibrating diaphragm is arranged obliquely; the mass will not slip down so long as the tone is present.

Even the ringing of a bell can be rendered visible. Fig. 19 shows the vibrational pattern that appears.

In order to take investigations into the vibration of complicated bodies a step further a photoelastic technique was developed. The stroboscope, which is an instrument for rendering visible the phases of rapid periodic motion, is used as the source of light. The stroboscopic light is polarized and penetrates the transparent model which is made to vibrate. The analyzer enables the vibrational process to be observed as a photoelastic phenomenon. This technique makes feasible the study of even such complicated forms as musical instruments (e.g. the violin) in a state of vibration, at feast within the limitations imposed by the use of a model.

If a liquid is used as an indicator instead of sand, an entirely different picture is obtained. The nodal lines disappear and the antinodes appear as wave fields. Fig. 20 is a sonorous figure. In Fig. 21 we have the same plate, excited at the same frequency, but covered by a sheet of liquid. The same pattern can be recognized in both pictures. In Fig. 20 the antinodes



18

18 The circular shape has been created out of a paste-like mass by a tone. The vibration holds the paste in its field even when the diaphragm is held obliquely or vertically. If the tone were discontinued in figure 18, the paste would flow downwards.

19

19 The mode of vibration of even such a complicated (non-calculable) form as a bell can be rendered visible. Frequency 13.000 cps. Diameter of the mouth of bell 15 cm, height 11 cm, thickness 0.3 mm. Lycopodium powder was used.

are empty, but the nodal lines are shown in sand. In Fig, 21 the fields of movement are rendered visible by the wave lattices; there is nothing to be seen where the nodal lines are. The most varied forms of wave trains are to be seen in lattice areas. The movements at the margins of the fields are striking. If lycopodium powder (spores of the club moss) are strewn on the surface, violent movements can sometimes be seen. A turbulent zone consisting of unstable wave phenomena often forms there. Thus in the one case (Fig. 21) the moving elements are shown; in the other (Fig. 20) those parts which exhibit no movement are shown. Thus the actuating is, as it were, opposed to the actuated, the creating to the created. This draws attention to the fact that the patterns taking shape must be understood in terms of their environment, that patterns in general are, as it were, an expression of the movement and energizing process. One might speak of a creans/creatum relationship. Thus there are many conditions under which the mind might be said to be directed to the environment, to the circumambient space, to the field from which space lattices, networks, etc. take their rise in the first place. In other words: observation of organized patterns and the milieu creating them raises questions as to the processes incidental and precedent to the formation of such patterns. This nexus of problems is one that merits further investigation, e.g. in mineralogy colloid chemistry, in periodic or rhythmic

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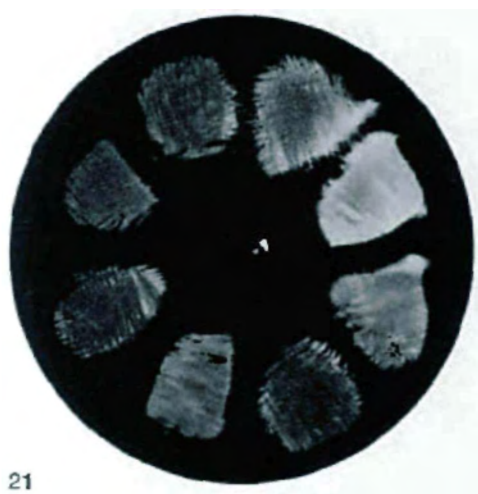
20 Sonorous figure on a circular plate. Diameter 16 cm, frequency 1060 cps. The nodal lines are made visible by sand.

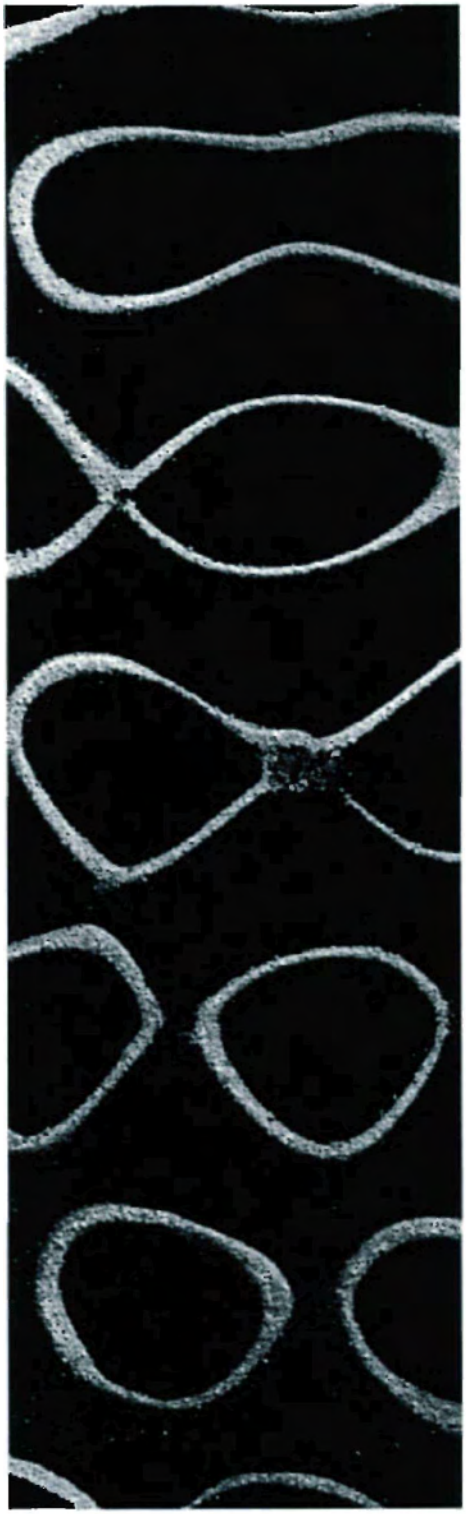


21

21 The same plate excited by the same frequency as in figure 20 but covered with a liquid. Now the areas of movement (antinodes) are visualized directly as wave fields.

precipitations, and in the field of chemical reactions in general. What happens before fibers, fibrils and crystals are separated out? Since such systems are shown to be periodically textured or patterned, periodic processes of a corresponding kind must be present in the preceding stages. But they always have to be verified in the concrete case.

Vibrating materials naturally react quite unequivocally to heat conditions. Not only the crystal oscillators, but also the plates and diaphragms change their vibrational characteristics to a remarkable degree. They might truthfully be described as sensitive. The following experiment is representative of many. Fig. 22 is produced by a tone with a frequency of 1580 cps. If the outermost edge of the steel plate is heated for a few seconds by a flame, the whole vibrational pattern changes at once, as is shown in Fig. 23. If the tone is continued during cooling, the original sonorous figure returns after a few moments (Fig. 22). Not only the effects of the vibration, but also the vibrating media themselves have highly specific characteristics.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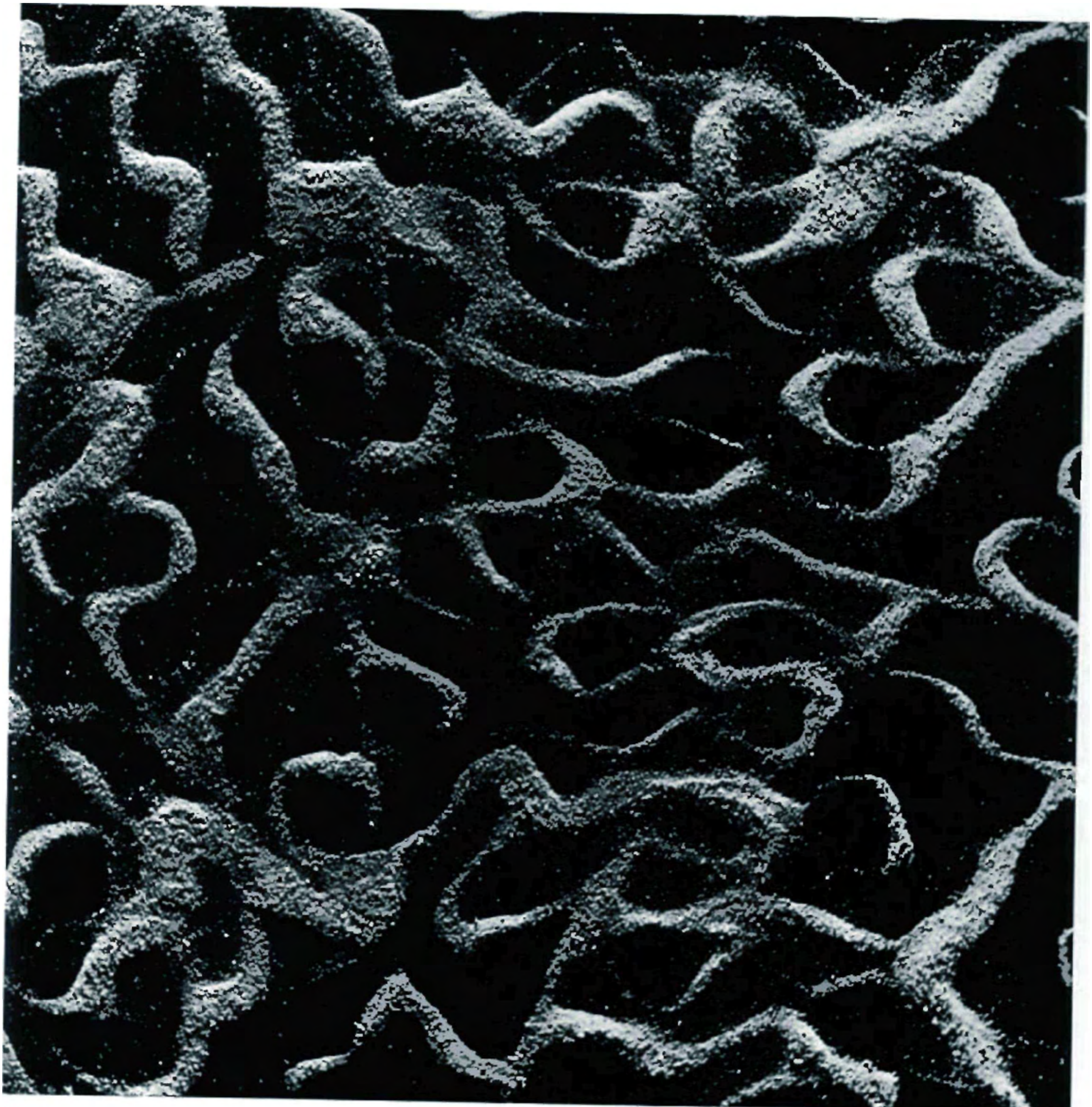
23

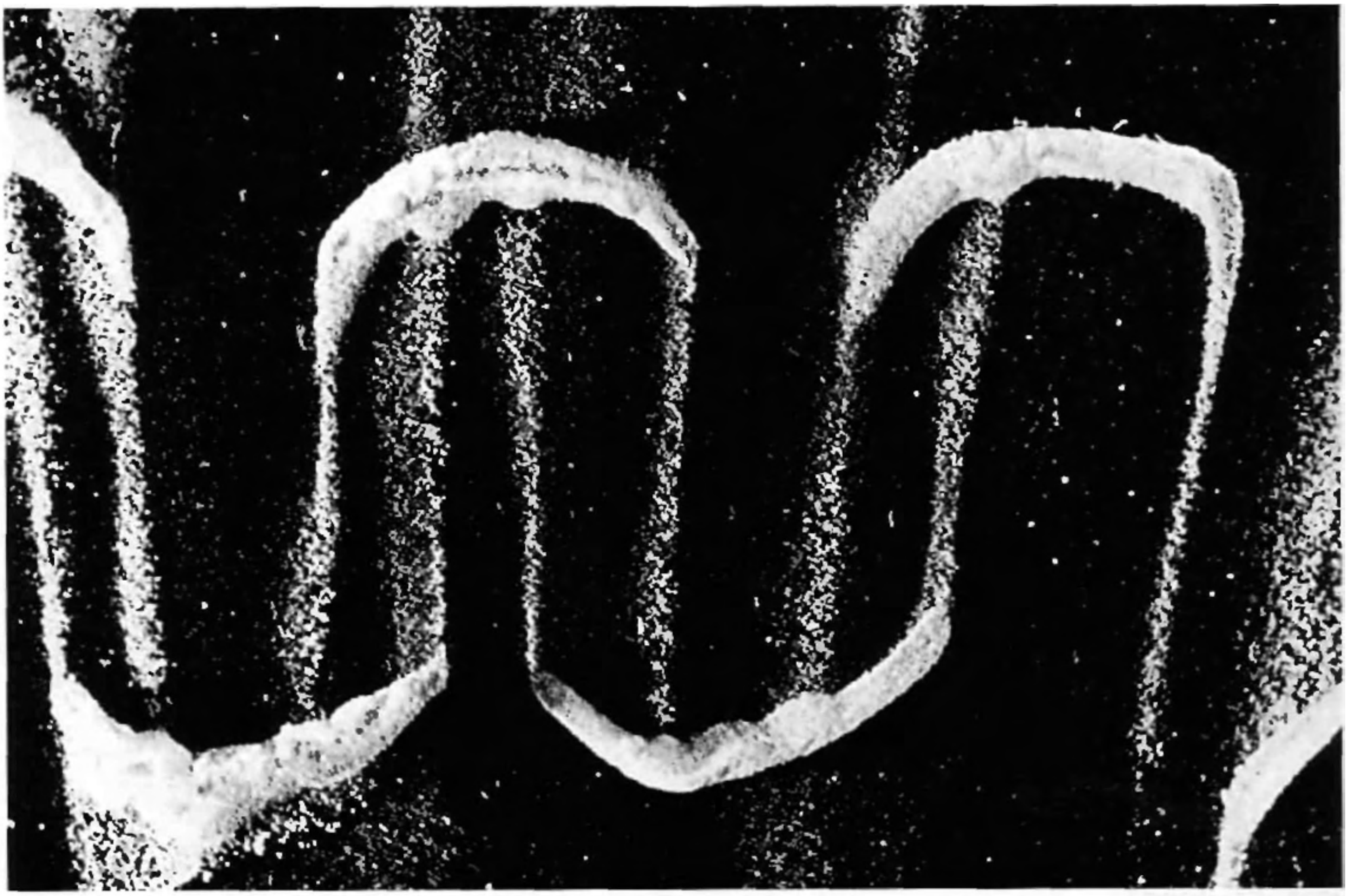
22 Sonorous figure. Rale 24.5 x 32.5 cm, thickness 0.5 mm, frequency 1580 cps before the effect of heat.

23 The same experimental conditions as In figure 22 except that an extreme corner of the plate was touched by a flame tor a few seconds. Immediately the whole shape is distorted. Figure 22 reappears once the plate has cooled.



24

24 The sand figure is not a sonorous figure in the usual sense; the particles of sand are in a state of flow. Excitation is by crystal oscillators. Steel plate 25x33 cm, thickness 0.5 mm, frequency 10,700 cps. (Cf. figure 12.)



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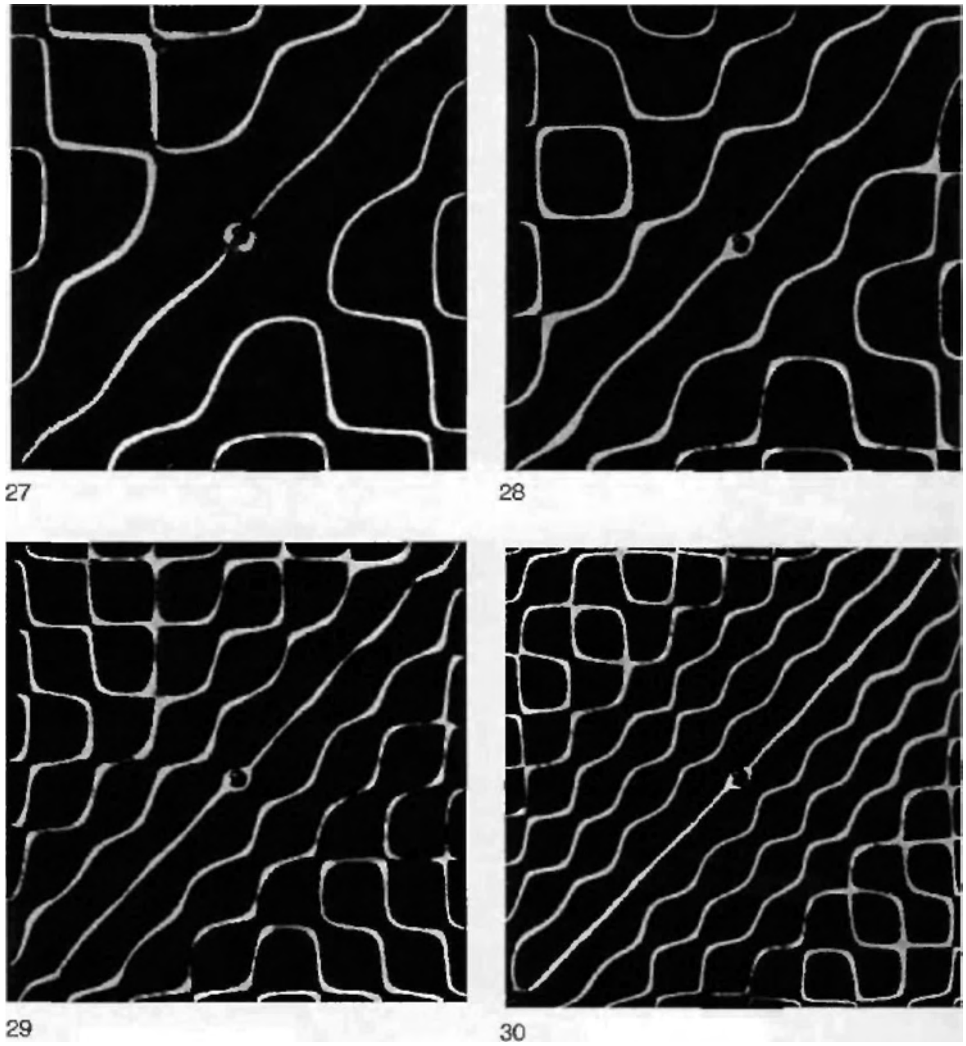
25 This again is a photograph of a "flowing figure", Lycopodium (spores of the club moss) is used to indicate the currents. Frequency 8500 cps. (Cf. also figure 12, detail)

26 Rotational effect. The round heaps of sand must be imagined in rotation. The sand is flowing in the two longitudinal areas; it is flowing towards the round shape and joining it at opposite ends. This exceptionally interesting phenomenon is, of course, reproducible. It may be termed a rotational system with two bridge arms. Frequency 12,470 cps.

26

27-30 The four figures reveal approximately the same pattern but the number of elements grows as the pitch increases. In figures 27 to 30 the frequencies are 1690, 2500, 4820, 7800 cps, respectively. Steel plate 23x23 cm. Thickness 1mm.



27 28 29 30

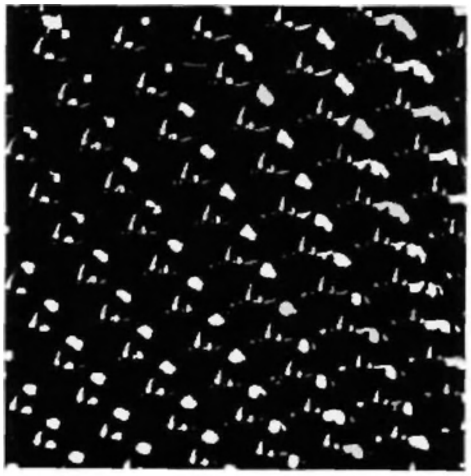
3

Examples of Cymatic Phenomenology

Some examples will now be given of vibrations rendered visible. What we actually witness here is the effect of vibration. The effects produced by vibration in this or that material, in this or that medium — that is what is to be demonstrated. We are in fact present at the very site where the oscillating process takes its effect. First we shall simply pass under review a series of such phenomena. The classes of phenomena appearing, and the relationships existing between them will be revealed little by little by the things themselves.

First we see some sonorous figures (Figs. 36-42). All these experiments were performed with crystal oscillators. This type of experiment enables the vibrational patterns to be produced in series and compared. It is notable in these serial experiments that the same formal pattern recurs at increasing frequencies, but that the number of constituent elements also increases at the higher frequencies. It is apparent from the series Figs. 36-42 that the figures at the higher frequencies display many more elements.

In Figs. 27-30 we see a formal pattern of which similar versions are repeated as the frequency increases. In Figs. 27-30 the frequencies are 1690, 2500, 4820, and 7800 cps, respectively. Here again use was made of a steel plate (23x23 cm and 1 mm thick). The size of the plates can, of course, be varied at will. We have used plates ranging from the size of the ear drum (approx. 7x9 mm) to 70x70 cm. Also the material of the plate can be selected as desired (glass, copper, wood, steel, cardboard, earthenware, etc.). Apart from the rule that the number of elements increases with the frequency, a variety of other observations may be made of the sonorous figures (Figs. 36-42). Since the process can be stopped at any stage, the formation of nodal lines can be followed step by step. The observer can see how the particles are transported and how two lines draw together In the marginal zones turbulent areas can be seen in which the particles form vortices. One point is particularly noteworthy. In the series of vibrations one metamorphosis is quite literally followed by another. The variety of resultants and products of co-acting forces is inexhaustible. Continuous variations are to be found on the basic concentric/radial pattern in round plates and the parallel/diagonal pattern in rectangular plates. But there is an additional factor to consider. One formal element is repeated in one and the same sonorous figure. We are therefore actually dealing with the same configuration. Now, no plate is completely uniform throughout, and as a result the energy imparted to it by the frequency is not evenly distnbuted. The consequence of this is that the pattern is imperfectly formed in some places and fails to appear completely; but more important still is the fact that the elements of form vary in the sense that they become, as it were, variants of a form (see e.g. Fig. 38). At one moment a pattern is closed and separate; at another the same element is open and linked up with its environment. Again, patterns become united which, elsewhere on the same plate during the same experiment, are disjoined. Simply by reference to these principles of resultant systems, metamorphosis and variability, an atlas of sonorous figures could be compiled. But amidst all these figurate patterns the kinetic factor keeps on appearing, particularly in the "continuous waves" we have already mentioned and the



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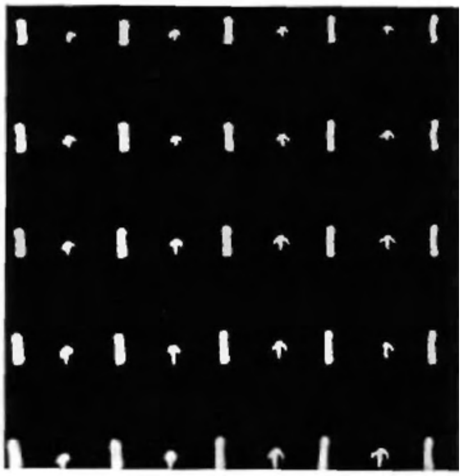

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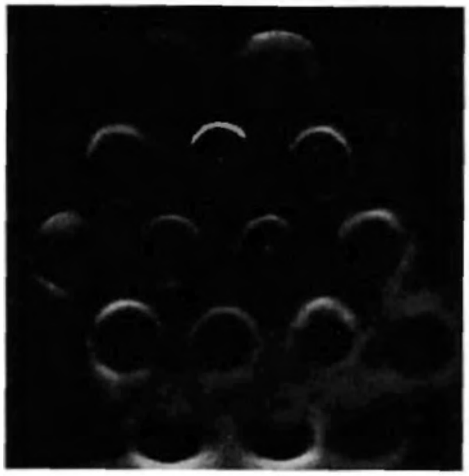

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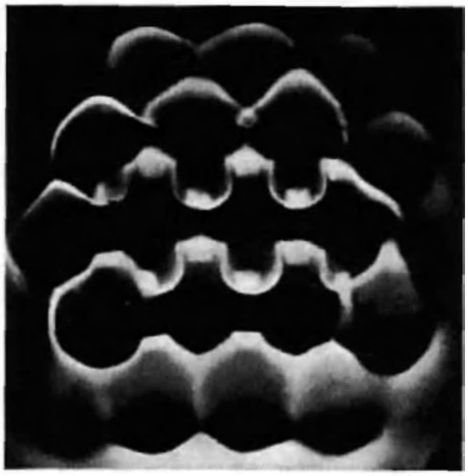


34

31-34 A liquid is made to vibrate on a diaphragm with a diameter of 28 crn; the modes of vibration give rise to a multiplicity of patterns and textures. Sometimes standing, sometimes traveling, they change as the frequency is modulated. Certain of the formations are reminiscent of Lissajous figures.

35

35 A train of waves generated in glycerin on a vibrating diaphragm. There are no transverse waves.

rotational effects. In such cases the whole figure is in a state of flow or comprises a number of rotational centers with adjacent centers invariably revolving in opposite directions. Figs. 13 and 24 must therefore be conceived not as figures, but in kinetic terms. Fig. 25 is a detail from a flow phase.

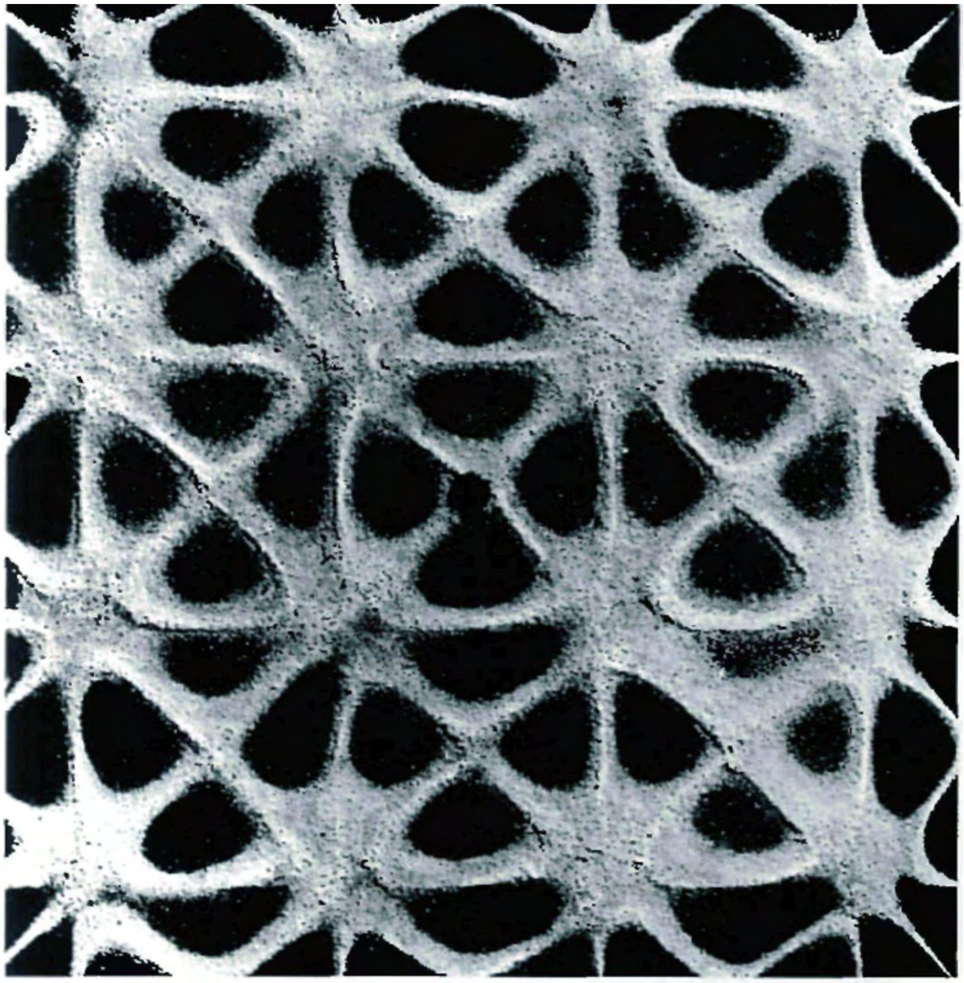
Thus when figure, configuration, form, pattern and texture, etc. are referred to in this connection, we are using empirical descriptions. The woof and weft of these phenomena is so continually shifting that they cannot be pinned down to any rigid definitions. It will be apparent in the course of our disquisition that these various categories of phenomena interlink and interpenetrate to such an extent that definitions would inevitably dismember something which represents a closely knit unity throughout. This applies in particular to the effects of vibration in liquids. Under the action of oscillations at frequencies as high as the lower ultra-sonic range, it will be noted that the surface of liquids crinkles to form a wave field. This effect can be traced in detail if the reflected image of a cross or lattice of threads on the surface of the liquid is observed. In the reflected light it appears to be distorted. The extent of the distortion corresponds to the exciting frequency. Figurate patterns, however also appear in liquids. Fig.44 shows such an oscillation pattern in glycerin; likewise Fig. 45. We must realize that in these and the following photographs a great diversity of things must be observed at the same time. Configurations (standing waves) can be recorded, but at the same time there are currents which impart flow to the patterns. Eddying regions point to turbulences. Now and again an interference oscillation flits across the field, etc. When various areas of oscillation move towards each other, there is a tendency for Lissajous figures to form with more or less clarity.

Figs. 31-34 and 46-49 show a transition from figures to organized arrays. Hexagonal, rectangular and imbricate patterns strike the eye as honeycombs, networks and lattices. Occasionally a picture forms but then the textures shift and change into every imaginable display. Figs. 46-49 and 31-34 may be taken as examples. Once again there are reminiscences of Lissajous figures (e.g. Fig. 49).

It is hardly necessary to add that interference phenomena can once again be demonstrated in these experiments with liquids. A pulsing movement may be imparted to the whole sheet of liquid while the wave lattices, depending on the phase conditions, may, for example, appear and vanish with lightning rapidity.

Mention should be made at this point of an unusual experiment. The curvature of the surface already referred to, causes the mass of the liquid to shift. This brings about a change in the oscillatory character of the whole system. The procedure is as follows. A film of water some 3 cm in diameter is energized by a frequency of approximately 2400 cps. Adelicate wavelike pattern is formed.

36 A sonorous figure produced by piezoelectric excitation. The triangle measures 24 cm along each edge. Steel plate. Frequency 875 cps.



37

37 A sonorous figure, also produced by piezo-electric excitation. Square steel plate 23x23 cm, thickness 1 mm. Frequency 6700 cps. In such experiments as these, the formation of nodal lines of sand can be accurately observed. They often pile up like dunes.

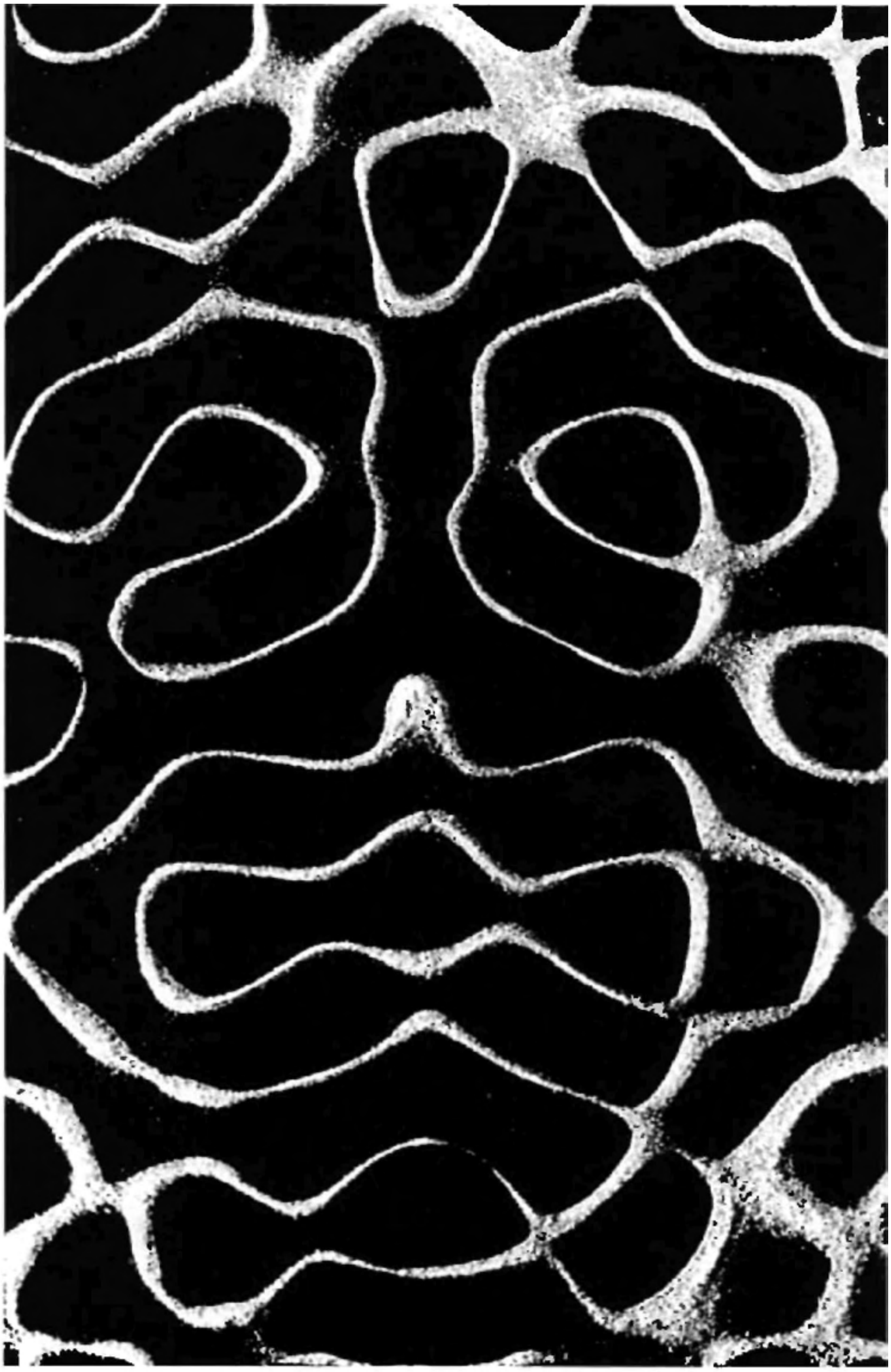
But at the same time a pulsing movement is set up which affects the whole. The curvature of the surfaces and the ensuing changes in mass and position cause the liquid to slip away from the frequency impinging upon it. The factor causing the curvature is thus removed. The mass now returns to the initial position and once again comes under the influences of the energizing tone. The process is repeated and this pulsation becomes regular. In the experiment described, the rate of pulsation was 80 per minute. This phenomenon exemplifies a pulsating system.

As we proceed with our series of experiments with liquids, we obtain organized patterns of ever increasing delicacy. The impression created is one of textures. Figs. 50-53 show what happens. The pictures look like closely interwoven fabrics. Appropriate changes in the strength of the vibration (amplitude modulation) can be used to show how these wave "fabrics" are woven out of wave trains. By adjusting the movement of a vibrating diaphragm it is possible to produce only one train of waves. The wave may be of the standing or traveling variety (Fig. 35). Further undulations can be generated by changing the amplitude, whereupon a grid-like pattern appears. In Fig. 54 this process can be seen in the nascent state. Some of the large waves are beginning to undulate in themselves. Signs of incipient transverse elements can be seen more particularly in the central parts of the photograph.

Whereas these figures, whether

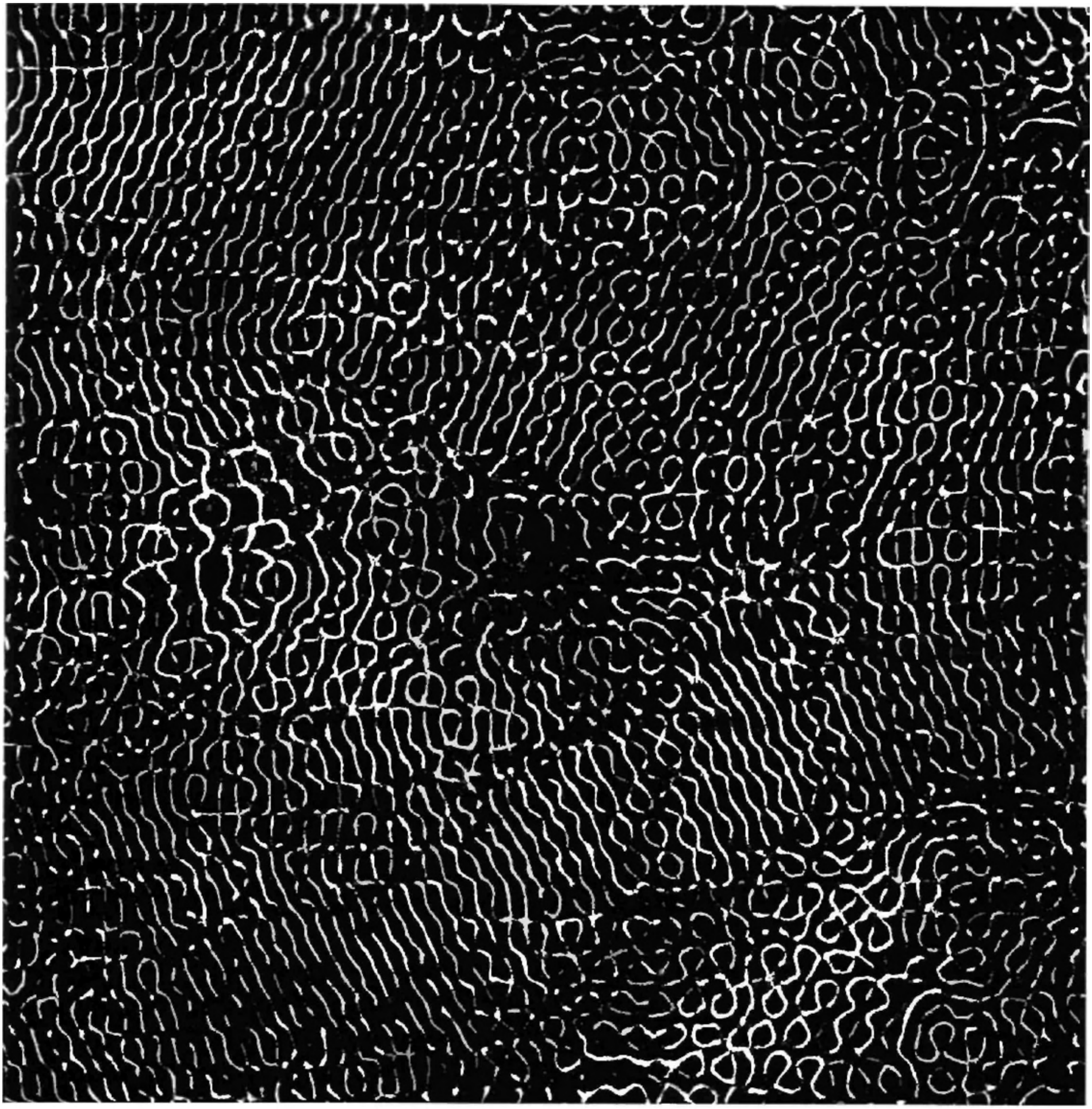
standing or traveling, have a certain constancy of appearance as organized patterns and textures, there are also phenomena in a constant process of change. Figs. 55-58 are turbulences generated by vibration, showing this type of dynamic formation. These formations, which are constantfy coming and going, appear in a marginal zone, where a vibrational process meets a zone of inactivity. They are thus entirely different from the turbulent processes appearing in flow phenomena. Nor should they be confused with vortices (to which we shall be proceeding in a moment) which are hydrodynamic phenomena produced by vibration. These "wave curls" must be conceived as being in motion, but in an unstable state. They disappear but appear again in a similar configuration; thus they are irregularly regular or regularly irregular. They are also in evidence along the borders of the wave fields noted in the sonorous figures produced in liquids. They show up particularly well in fluorescent liquids. In ultraviolet light, for instance, they figure as "light sources" in contrast to the non-fluoresceni areas. This curious phenomenon with its vortices and waves which tend to vanish and then return, is thus rendered wholly visible. Pictures such as Figs. 57-58 may look so similar that they might be thought to be photographs of the same situation but with some variations. It may happen that the waves disappear between the photographs and then reappear.

In 1928 G. von Bekesy discovered in experiments with models of



38

38 Sonorous figure. Plate 25 x 33 cm. Thickness 0.5 mm. 5330 cps. Configurations like these enable us to follow the variety of forms which one and the same pattern can assume. The basic pattern undergoes metamorphosis.



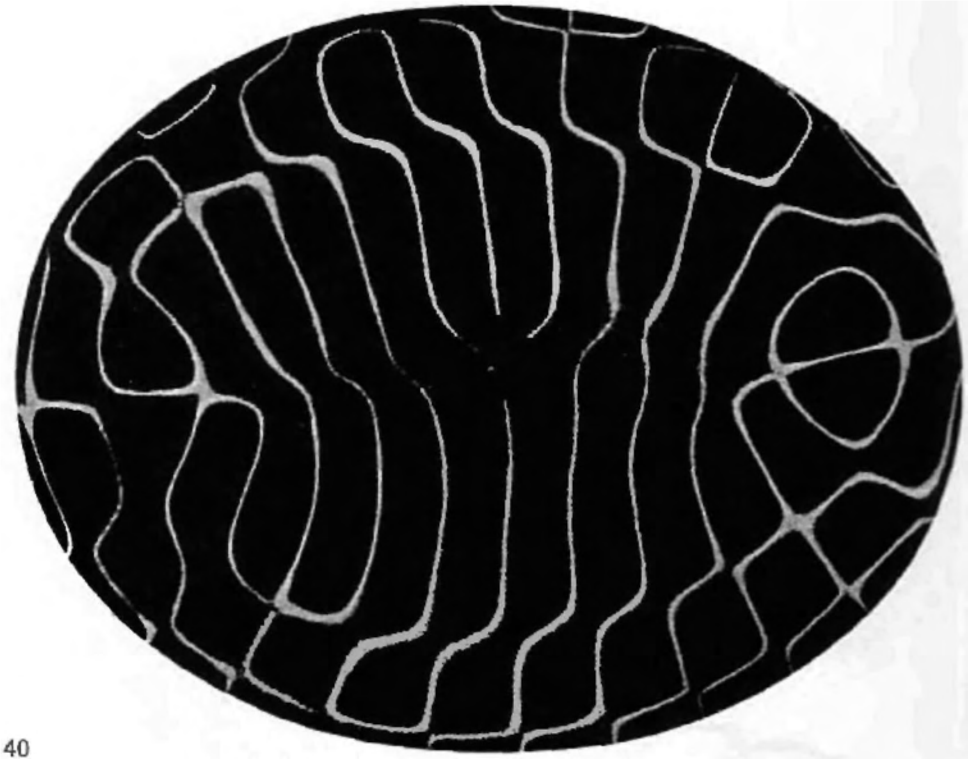
39

39 A sonorous figure excited by crystal oscillators. Steel plate 70x70 cm. Frequency 17,600 cps. The high frequency results in a large number of fields.

the cochlea of the ear that vortices are formed by vibration. Two vortices were formed at the same time at a specific site depending on the frequency. Von Bekesy was then able to observe these eddies in the ear itseif and also their transmission in the spiral of the cochlea. He found that as the frequency increased, the two eddies moved towards the stapes in precise conformity with the laws of hydrodynamics. The direction in which the eddy rotates is constant; the speed of rotation increases with the strength of the vibration; the location, as explained, is determined by the frequency. These therefore are hydrodynamic phenomena caused by vibration.

In the experiments described here, vortices are also produced by tones although in an entirely different way. The simplest case is shown in Fig. 59. This is a film of liquid a few centimeters in diameter. To make the pattern of currents visible, a black dye was used as an indicator. It will be seen that a pair of eddies is formed symmetrically. Here again the speed of rotation is proportional to the amplitude. Fig. 60 shows the process by which the eddies are generated. This experiment, however, is performed with a sheet of liquid about 23 cm across which is made to vibrate by a tone (frequency 100 cps). Trains of waves corresponding to this tone can be seen in various parts of the photograph. The black dye which originally covered the whole sheet begins to form eddies; in other places it is still unbroken. What we see in this photograph is really the nascent

40 A sonorous figure on an ellipsoid steel plate.



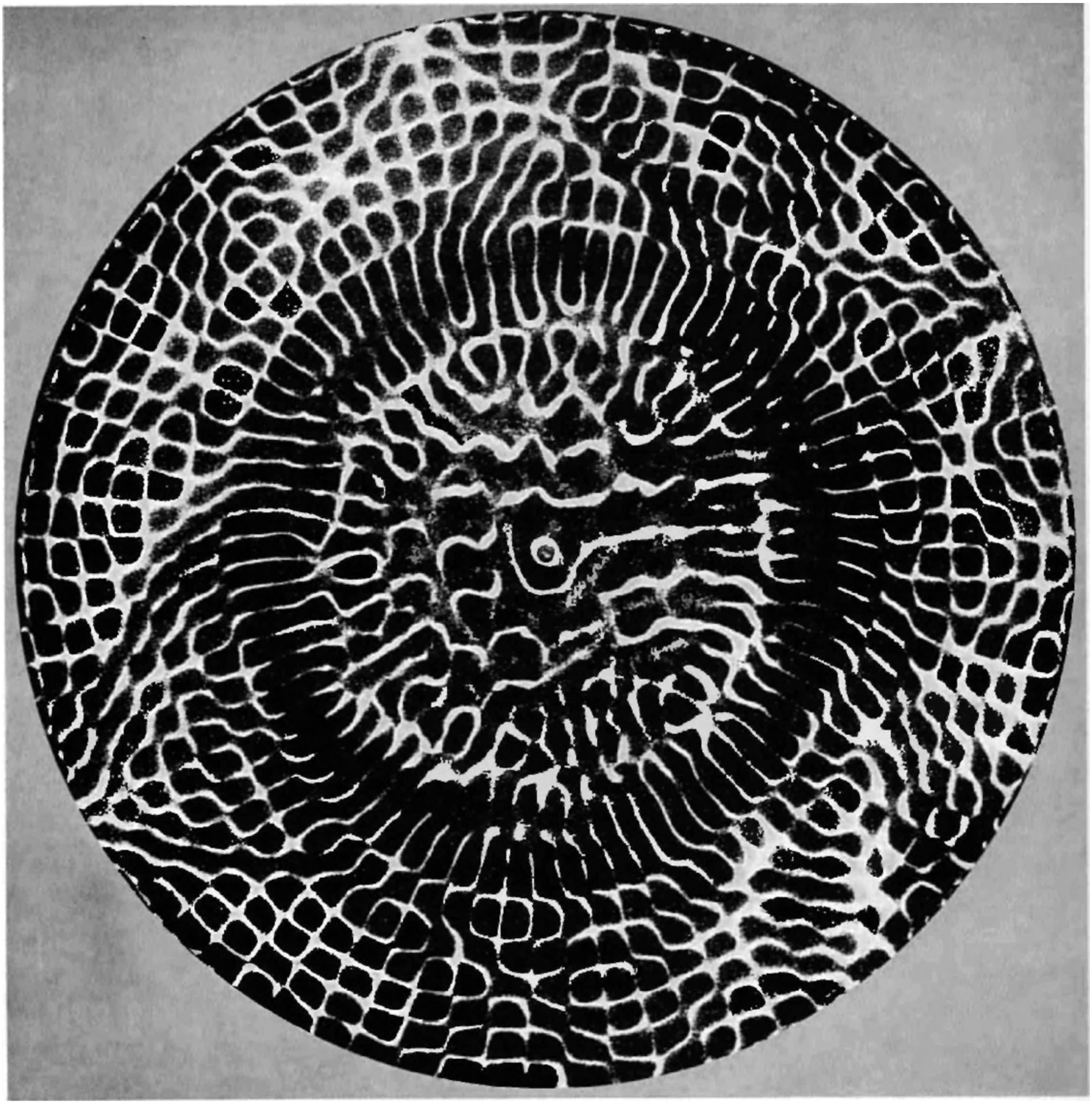
40
Greatest diameter 31 cm, 3095 cps. Excitation by crystal oscillators. Quartz sand was strewn on the diaphragm.

state. In Fig. 61 the process has progressed much further. Some pairs of eddies have formed. In such cases there is always a strict bilateral symmetry. On the face of it, this is astonishing. This eddy formation, however, is found to be directly connected with the vibrational pattern and its organization. Individual wave trains can also be discerned in this vibrational pattern. Additional pairs of eddies are formed at the sides, and these again are strictly symmetrical. In the marginal regions rotary currents with a tendency to form vortices can be seen everywhere. In passing, it is interesting to note the numerous turbulent areas which form in the marginal zones. Figs. 62 and 63 give details of this phenomenology of eddy formation. Fig. 62 affords a picture of the very center of this symmetrical pattern. The precision of the flow is clearly visible; the axis of symmetry runs from the top to the bottom, and the dividing line between the quadrants runs from left to right. Below right the eddy turns in a clockwise direction, and below left in a counterclockwise direction. It is particularly interesting to see in Figs. 62 and 63 how the currents move in layers. The dye indicator is distributed in laminar fashion. Fig. 64 shows once again a vortex in the form of four quadrants; once more there is symmetry and laminar flow. In all these pictures it must be imagined that the liquid is flowing quietly in a vortex while the energizing sound can be heard. If the experiment is performed with an opaque liquid, say mercury, some lycopodiurn can be strewn over it in order to make the currents visible.

These experiments have similarly revealed that not only are proper vortices formed, but also curious rotational currents such as may be seen in Fig. 65. The first beginnings of vortices can be discerned in the upper and lower section of the energized liquid. In the center there are indications of a figure-eight form, whose periphery is formed by the black fluid made to flow by the energizing sound. There is, of course, no division in the form of a lemniscate; here again the rotational flow is steady.

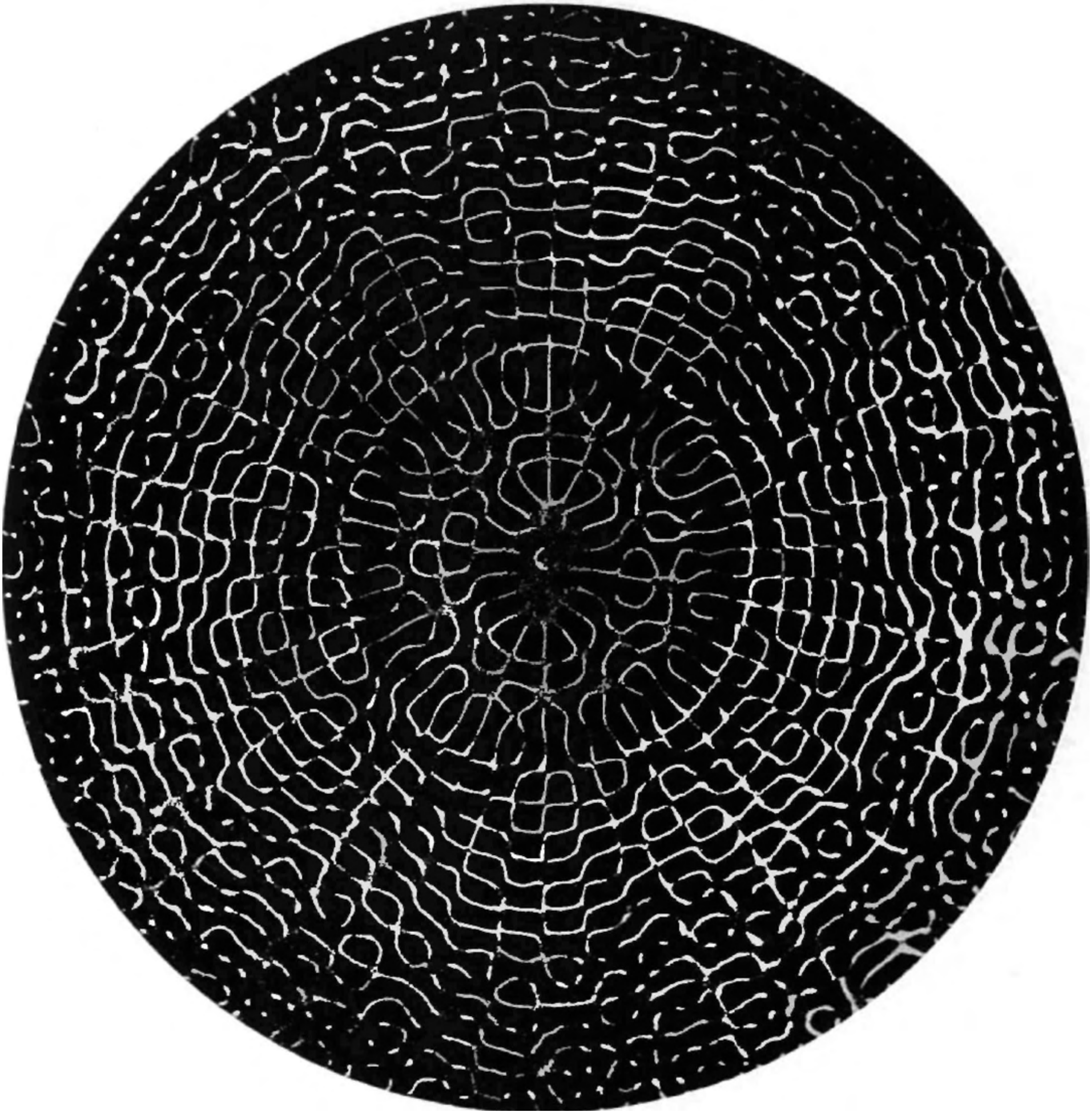
This particular field of cymatic studies calls for further extensive research. How do currents flow in three-dimensional space? Currents and countercurrents must be demonstrated, and above all, the operation of these hydrodynamic phenomena must be studied at the minutest scale, as we have already seen in the hydrodynamic theory of hearing.

If we allow these examples of cymatic phenomenology to file past our inner eye, we are struck by the extraordinary richness and diversity of the forms and processes. Yet even at this siage, certain significant features stand out from the background pattern. Figures, organized patterns and textures appear, real wave processes arise, then the whole is set in motion and fluctuates, giving rise to eddies, flows and streams. However, still further categories of phenomena will become apparent to us; and we shall then see whether we can gradually educe the outlines of basic phenomena



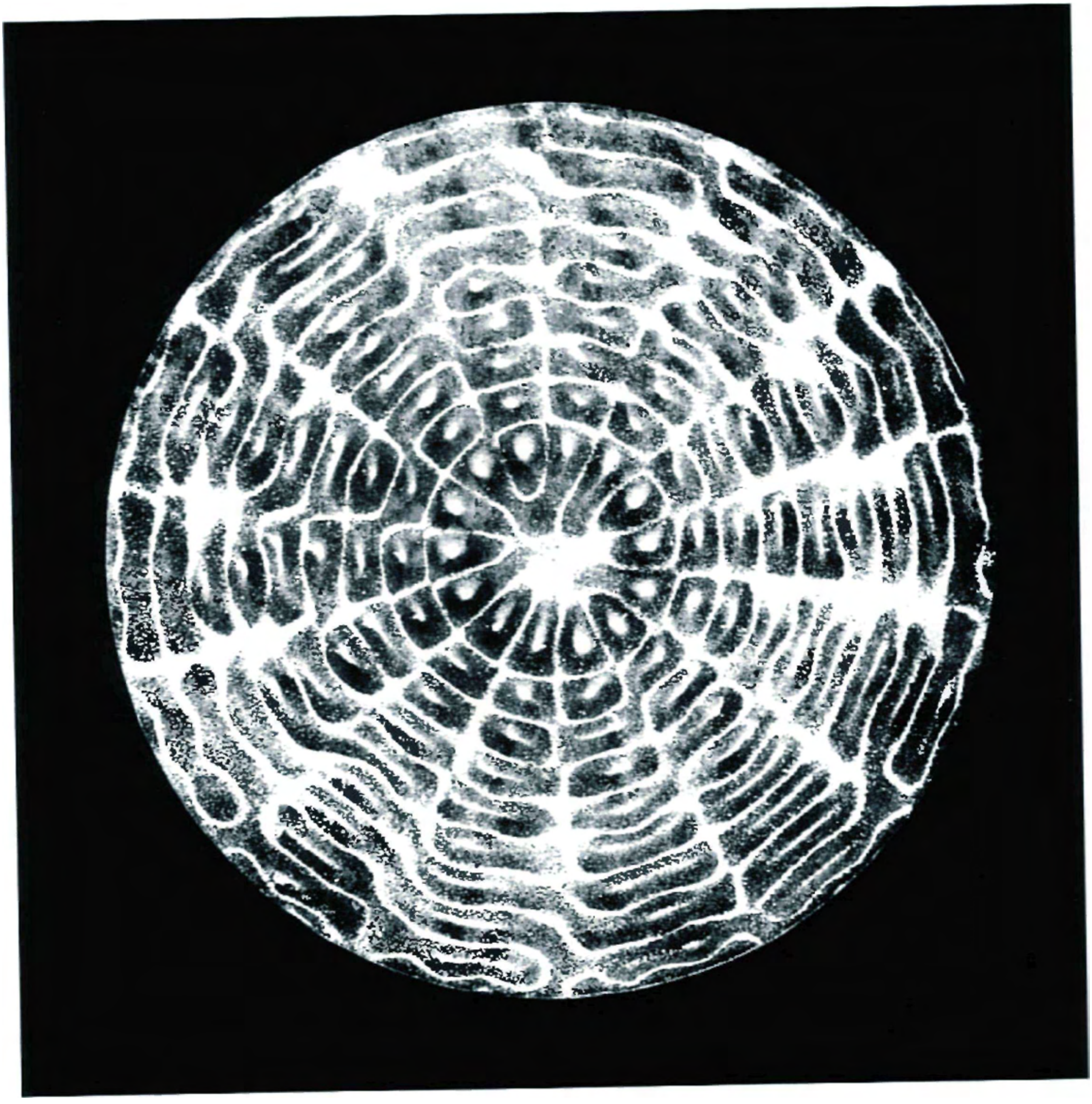
41

41 A sonorous figure excited on a circular steel plate. Diameter 50 cm, 6250 cps. In pictures like these the patterns resulting from radial and concentric nodal lines can be studied.



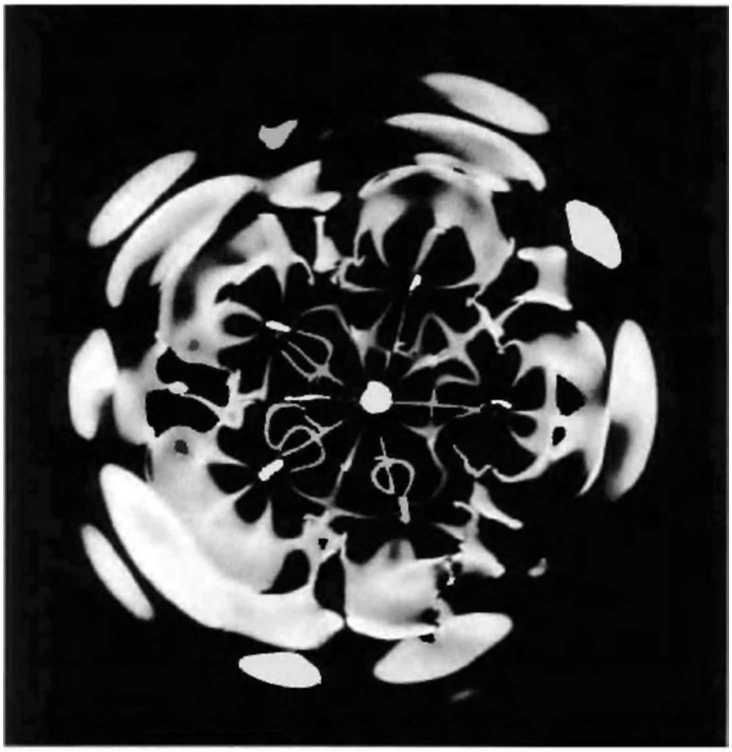
42

42 The same plate as figure 41 except that the frequency of vibration is 16.000 cps. By using the piezoelectric method, patterns of vibration can be produced in series. The fact that the frequency is higher than in figure 41 can be inferred by the larger number of fields.



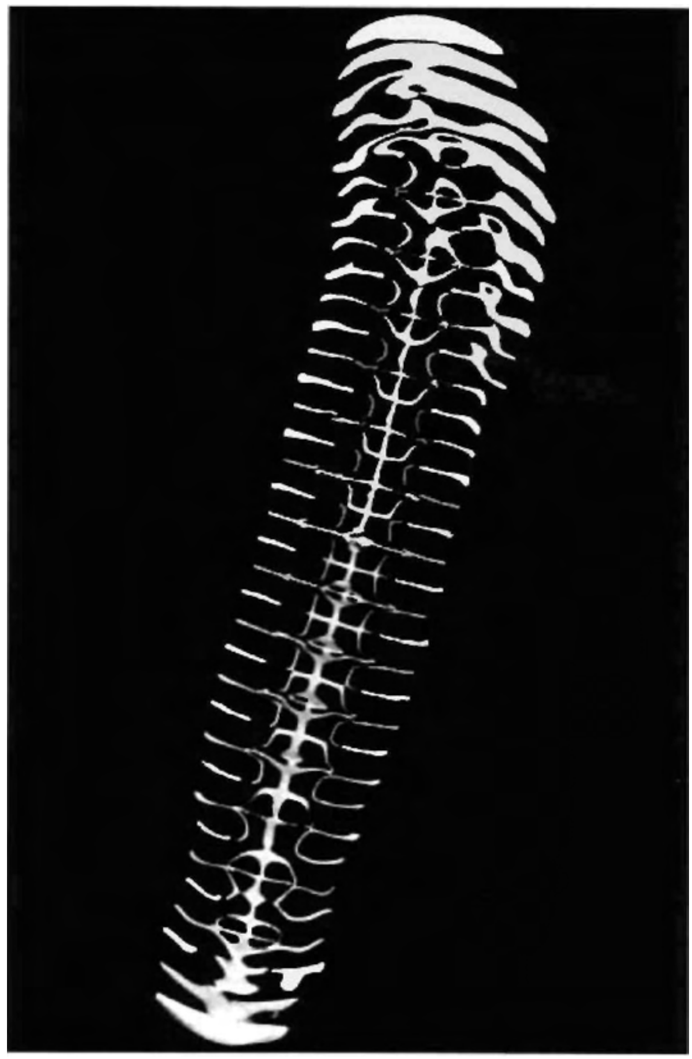
43

43 Sonorous figure. Plate: diameter 32 cm, thickness 0.5 mm, the material is strewn quartz sand, frequency 8200 cps.



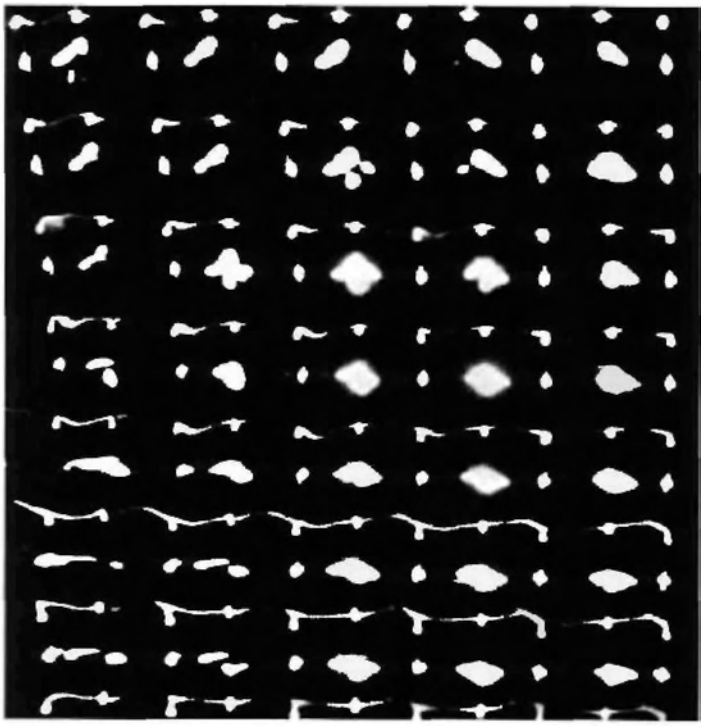
44

44 A layer of glycerin excited by the oscillation ot a membrane. Figures can also be seen in the liquid.



45

45 As in figure 44, a layer of glycerin has been made to vibrate by a tone acting upon a diaphragm. The result is a continuous formal pattern.



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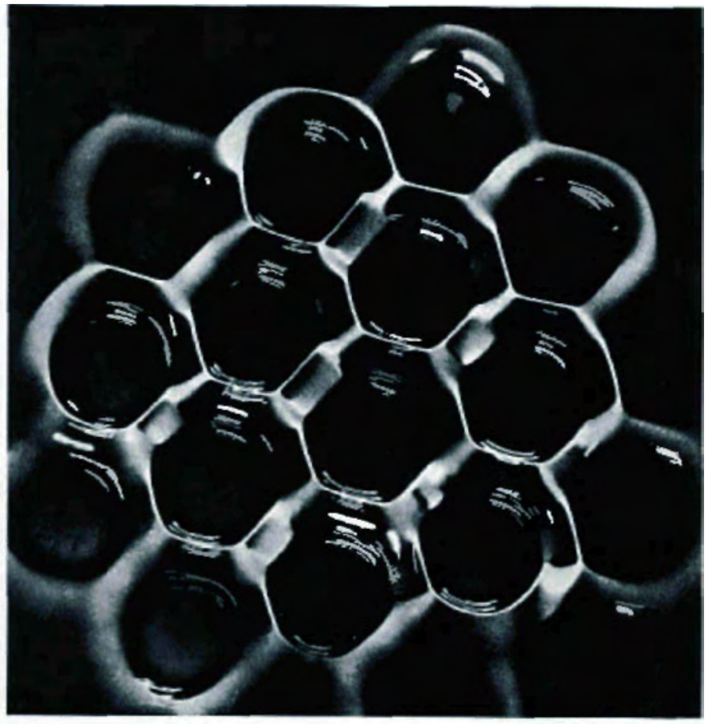
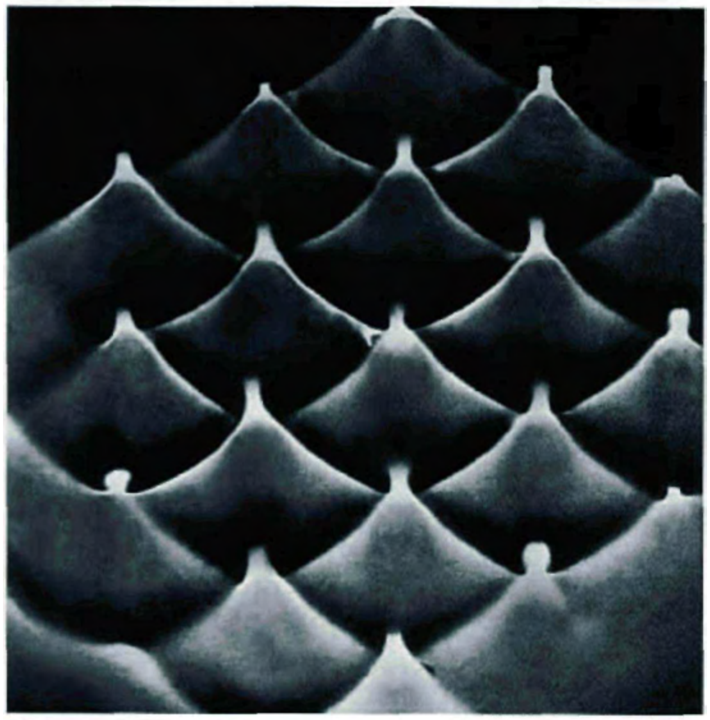


47

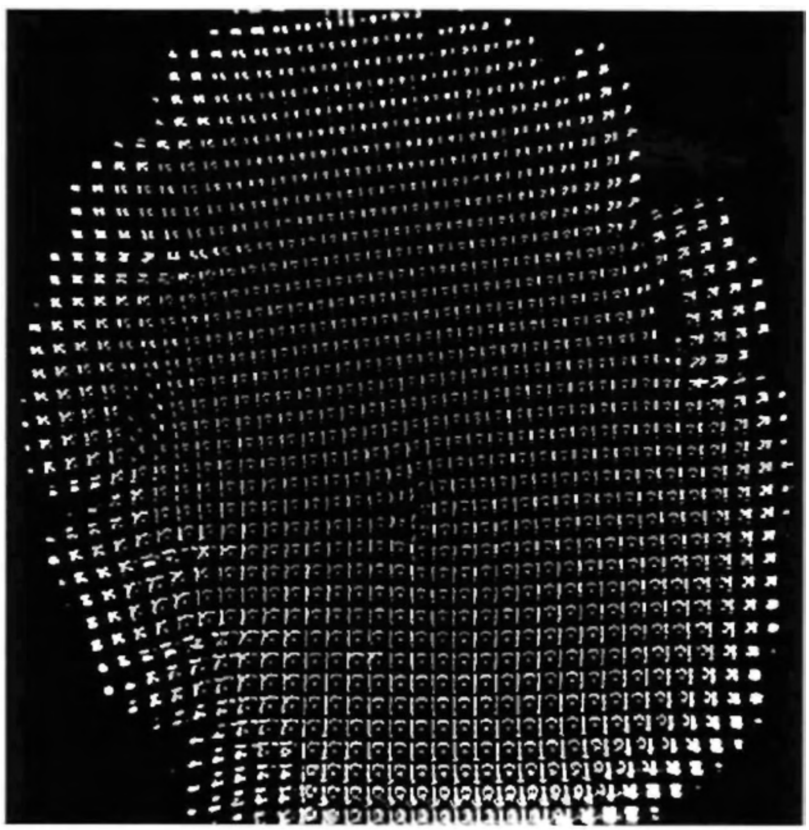
46. 47, 48 Numerous varieties of "woven" patterns are found in various materials, particularly liquids. These forms may have a cellular (46), honeycomb (47), or imbricated (48) appearance and are produced in the liquid by vibration.



48

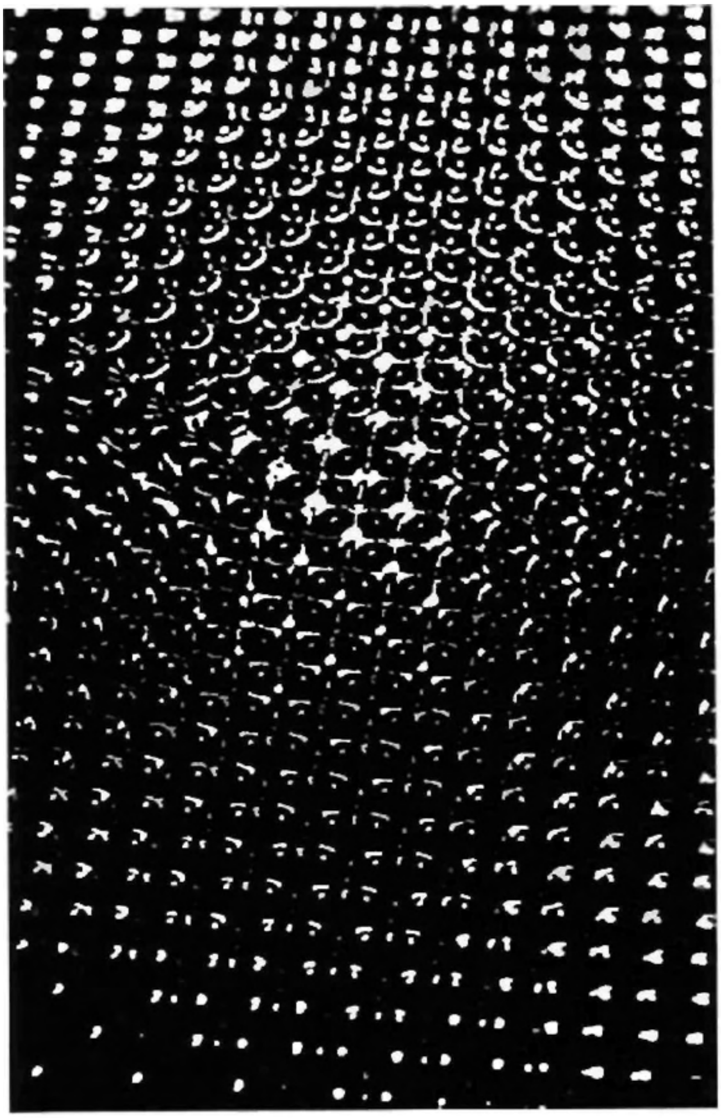
49

49 Here the "forms" are seen to be flowing and pulsing. The shifting figures produced in this sheet of liquid by vibration are reminiscent of Lissajous figures.

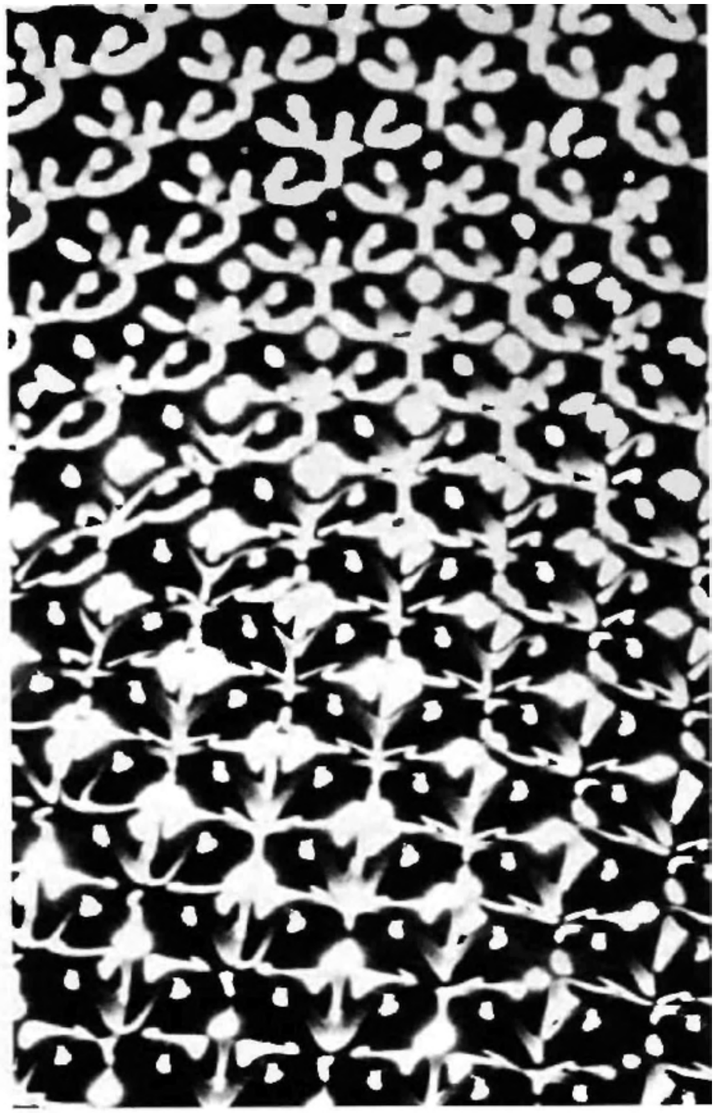


50

50 "Standing" lattices showing great regularity in their features may appear in oscillating sheets of liquid. Glycerin has been poured onto the diaphragm as a liquid layer.

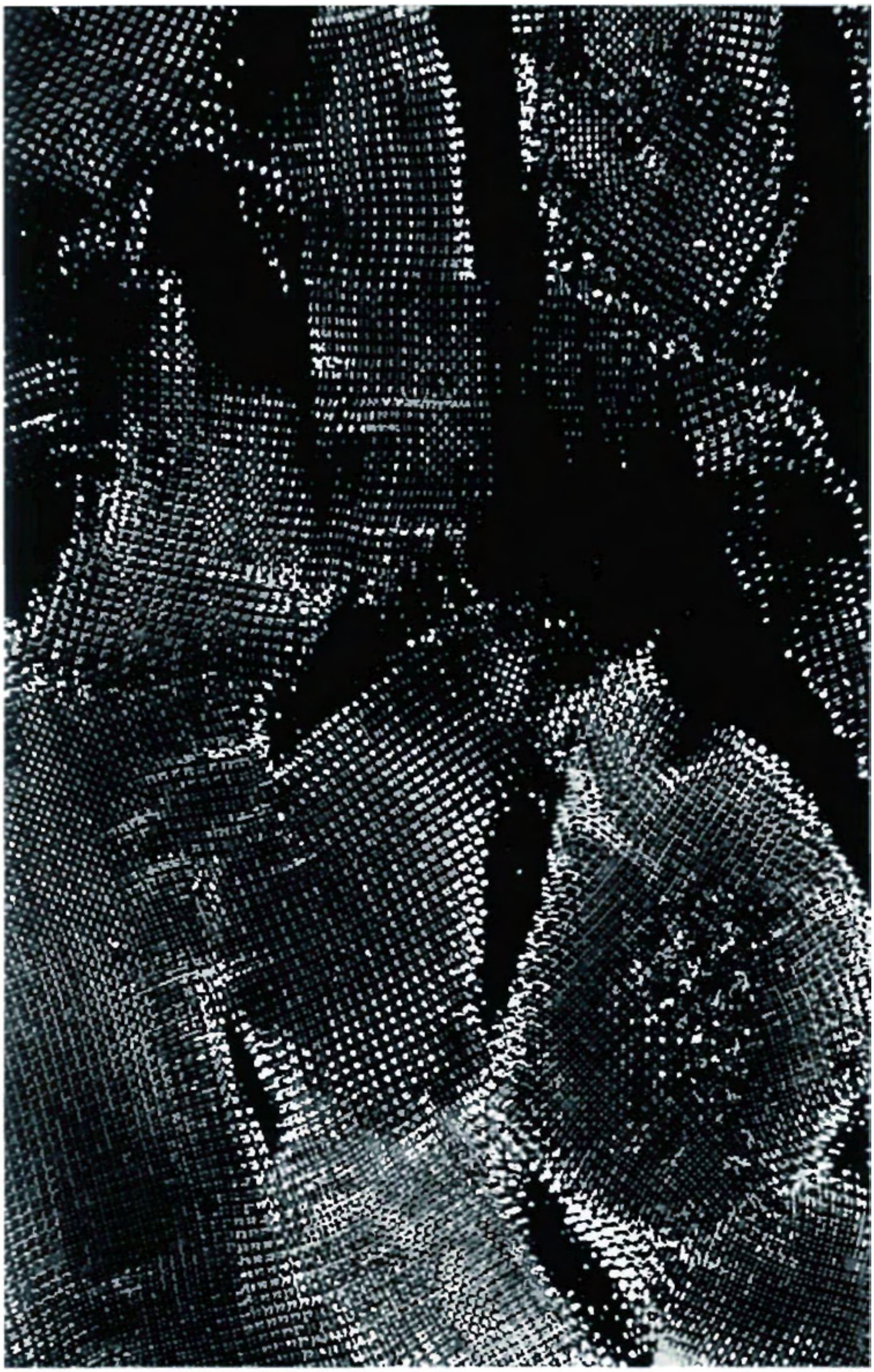


51



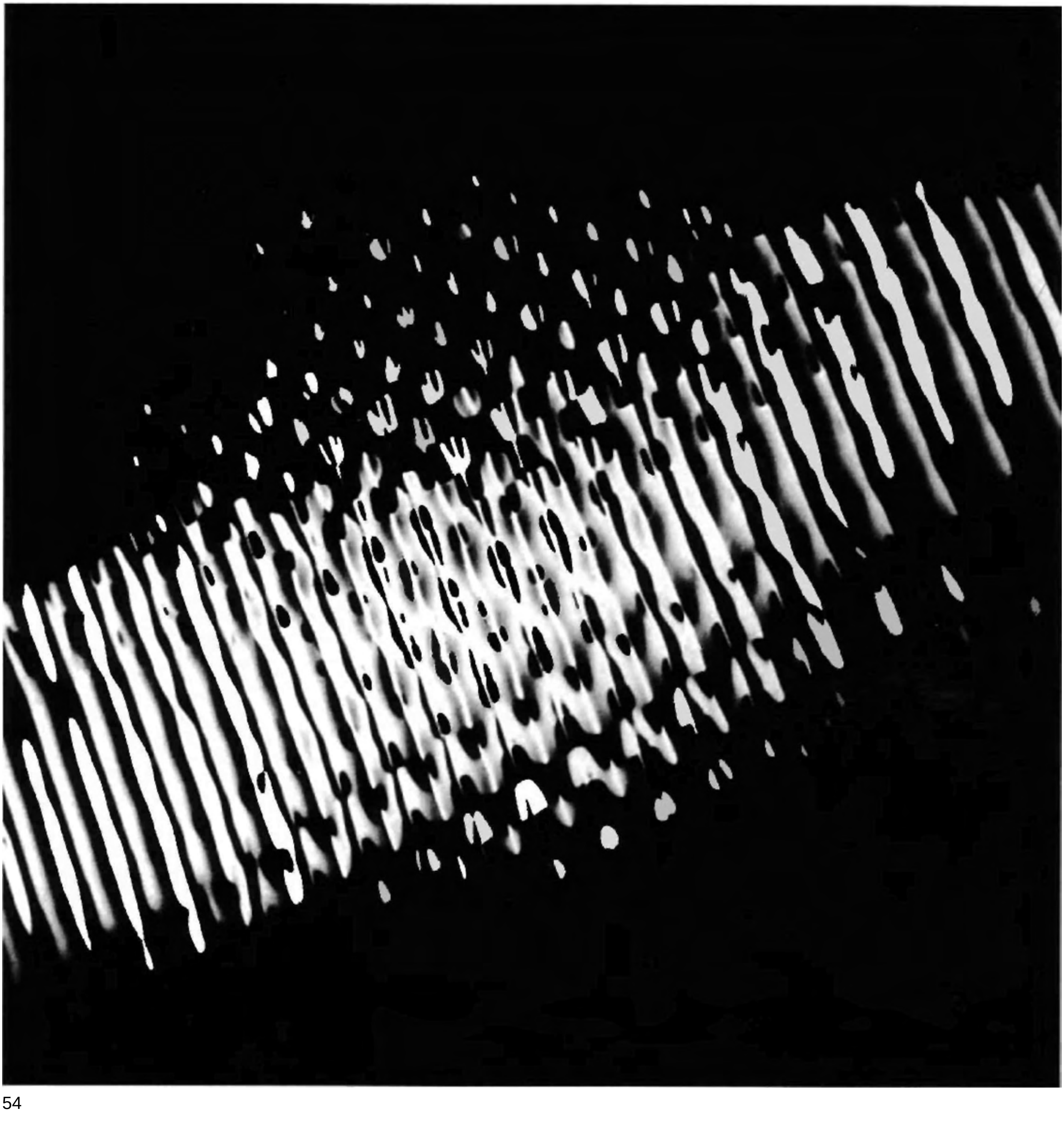
52

51, 52 The pictures change dramatically with even slight modification of the exciting frequency or amplitude. They must be conceived as being in motion and also subject to interference phases. (Figure 52 is a detail of the central part of 51.)



53

53 When the pattern produced by vibration is as delicate as this, it may be appropriately termed a texture. These wave fields are produced in a layer of glycerin on a diaphragm excited at a frequency of 300 cps. Here again many parts must be imagined in motion. Labile waves appear, particularly in the marginal areas of the textures, and often look like turbulences.



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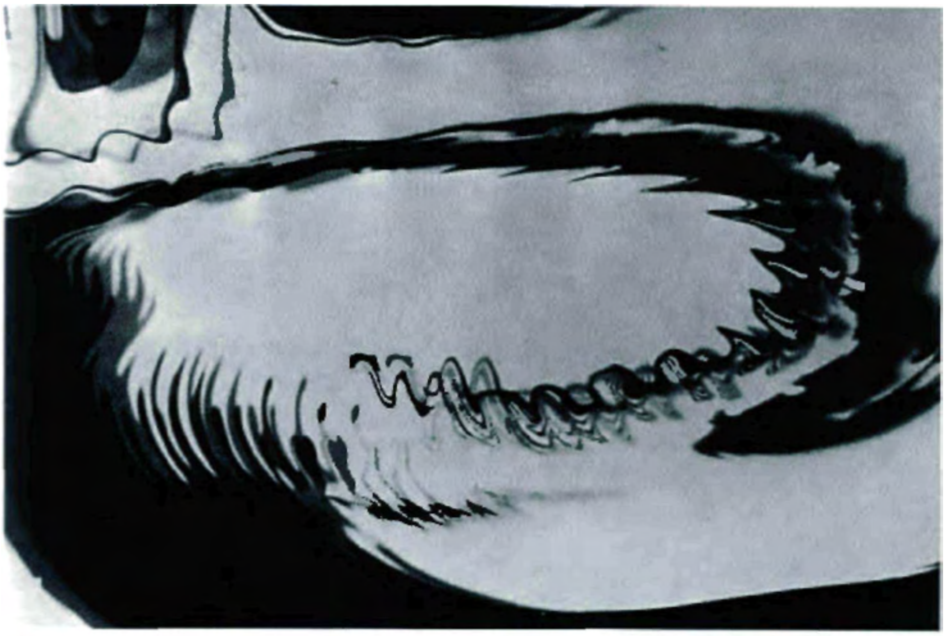


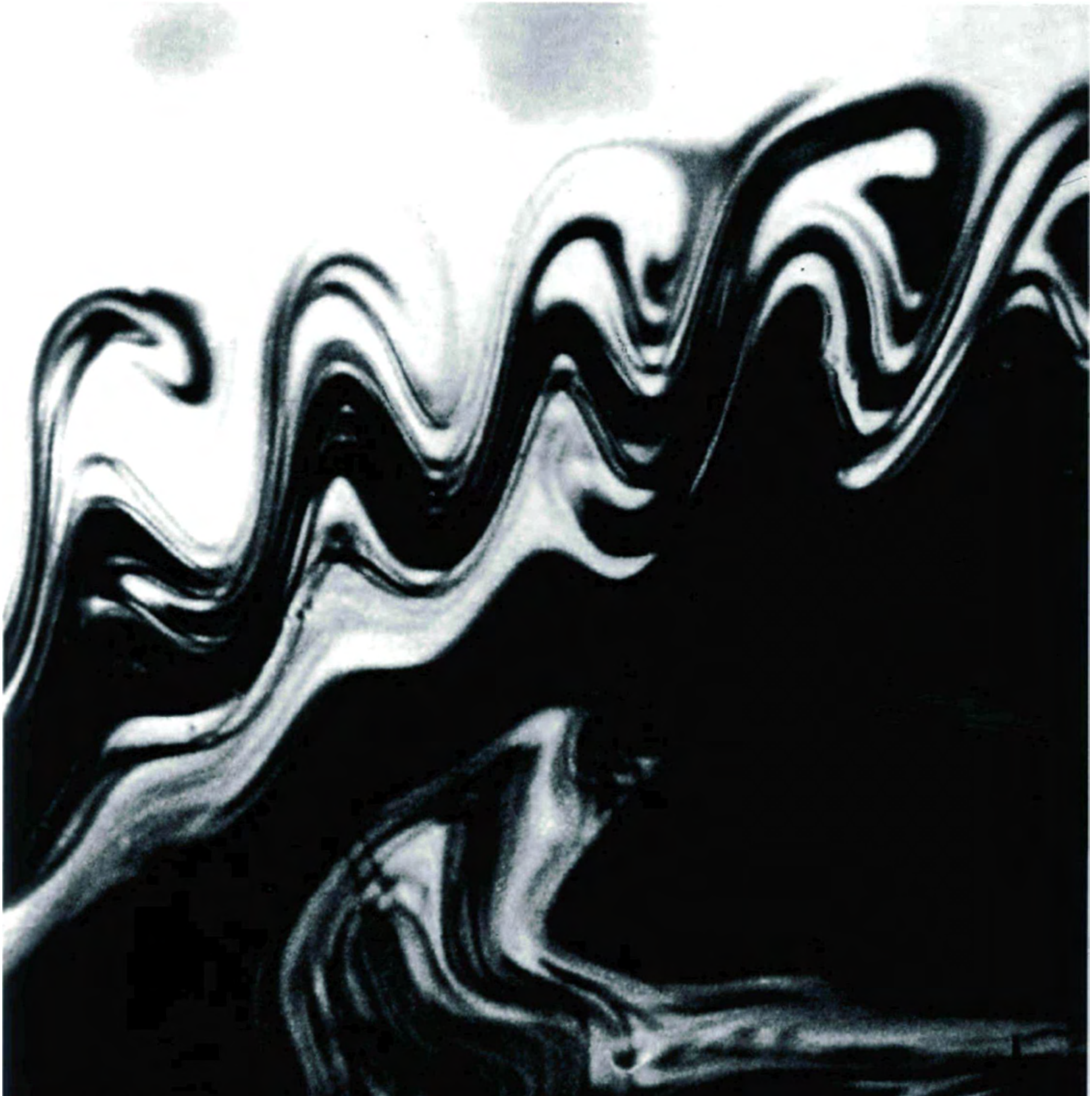
55

54 This wave structure is a development from the pattern in figure 35. There we saw simply a train of waves. Here the amplitude has been increased (which corresponds to a crescendo). This causes the formation of a lattice which can just be made out in figure 54. Some waves are just beginning to revea! in themselves the effects of cross-motions: wave lattices in the nascent state.

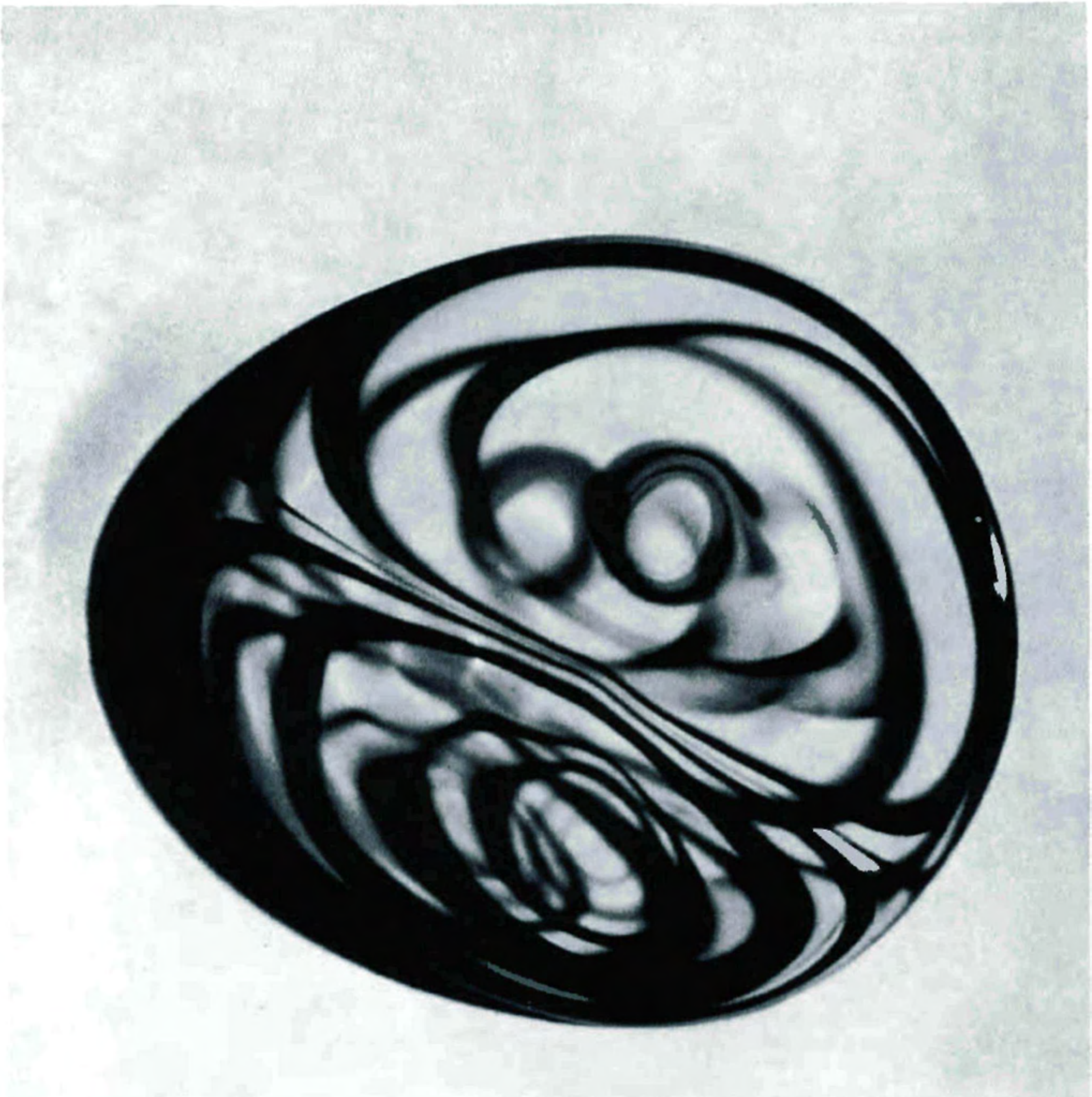
55-58 These are photographs of turbulences. They are not turbulences as understood in terms of hydrodynamics, rather they have been created by vibration. They appear, fade away and reappear. They are therefore labile waves which have a complex and vortical appearance. They appear more particularly in and near marginal areas between two different areas of movement or between dynamic and static areas.

56


57



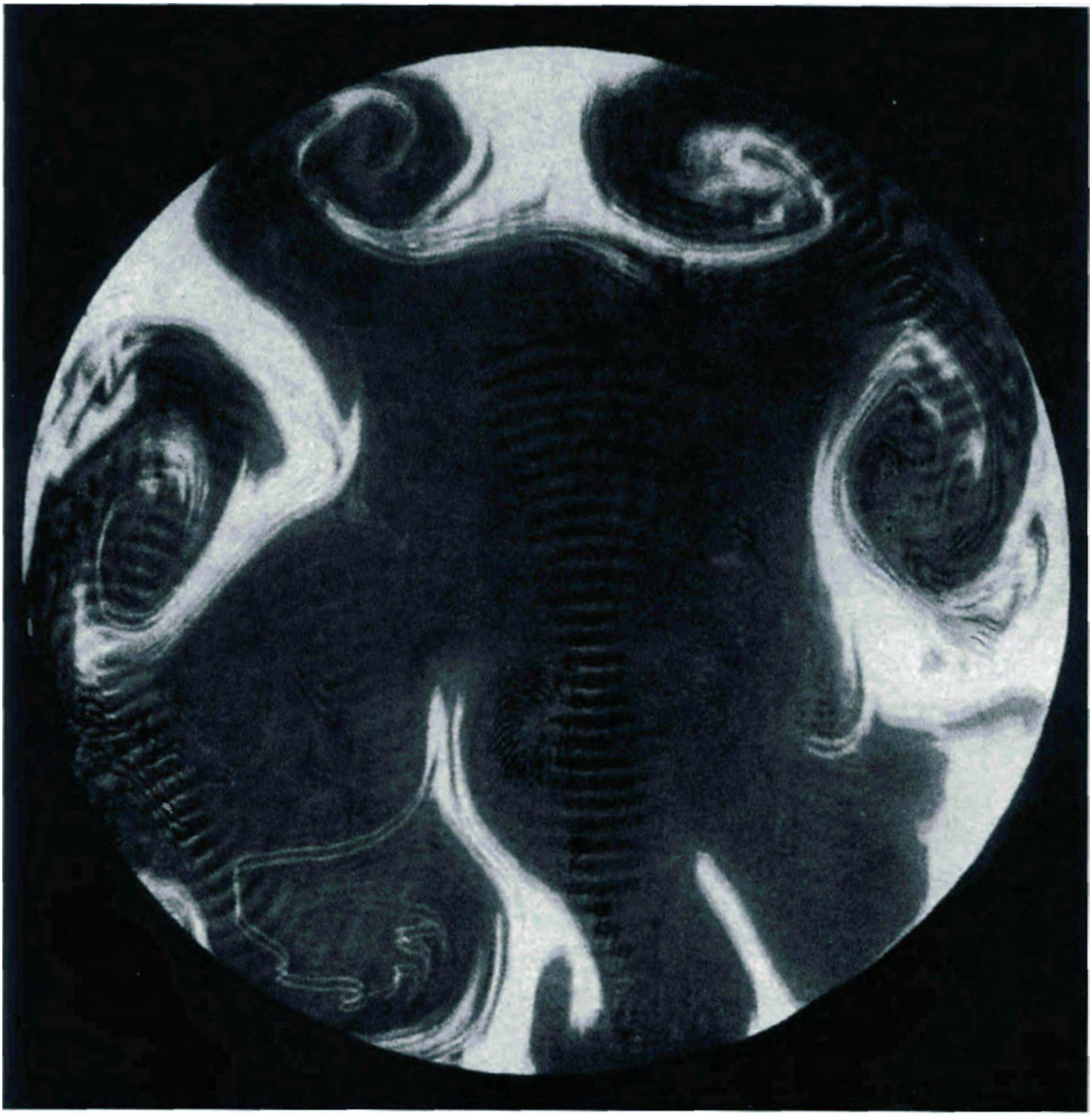
58



5S

59 The simplest case. Diameter about 2.5 cm. One pair of vortices has formed. A black dye was used as an indicator.

59-66 In these photos we see hydrodynamic phenomena caused by vibration. If liquids are excited under suitable experimental conditions, vortices are formed which remain remarkably symmetrical in their behavior. Vortices are invariably formed in pairs and rotate in opposite directions.



60

60 The process is in the nascent state, i.e. the vortices are just forming. Some wave sequences can be observed. These are a sign that vibration underlies the whole process. (Diameter 23 cm., 100 cps.)

61

61 A stage further in the process. Several pairs of vortices have formed, each strictly bilateral in its symmetry. The vibrational field measures 28 cm across.

62

62 Detail from an experiment with vortices. We can see the point at which four quadrants abut. The axis of symmetry runs from the top to the bottom. The flow — these vortices must be imagined in constant rotation — is laminar in character, i.e. it proceeds in layers.

63

63 Another detail from an experiment with vortices. A pair of vortices, the one on the right turning in a clockwise direction and the one on the left in a counterclockwise direction. This experiment is also audible.

64

64 A pair of vortices, each pair situated in a quadrant. Again there is bilateral symmetry. The louder the tone (i.e. the greater the amplitude), the more rapid the rotation.

66

65 Hydrodynamic phenomena originating in vibration are a rewarding Held for observation. In addition to vortices other now patterns can be found. In figure 65 a figure-eight form can be discerned; there is however no intersection as in a lemniscate. The effects of sound have produced circulation.

65

66 Detail of a vortex. All these forms are in the strictest sense hydrodynamic phenomena originating in vibration.

61

4

The Tonoscope

Observing the action of the human voice on various materials in various media suggests itself as an obvious procedure. For this purpose the tonoscope was developed. This is a simple apparatus into which the experimentor can speak with out any intermediate electroacoustic unit. Thus vibrations are imparted to a diaphragm on which sand, powder, or a liquid are placed as indicators. Speaking actually produces on this diaphragm figures which correspond, as it were, to the sound spectrum of a vowel. Figs. 67.68 and 69 are photographs of these vowel figures. The pattern is characteristic not only of the sound but also the pitch of the speech or song. The indicator material and also the nature of the diaphragm are, of course, also determinative factors. However, given the same conditions for the experiment, the figure is a specific one. One can sing a melody and not only hear it, but also see it. As the photographs show, organized patterns and configurations are quite apparent. They are there for the eye. man's most sensitive organ of sense, to see. A pattern appears to take shape before the eye and, as long as the sound is spoken, to behave like something alive. The breath alone can cause it to move; a texture of forms is created by the fluctuations of the voice. The eye can also see variations as the voice is raised or lowered. During continuous speech the patterns metamorphose continually. The purpose of these observations was to show that such figures and patterns can give rise to a visual experience which can be fully equated to the aural experience. This is an achievement which not only opens up a new world to those with normal hearing, who see for themselves that their speech actually involves the production of vibrating patterns which continually penetrate and fill space, but also, and most important of all. it enables the deaf to experience what they are actually producing with the speech they have learned and been trained to use. They do not hear the sound they create although they no doubt see the speech movements of others. But they have no sensory experience which is equivalent to hearing a tone, a vowel, a word. A truly figurate pattern, however, speaks a language of its own; a picture is a perceptual experience complete in its own terms. Experience has shown that these tonoscope pictures are highly stimulating to the mind of the deaf-and-dumb. If a deaf-and-dumb patient, for instance, speaks an 'O', the sound element contained in the speech of the deaf-and-dumb subject also appears in the vibrational pattern. Now he can see the 'O' which a normal person speaks. The difference between the two pictures is very marked, but he is now given an opportunity of practicing until he has achieved the form of a purer 'O' sound. Everything he does becomes visually apparent to him. As soon as he can produce the form of a purer 'O', we can hear that he is also speaking a purer 'O'- The same holds true for pitch. Here again he is enabled to practice until he can achieve nuances of speech which he is unable to experience through the sense of hearing. He is now open to visual experiences which can be equated with the stream of speech, the pulsing of the air mass, the air stream, etc. He can see the to-and-fro motion of his sounds, his words and sentences, and also the flow patterns made by good speech. Since deaf-and-dumb patients have very sensitive vision (and a very fine sense of touch) they can familiarize themselves with the visual speech of the tonoscope and train with its aid.

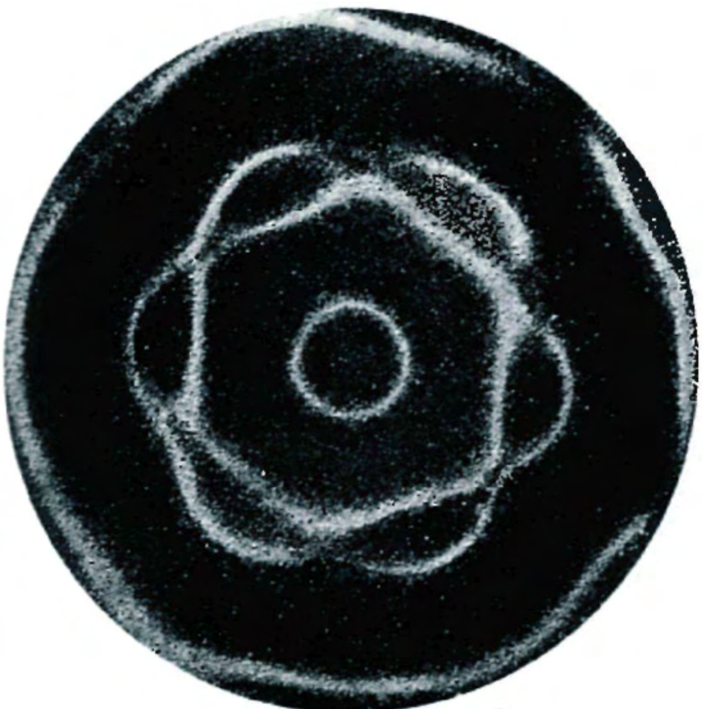
An electroacoustic variant of the tonoscope is suitable for visualizing not only speech but also music. The sonorous patterns are directly impressed on, say, a liquid, and not only the rhythm and volume become visible but also the figures which correspond to the frequency spectra exciting them. These sonorous patterns are extraordinarily complex in the case of orchestral sound. Figs. 70-73 show the visual versions of musical excerpts: 70 Bach, 71 Bach. 72 Mozart, 73 Mozart.

If we look at these passages on a silent film, we can at first make nothing of them. If, for example, we see the Jupiter Symphony without being able to hear the music, we should never guess from the visual effects with their flowing and constantly changing patterns, that we were seeing Mozart. The rests in particular, which are inscrutably and essentially part of the music, appear at first to the beholder as black holes, as a cessation of activity. But if the sound is turned on, everything flashes to significance for the eye. Hearing is added and restores to experience its full content. It takes training to be able to "hear by seeing". The tonoscope is a device with which one can train oneseif in this art.

In this particular context it may be said that the sounds of the human voice have specific effects on various materials in various media, producing what might be called corresponding vocal figures. These again are patterns produced by vibration and as such are appropriate objects for cymatic study.

67,68, 69 These three forms have been produced by speaking directly into the tonoscope. This is a simple apparatus with which a spoken sound can be rendered visible on a diaphragm. Figures 67-69 show the vibrational patterns produced by vowels, reflecting the sound spectra and pitch of each particular sound. The material of which the diaphragm is made and the indicators used (powder, sand, liquid, etc,) are also important factors: the partem also changes according to the quality of the individual voice. But the form remains the same as long as there is no change in the conditions of the experiment.

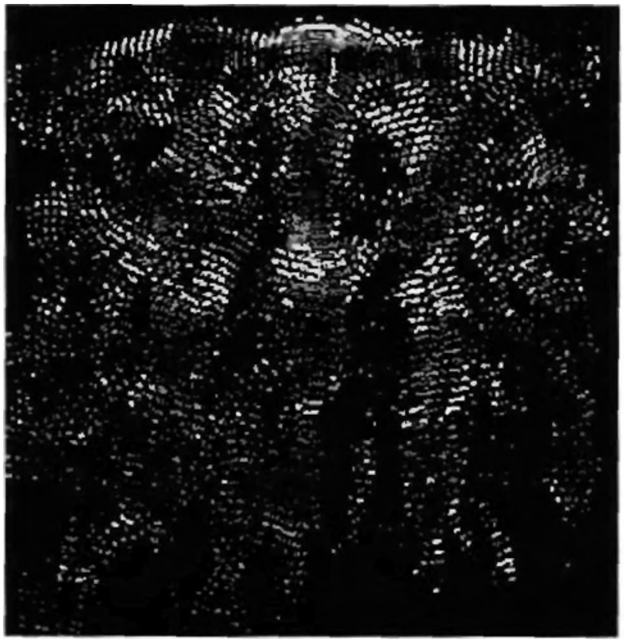
67



68

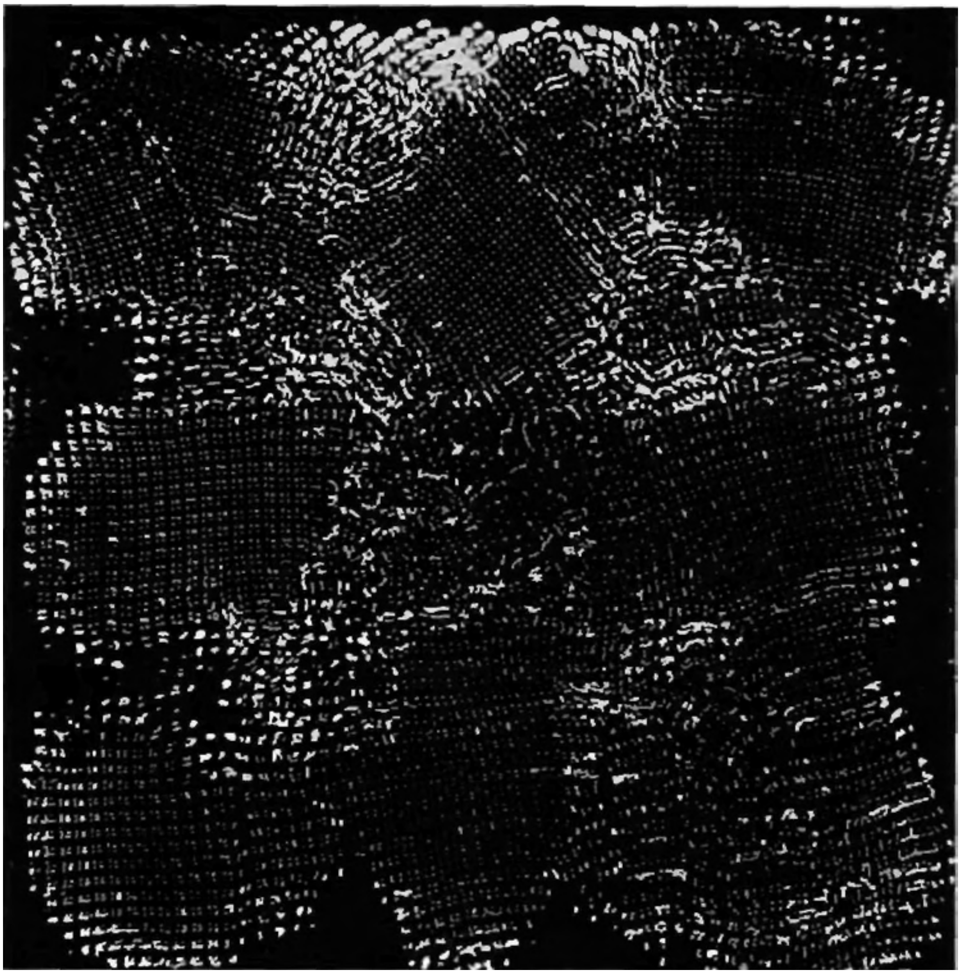
69

70-73 Like the human voice, music can also be made visible by means of the tonoscope. For this purpose an electroacoustic version of the tonoscope is used. Liquid was used as a reagent in the pictures shown here. The vibrational figures appear indirectly in the layer of fluid. They are entirely characteristic of the music played. However, the eye is unaccustomed to seeing music and is at first lost without the guidance of the ear. But with the ear to prompt it, the eye experiences these tonal events in full visual detail.



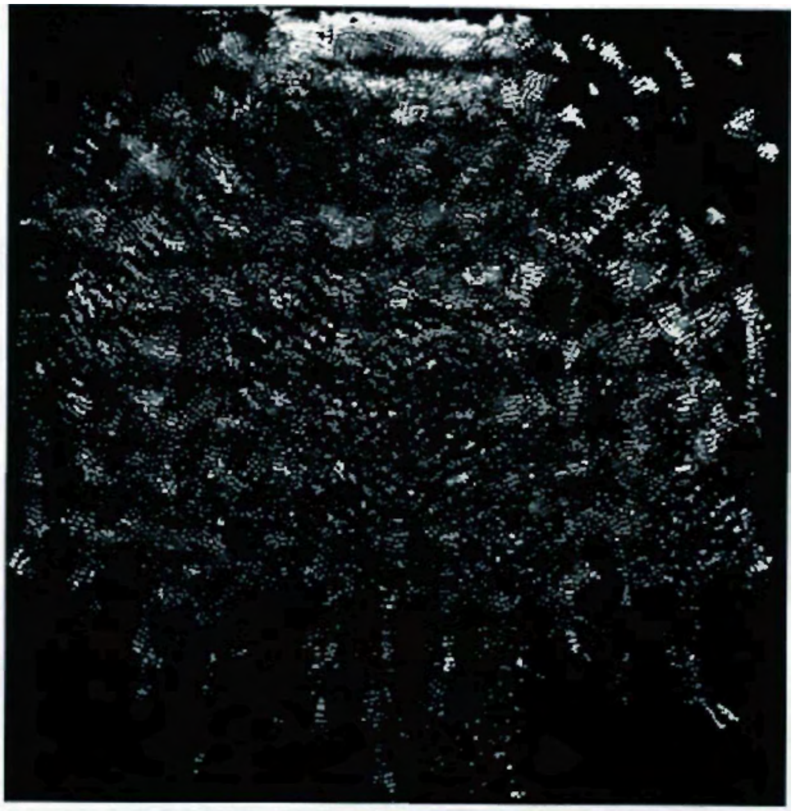
70

70 Bach, Toccata and Fugue in D minor, 1st movement, bar 30, before start of andante.

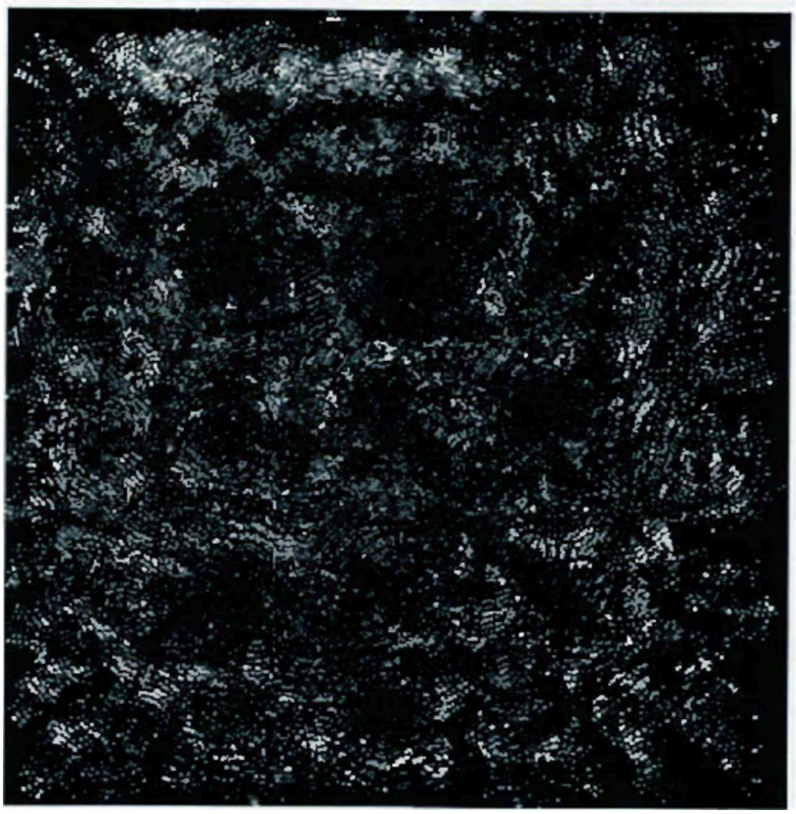


71

71 Bach, Toccata and Fugue in D minor, 1 st movement, bar 29, start of fortissimo passage.


73

72 Mozart, Jupiter Symphony, 1st movement,
bar 173, beat 3.


72

73 Moz Mozart, Jupiter Symphony, 1st movement,
bar 59, beat 1 (trill).

5

The Action of Vibration on Lycopodium Powder

To provide a fuller account of the way in which a cymatic process may be observed, an example will be discussed at greater length. We shall describe a series of effects which appear when lycopodium powder is subjected to vibration. One can affect changes almost endlessly in experiments of this kind. There seems to be a risk of losing oneself in the infinite. All the same, the phenomenon must be made to yield as much specific knowledge as possible. There is no point in merely reading from the phenomenon what is immediately apparent. Time and again one is reminded of Goethe's words: "All have a similar form yet none is the same as the other, and thus the choir shows a secret law, a sacred mystery."

Of course, many processes can be analyzed, measured, and expressed in formulae. Of course, formulae, graphs, and probability relations are also derived from reality. They are images of reality and as such are also real. With their aid one can influence this reality, and indeed create new realities (e.g. in technology). But they are derived from reality; they are outside that which really exists; and the latter is more, much more, than the formula, than the quantitative determination, can indicate Only certain aspects of the phenomenon are grasped. But how is it possible to grasp the complete phenomenon, the realty real, at all? The creation of purely philosophical ideas, which paints Nature in mentai images, is likewise incapable of grasping existence in its vital plenitude. It is "above" the really real. Even this speculative philosophy cannot penetrate the mystery of existence in all its fullness. This will only reveal itself progressively if we do not merely analyze it and anatomize it to a skeleton; if we do not merely try to take mental possession of it but instead patiently attend upon it, neither raising ourselves above it nor killing it.

However much it may seem that "nothing" is thus achieved, this close observatio s nevertheless the way that renders sources of knowledge accessible to research, enables the seeker to stay the course, and confers vitality. It will inevitably become apparent in the course of our descriptions whether this method of observation and more observation, whether this preservation intact of what is observed, this non-interference with the phenomenon, will elicit the outlines of basic phenomena and reveal something intrinsic and essential.

The lycopodium powder is strewn evenly on a diaphragm (Fig. 74). The diaphragm is excited by a tone. Immediately a number of small round shapes are formed (Fig. 82}. If the amplitude is increased, these shapes begin to migrate to the places where the oscillatory movement is more pronounced (Fig. 83). As this happens, many of them unite to form new piles of spherules. If this process is continued, more and more of these formations join up. One large overall form might appear. Fig. 83 shows the migrating piles of spherules and the paths they follow. All these round piles are in a state of constant circulation; that is, the particles on the upper surface move from the center towards the periphery and those at the bottom in the contrary direction. They rise upwards at the center and then proceed towards the periphery, etc. There is thus a kind of radial circulation. Marking with colored grains enables these

74

74 Before any acoustic irradiation, the lycopodium powder (spores of the club moss) is spread evenly over the diaphragm. The diameter of the diaphragm is 28 cm.

75

75 When the tone is loud (large amplitude) the powder is thrown up in fountains or even ejected. Yet by means of the stroboscope, which renders rapid phase sequences visible. it can be seen that vibration imposes its pattern on both the form and the dynamics of these eruptions.

76 Here again a lycopodium fountain can be seen. A spiral formation can be discerned in the column of powder. 130 cps, large amplitude.

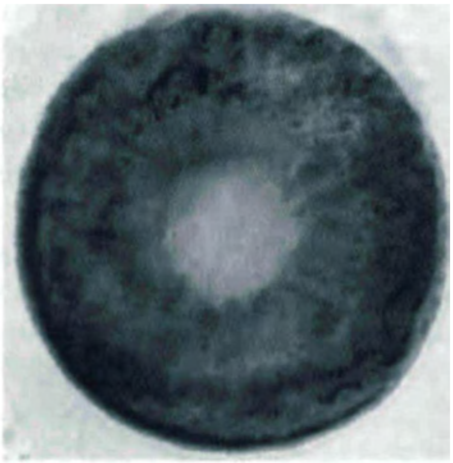
circulations to be observed. The same circulation also takes place in the large forms; however, these processes can be seen taking place in the areas where organized patterns have been formed by the vibration. Fig. 84 shows a large complex of this kind. We can see the patterns whose configuration changes with shifts of frequency. Fig. 84 is formed by a soft tone. Fig.85 shows a large circular shape about the size of a small chicken's egg at a frequency of 300 cps. If the amplitude is further increased corresponding to a crescendo for the ear, the movements become increasingly violent. The circulation becomes faster and proceeds on a larger scale. Eventually masses are thrown up and ejected. There are eruptions and fountains of powder which swirl high into the air {Fig. 75). A vortical movement can be seen in one of these powder fountains (Fig. 76). But while masses are ejected at one moment, they fall and are returned to the system at another. Thus, for all the changes and transpositions, a certain constancy of mass is curiously retained. The forms move to-and-fro both when the frequency is changed and the amplitude. In doing so they move as wholes, i.e. when they move in one direction by putting out an arm, the whole follows, and there is retraction at another place. Thus locomotion is truly correlated throughout. Instead of parcelation, there is a uniform streaming

76

or flowing. This character is, of course, determined simply and solely by the vibrational pattern. Once the tone is discontinued, the powder lies undisturbed as an accumulation of particles. Even the separation and repining of the formations take place in this uniform manner. Whether they engulf each other or disjoin from each other, there are no indications anywhere of a disintegration or disruption. It can sometimes be observed by stroboscope that the conglomerations are pulsating.

If the amplitude is greatly increased (fortissimo), the powder changes into a cloud of dust. The phenomenon enters the spatial or three-dimensional Even so, the stroboscope still reveals in these turbulent, eddying masses certain arrangements which can be traced back to the vibrational pattern (Fig. 77). Where the turbulence is most marked, vacant zones, spatial eddies, "empty spaces" alternate in conformity with the patterns imposed by the vibration. If at the greatest amplitude when the powder is thrown up into a veritable cloud storm, the sound is switched off abruptly, the powder falls back onto the motionless diaphragm more or less evenly. At this maximum modulation of amplitude, then, what might be described as an integrating effect is possible. The configuration of particles, for all its multiformity and individualization, can be integrated in an instant, and we are back at the initial position.

How precisely the spherules are concentrated at the sites of movement

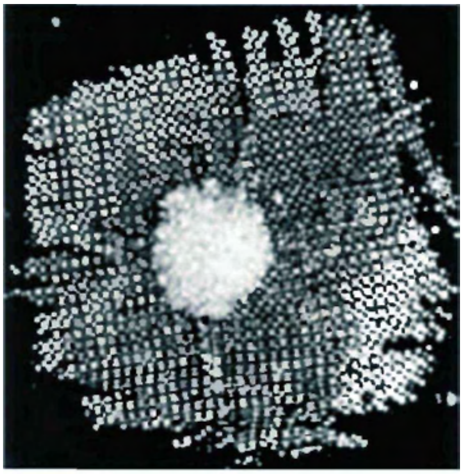


77

77 A still larger amplitude throws up a cloud of lycopodium. The process actually takes piace in the space above the diaphragm. Vortices, turbulences and also patterned elements can be seen. There are areas of greater or lesser density. Here again the stroboscope reveals details of the vibrational topography, 300 cps.

78

78 Figure 78 shows how characteristically the various substances behave. Hexagonal steei plate, 3600 cps. The strewn material is quartz sand ana lyccpodium The sand moves into the nodal lines and the powder into the antipodes, where it circulates in the center as a round shape. The behavior of the two substances under these experimental conditions is specific.



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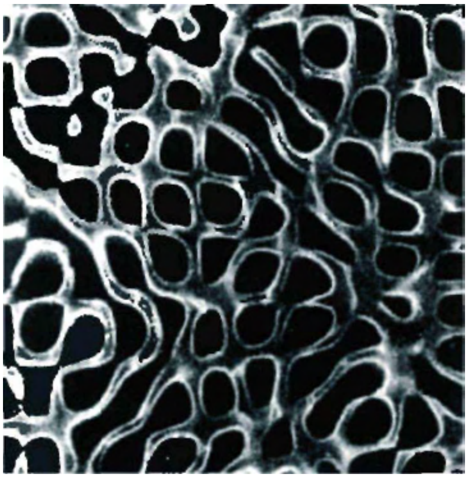
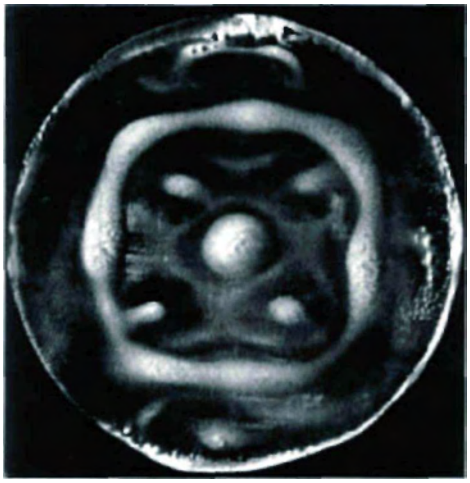
79 Under different conditions the quartz sand also forms into circulating round shapes. Fig. 79 shows a wave field of vibrating water. The sand heaps up in the center and circulates. Frequency 1060 cps.



80

80 When conditions are different, the lycopodium powder forms sonorous figures. Figure 80 is a detail of a sonorous figure formed of lycopodium powder on a steel plate, 31 x 31 cm. Frequency 12,900 cs. This picture shows very strikingly how the powder is transported from the zones of movement towards and into the nodal zones. The precise way in which the double contours mark out the nodal zones is very conspicuous.



81

81 Sonorous figure appearing in lycopodium powder on a diaphragm, 250 cps, large amplitude, The neatness with which the particles are transported and deposited is a recurrent feature. Before acoustic irradiation the powder was spread out evenly.

can be clearly shown if, say. a steel plate is evenly strewn with quartz sand and lycopodium powder. When vibration is switched on, the grains of sand move into the nodal lines and the lycopodium spores into the antinodes, in the center of which they join together and start to circulate. In Fig. 78 (steel plate, frequency 3600 cps) the quartz sand is in the nodal lines and the central white spots are lycopodium. The round circulating heaps are not to be found with lycopodium alone. If quartz sand is poured into a vibrating sheet of water, round heaps of circulating sand can be discerned in the wave fields of the liquid i.e in the areas of motion. Fig. 79 clearly demonstrates this.

Needless to say, the processes of interference referred to above can also be generated with lycopodium powder. The forms then move to-and-fro between two positions, or phases of rest alternate with phases of movement.

Since a vibrational system contains certain heterogeneous elements within itself it is possible for interference phenomena to be generated by one tone and shown by the indicating material.

Rotational effects can also be seen here. In the circular heap, the movement created follows a circular path. If this process takes place in two directions, a seesaw effect results. The phenomenon occurs like this: a stream of powder follows a circular path through the round form, moving forward in what looks like minor eruptions; there is a period of rest, and then the same movement starts again, but in the opposite direction; another period of rest; and then the first movement is repeated, and so on. This seesaw effect has, of course, been filmed (as has all the phenomenology shown here).* It might also be noted that it can be produced with an impulse at only one frequency. Thus a system, if it is of such a type as to contain several oscillatory responses, can be made to produce interference by one frequency or even produce a seesaw effect (i.e. without frequency modulation in the generating tone).

This series of experiments is exceptionally diversified. Well-known sonorous figures may appear with lycopodium under certain conditions. Fig. 80 shows a sonorous figure rendered visible on a steel plate with lycopodium, at a frequency of 12,900 cps. By using lycopodium. patterns can be obtained in which the powder is driven into certain zones while olhers remain entirely free from particles, e.g. in Fig. 81. There are empty spaces on the one hand and powder erupting into clouds on the other. It might also be noted that a few isolated round shapes have formed where the vibration is less violent. Kinetic-dynamic processes can be instigated by frequency modulation. Here the situation is not static, as in Fig. 81; instead currents race around the empty spaces, partly in opposed directions. Figs. 86-88 are photographs of

*Editor's note: See color insert at the back of this book.

this kinetic-dynamic phenomenon. These proceedings must be visualized as "current storms" or storm currents. However, this is not an unregulated chaos; it is a dynamic but ordered pattern. Fig. 86 gives a detail of such a raging mass of spherules The laminar flow of these rapidly moving masses is clearly visible.

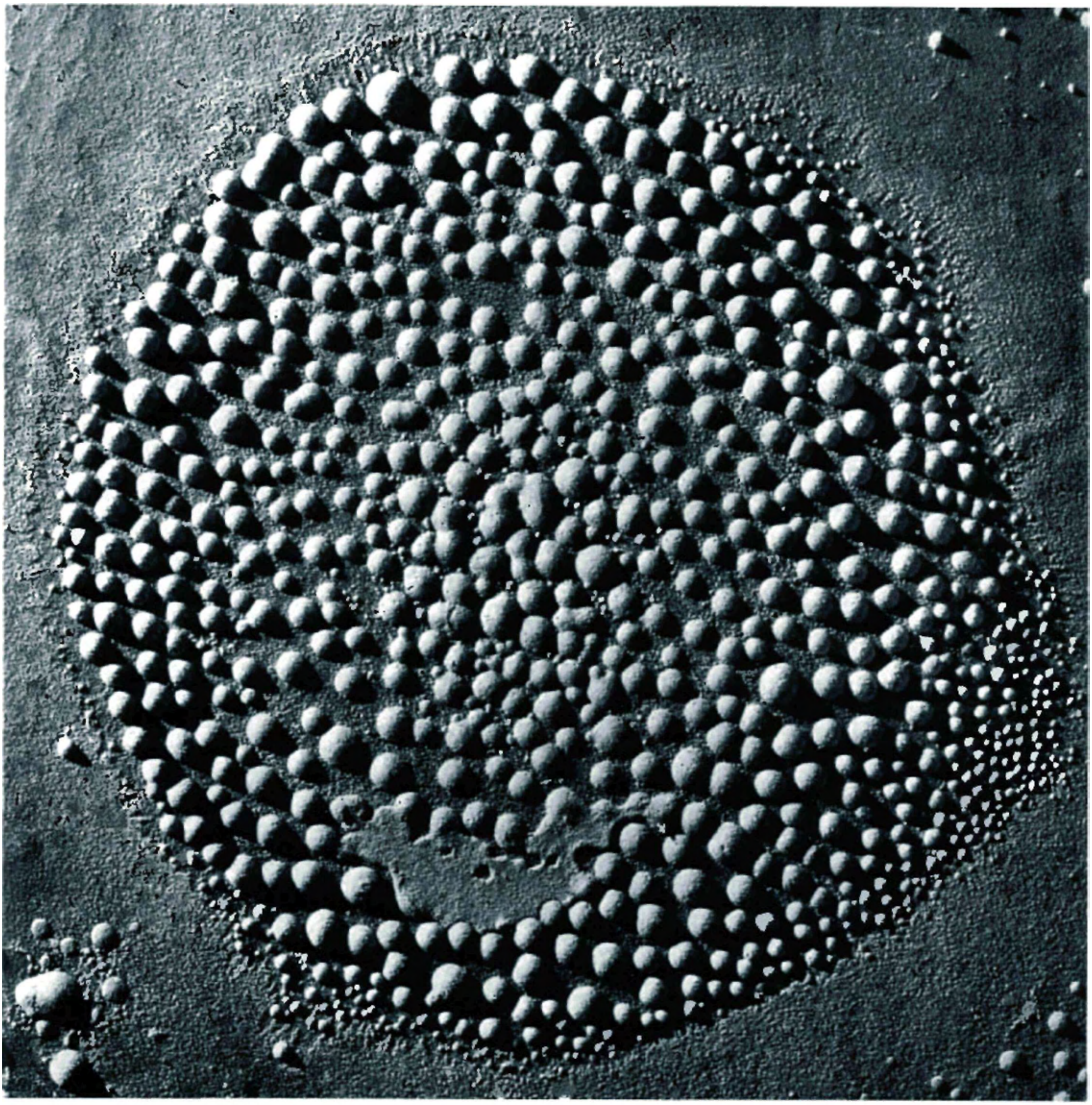
Let us summarize some of the effects we have observed in lycopodium powder under the influence of vibration.

These vibratory effects are:
The creation of forms, formations
The creation of figures
Patterned areas
Circulation

Constancy of the material in a system
Pulsation
Rotation
Interference
Seesaw effect
Correlation
Integration effect
Individuation
Conjoining and disjoining of a single mass
Dynamics of eruption
Dynamics of current flow, etc.

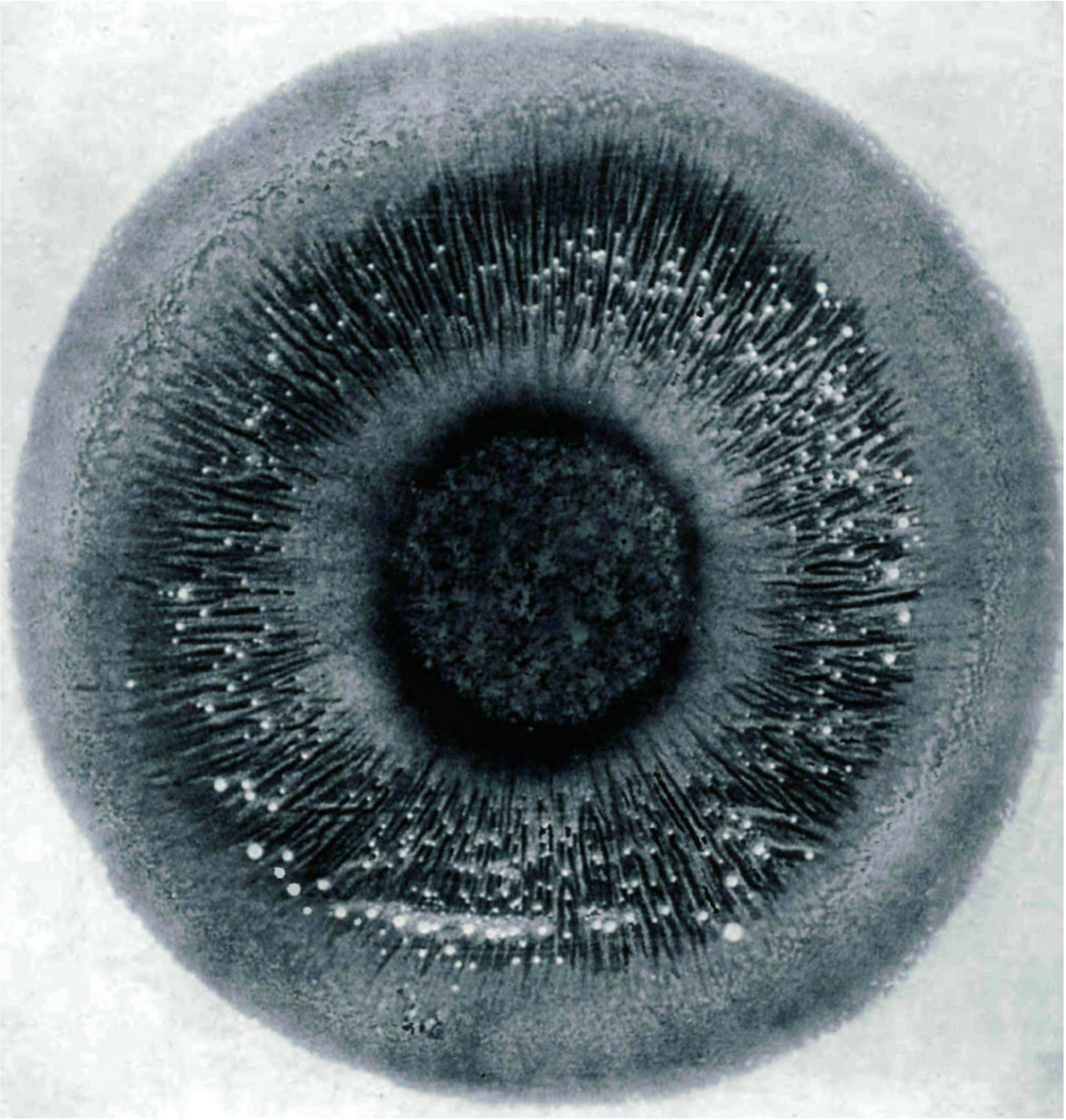
This list shows that vibration produces a great diversity of effects. Vibration is polyergic and many of its effects are specific.

It is not our intention to order or analyze these categories but rather — in accordance with the empirical method adopted — to leave the whole complex of phenomena as it is, with this category, now that category dominating. But it is through this generative and sustaining vibrational field that the entire complex comes into being, and this complex whole is omnipresent. There is no parcelation, no patchwork: on the contrary what appears to be a detail is utterly integrated with the generative action and merely acquires the semblance of an individual, of an individualized quasi-existence, the semblance of individuality.



82

82 Acoustic irradiation transforms the uniform layer of lycopodium powder into a number of round shapes. Each of these rotates on its own axis and at the same time circulates in a constant manner around the whole figure.

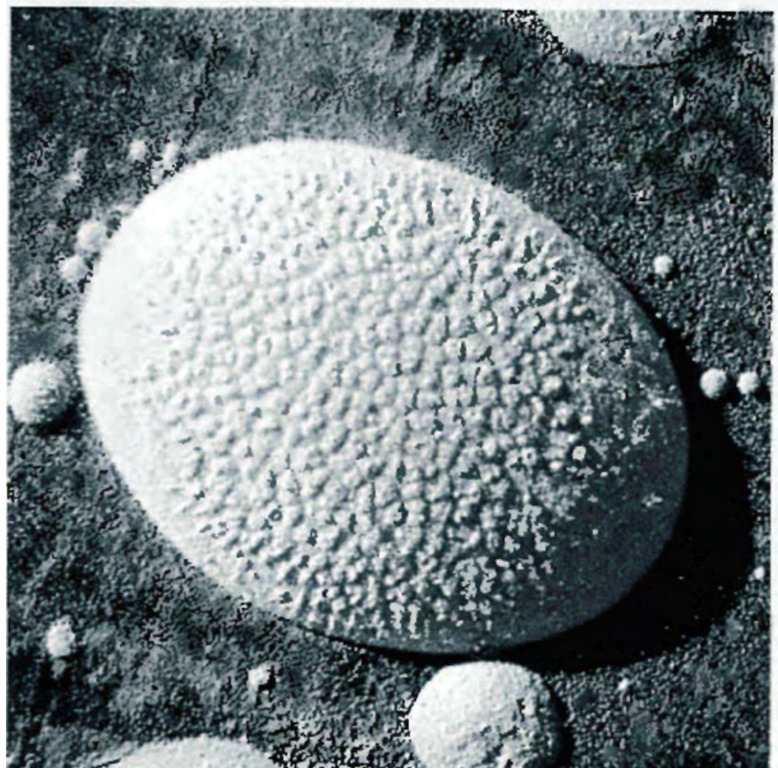


83

83 On a crescendo, the round heaps migrate to the center following the topography imposed by the vibration. The numerous radial pathways can be seen.

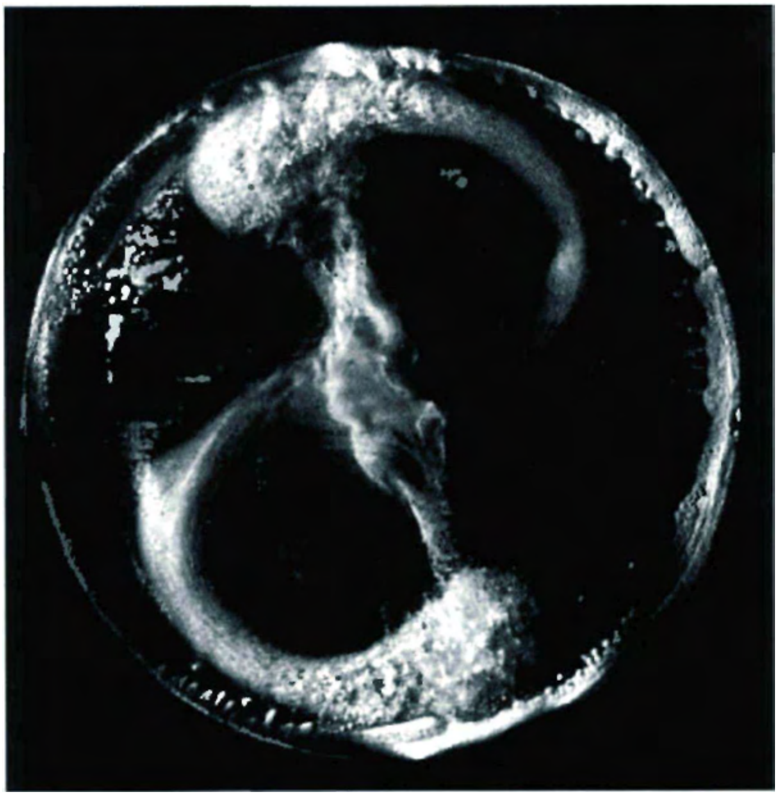
34 The individual shapes unite to form a large pile, which, however, continues to rotate on its own axis. At the same time patterned markings can also be seen. Figure 84 was produced with a soft tone. Frequency 50 cps.

84



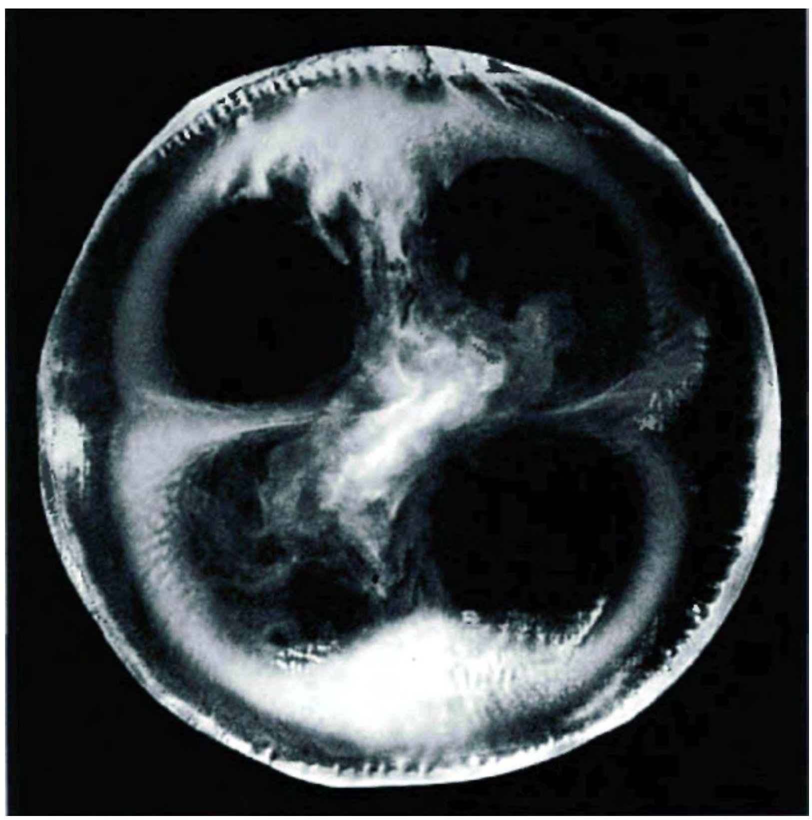
85

85 Again a large round form. This time the frequency was 300 cps and the pattern is accordingly of a more delicate character. (See color plate section.)



86

86,87,88 Since the apparatus used for these experiments allows frequency to be increased systematically, it is possible to produce not only sonorous figures (as in figure 81). but also flow patterns in which the streams of powder move in a significant manner, tn figures 86 and 87 the powder must be imagined to be streaming along at a great rale in the visible forms. but exactly in the patlern and direction imposed by the vibration. The process is thus not chaotic. Figure 88 shows a detail. The laminar configuration of these storm currents or "current storms" should be noted.



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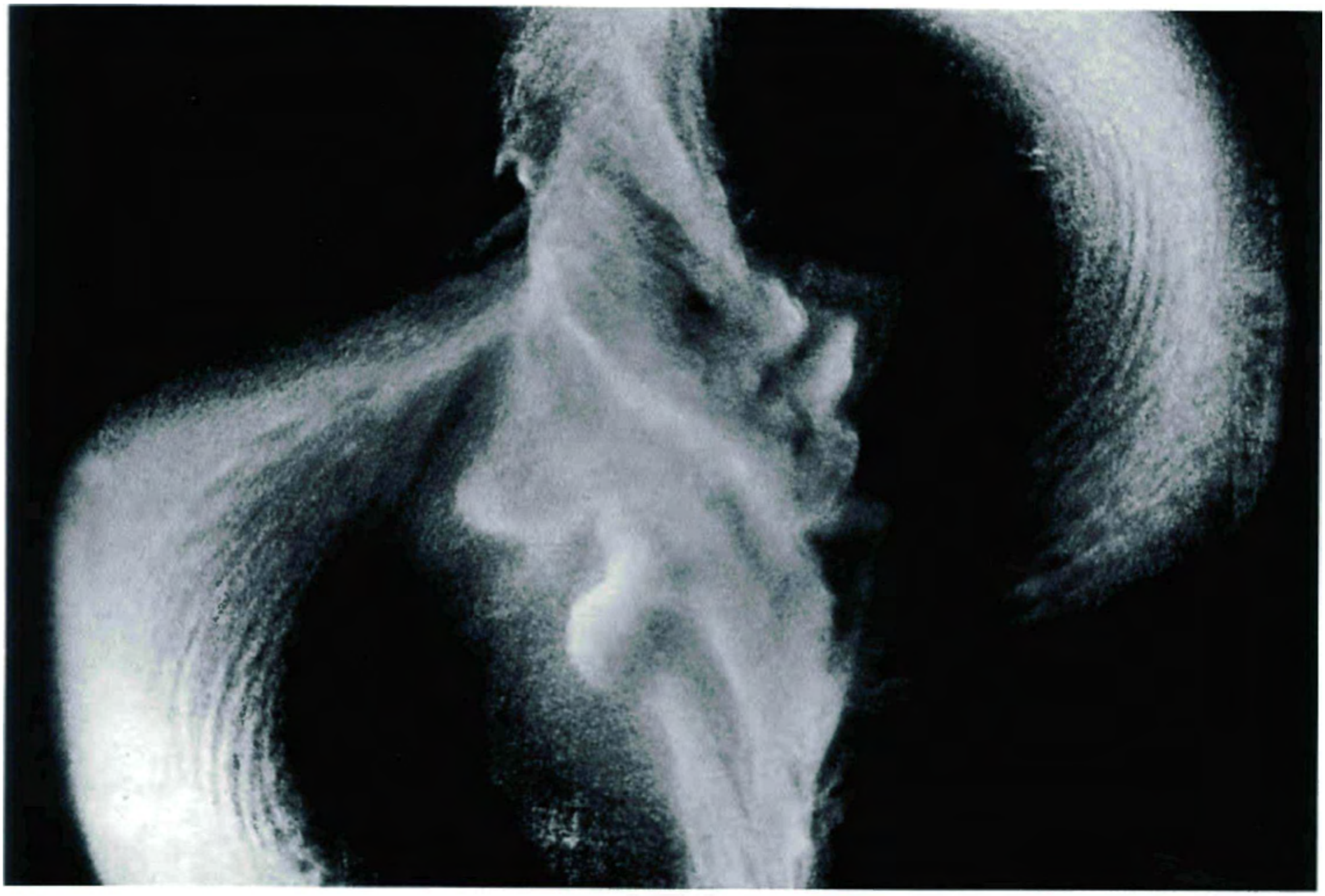
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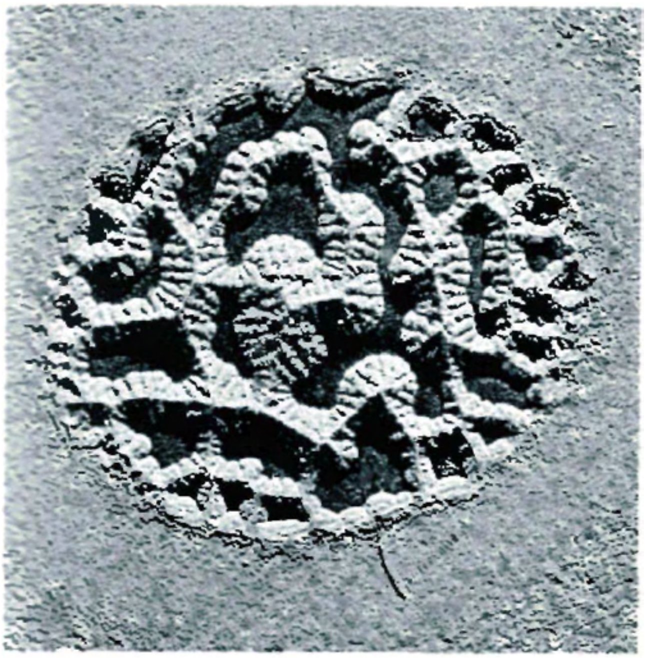

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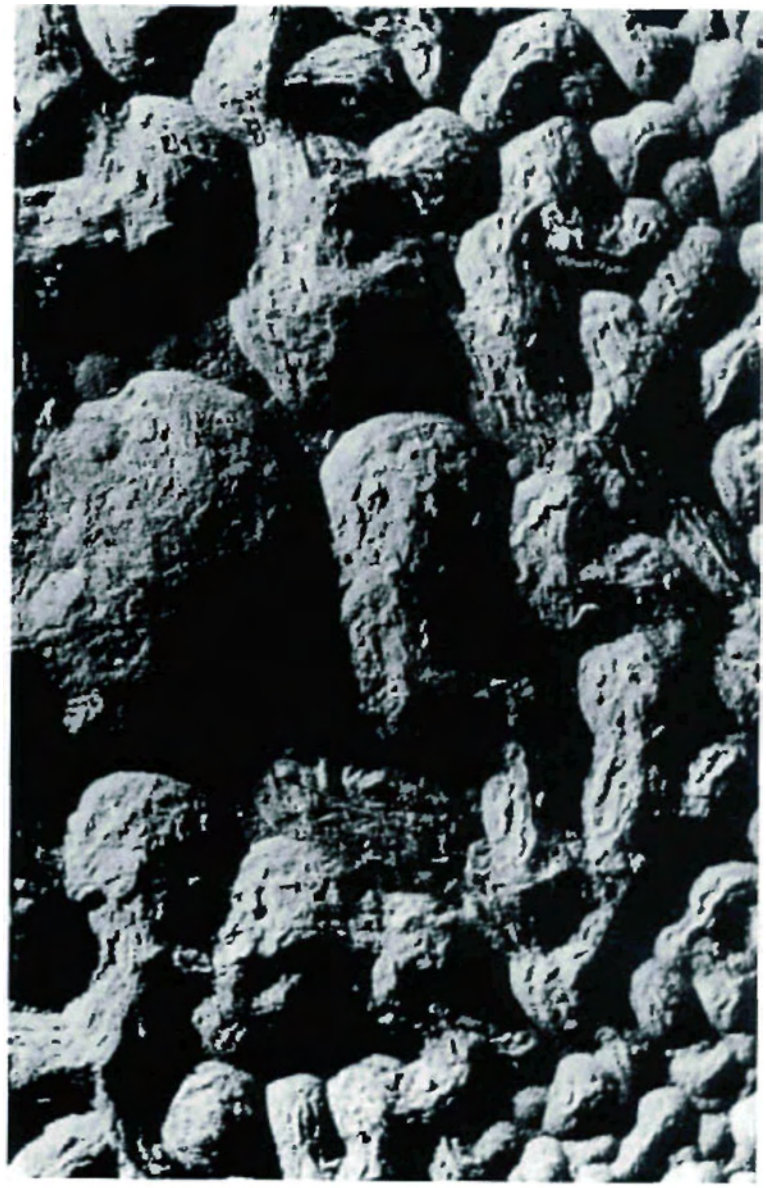


91

89, 90, 91 As the amplitude is varied, the pattern goes through a number of changes. The dynamics of the moving mass of lycopodium particles alter, depending on whether the tone is loud or soft. (See color plate section for Fig. 90.)


92

92 This landscape of lycopodium powder under the influence of vibration is a synoptic view in which the various phenomena can be recognized in all their diversity. Everything must be imagined as circulating, moving, pulsating etc. and all this is caused by the vibrations of a tone which can be heard the whole time the experiment is in progress.

6

Periodic Phenomena Without an Acutal Vibrational Field

93

93 Liesegang rings or periodic precipitation. This phenomenon is a periodic process taking place in a field of chemical reaction without vibration. The salt, silver chromate, is precipitated in regular concentric zones which proceed from the center to the periphery.

From the very large number of periodic phenomena in which no actual vibration is involved we have singled out three examples and sketched them in their phenomenal form.

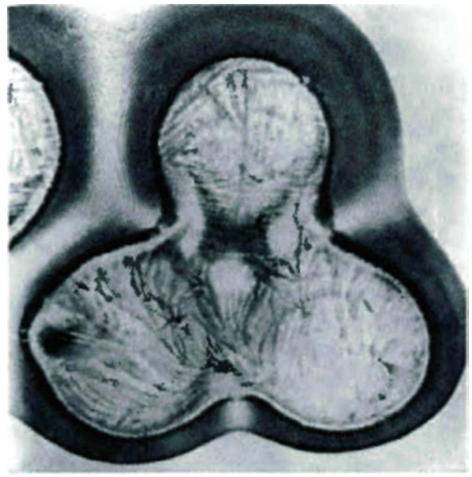
The first example concerns Liesegang rings or periodic precipitations. They were discovered by Raphael Eduard Liesegang (1869-1947), and they involve processes in the field of chemical reactions. The experiments described in Figs. 93-95 and 102 were performed essentially according to Liesegang's method. A layer of gelatin containing the chromium salt potassium bichromate, is poured onto a glass plate: a drop of silver nitrate is then placed on this gelatin layer. A chemical reaction takes place between the two salts and silver chromate is formed. This precipitated salt however, is not diffused evenly, but periodically or rhythmically; zones of precipitation alternate regularly with zones free from precipitation. In this way the concentric rings seen in Fig. 93 are formed. The process proceeds from the center towards the outside, pace for pace with the diffusion of the substance. Fig. 94 shows the same process in a vertical direction. The layers of precipitation follow from top to bottom. Hence these are not crystalline configurations, but the product of periodic precipitation, the result of a process which is characterized by rhythmicity. In Fig. 95 Liesegang precipitations appear again. The innermost of the zones enclosed by the curved lines, however, displays crystallization. Thus the features of the two patterns can be seen side by side and compared. If the experiment is on a larger scale, whale "precipitation landscapes" are created as seen in Fig. 102. However the drops of silver nitrate are placed, the same picture of periodic precipitation is obtained everywhere.

The curvilinear patterns of periodicity are brought about by these precipitations and processes of diffusion. In every pool one can see the first beginnings of a rhythmic pattern.

The various theories advanced to explain this phenomenon will not be discussed here. Even the many analogies drawn with patterns in the animal and vegetable kingdom (as for example the arrangement of pigment on butterfly wings, comparisons with bone lamellae, etc.) cannot be verified. From 1913 to 1935 Liesegang himself probed deeply into the true nature of these reactions. He studied agate, the banding of rock formations,

94

94 Liesegang precipitations proceeding vertically from lop to bottom. The layers follow each other in rhythmic sequence reflecting the periodic nature of the chemical process.



95

95 Liesegang rings. The salt has crystallized out in the interior areas. Rhythmic precipitations which are not themselves a crystallizing process can be compared with crystalline formations.

the formation of layers in salt deposits, and numerous other geological examples, and also the concretions of the body, such as gallstones and calculi. In these studies he made a clear distinction between internal and external rhythm. He assumed the first to be present only when the rhythmicity necessarily arose from the system in question.

We chose the example of Liesegang rings in order to direct attention to the wide field of periodicity without vibration in chemical reactions. This opens up a whole realm of phenomenology, the basic outlines of which were already sketched by Liesegang; simple and multiple periodic precipitation, periodic formation of semi-permeable membranes, rhythmic precipitation without gelatin, rhythmic crystallizations, stratification in drying colloidal layers, rhythmic deposition of precipitates, rhythmic precipitation of vapors. The problems of "chemical periodicity" take us far into the fields of biology and physiology. Indeed, it is hardly surprising that these phenomena bring us to the question of how catalysis functions.

Figure 103 portrays another example of a periodic process taking place without vibration. Drops of an emulsion dyed red are placed in a weak solution of Indian ink. The diameter of the area of ink is about 30 cm. First of all a delicate film forms over the entire surface. Then the emulsion slowly diffuses into the fluid according to the concentration gradient. The focus of interest here is on this diffusion: it proceeds in a periodic, rhythmic, to-and-fro manner. The flow of the diffusion is serpentine in character. Long winding processes are sent out and tail off to nothing as they become diluted. If drops are placed in several positions, the pressure of diffusion causes the circumambient areas to become displaced in relation to each other; some expand while others contract. In this way cell-like zones are formed whose boundaries consist of films of constantly increasing thickness. Since there are no walls or "banks" within each individual region and liquid can thus move in liquid, the emulsion can diffuse away without impediment, and the process of diffusion is as free as can be imagined. This is what happens on the one hand. On the other hand, this spreading does not proceed on a uniform linear front, but according to a hydrodynamic pattern displaying periodicity in great variety. If the quantity and the concentration are altered, a whole array of phenomena make their appearance: thick serpentine spurts of fluid; then again, delicate formations vanishing like wisps of mist (Fig. 96); centers flowing out radially in all directions; in several places tiny streams crisscrossing and forming a lattice; and then again hair-like threads of fluid anastomizing (Fig. 97). In Fig. 103 a whole series of these processes can be observed. However, it must be remembered that all the red structures are in a state of flux, that the cells are shifting to-and-fro, and the liquid system is constantly diffusing away. As we mentioned before, all this takes place without vibration in the true sense of

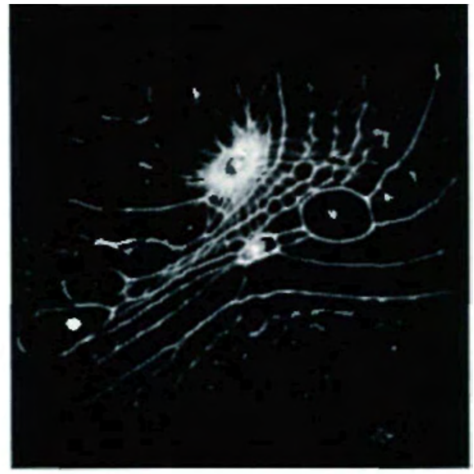
96, 97 Dispersion at a concentration gradient similarly takes place in an oscillating, periodic manner. A whole hydrodynamic phenomenology makes its appearance. In figure 96 the concentrated emulsion disperses by. as it were, trailing off on every side into delicate rivulets. In figure 97, on the other hand, we have a picture in which the delicate, flowing rivulets anastomize and form a network.

98 Here we have an entirely different picture. The whole has been made to oscillate and vortices have appeared at once. As soon as the tone is discontinued, dispersion is resumed in the manner seen in figures 96, 97 and 103, and this continues until the gradient has ceased to exist.

99, 100 If a doughy mass is pulled apart, the surfaces do not reveal a random but rather a characteristically organized pattern. This phenomenon of dehiscence produces tree and branch-like patterns, delicate filigrees and fine networks. The branch work in figure 99 is sometimes thick, but in figure 100 (he dendritic pattern is more delicate.

101 This cell-like pattern is again the result of dehiscence.

96



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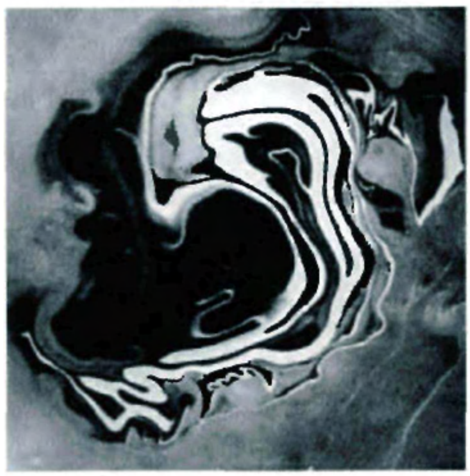

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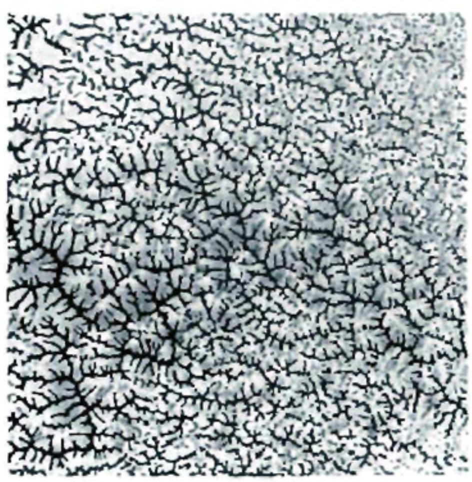

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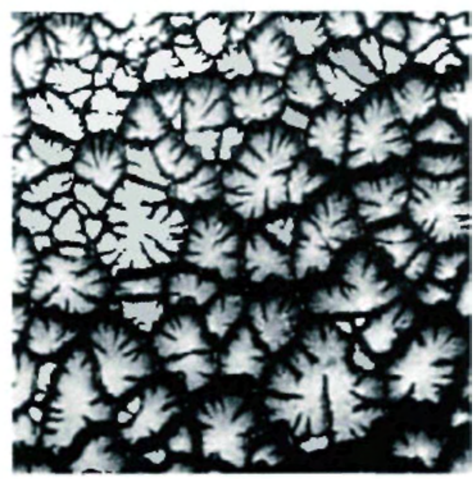

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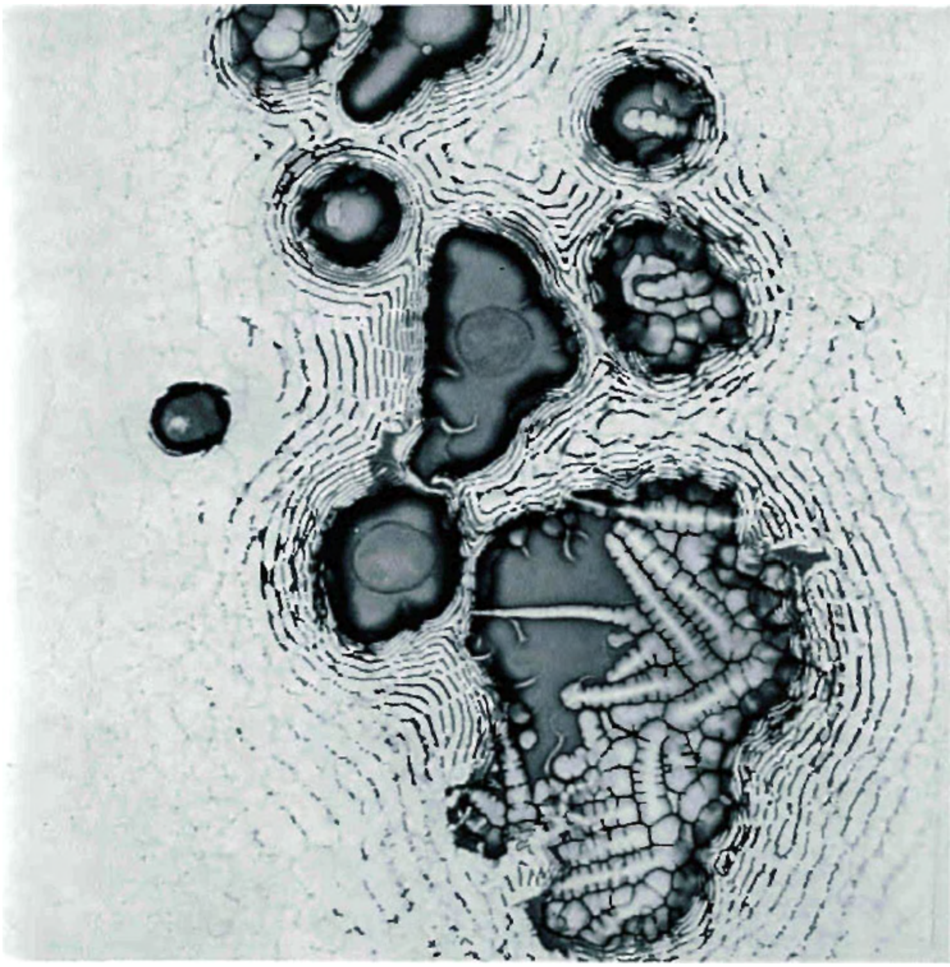


102

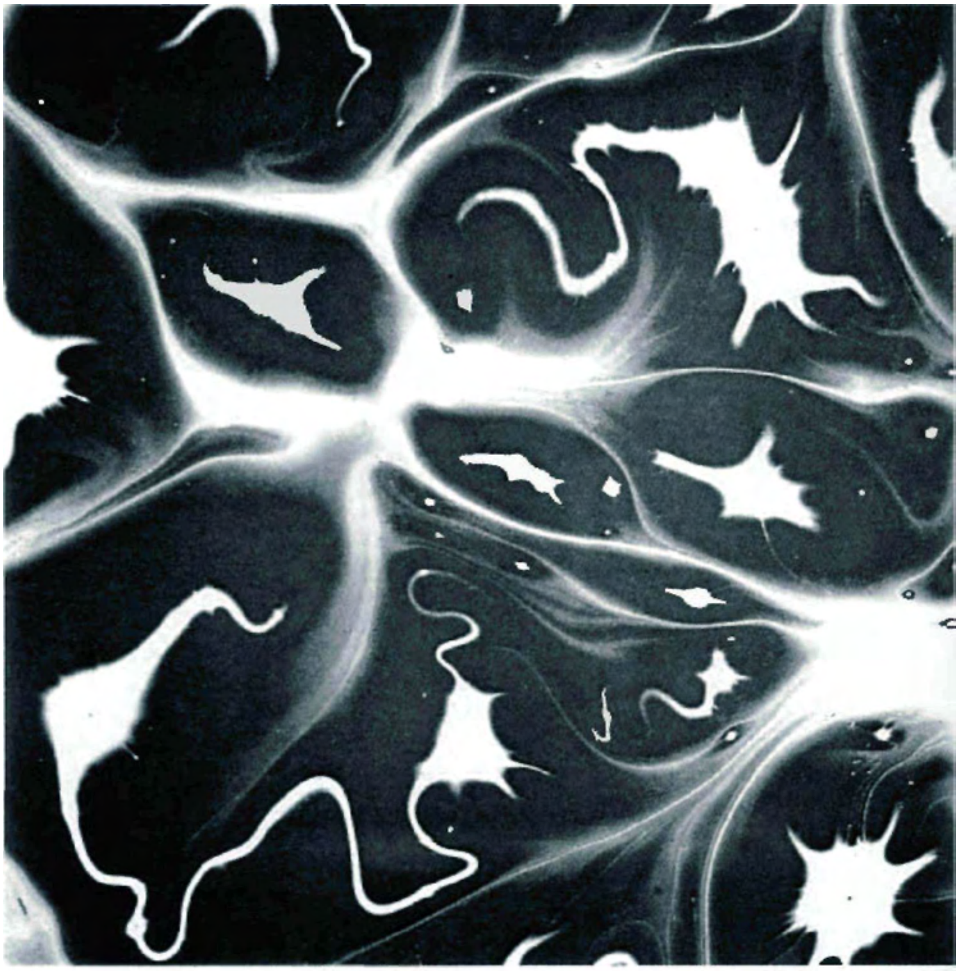
102 Precipitations with Liesegang rings have been started by dropping the silver salt at random on the plate. The zones of periodic precipitation reveal how the precipitates are arranged. Everywhere there is a tendency towards a rhythmic process. This tendency can be seen in each pool. (See color plate section.)

the word. If the fluid is energized by vibration there is an instantaneous change in the picture (Fig. 98). The masses are transformed into vibration patterns: turbulences, vortices, wave fields appear. Upon the sound being discontinued, the weaving, wandering "red structures" reappear; centers, cells, flows and current networks emerge again. Once again the interplay of this hydrodynamic pattern with its rhythms, to-and-fro motions, and periodic floating movements is dominant. Gradually the concentration gradient disappears.

One more phenomenon demands our attention and that is the dehiscence of doughy masses. If such a mass is torn apart, curious structures are revealed. These forms can be accurately described as dendritic (Figs. 99, 100, 101,104 and 105). This
dehiscence can be most simply produced in the following manner. A layer of the doughy plastic mass is placed between two glass plates. The glass plates are then drawn apart and the cohesion of the mass is overcome. The result is that the mass is torn apart. The appearance of the two surfaces is dominated by structures which interbranch and interdigitate in conformity with a law (Figs. 99-101, 104 and 105). These formations change depending on the consistency of the material and the quantity used. "Trees" can be produced, then fine "bushes", filigree patterns, the most delicate network, and cellular textures (Fig. 101). What the eye perceives here is the regularly patterned tear of

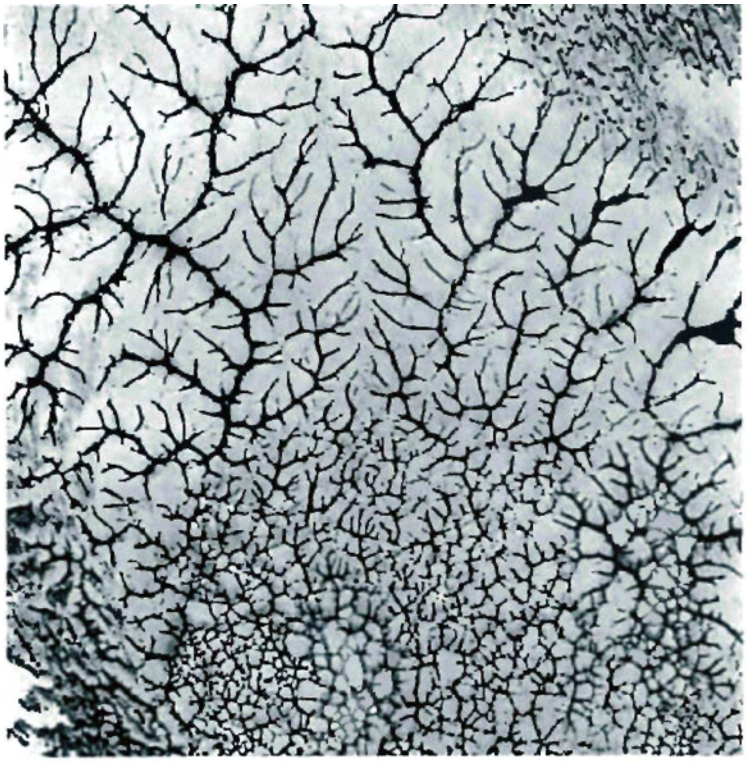
the mass. Dehiscence proceeds in such a way that true periodicity is revealed in its appearance.

Any number of similar examples could be adduced, but these three must suffice. A number of analogies immediately spring to mind in this connection. The Liesegang experiment invokes the picture of a zebra, the systematic banding in the plumage of many birds, and the regular banded and criss-cross patterns of pigmentation in many species of animals. The to-and-fro hydrodynamic pattern is reminiscent of the circulatory systems in the lower animals or in the development of the embryo. And there is no end of organizational forms which are brought to mind by the dendritic structure of dehiscence. Nevertheless such similarities and interpretations as these, derived as they are from external appearances, invariably and inevitably peter out in generalized statements which are devoid of authentic meanings and never reach the real unity of things. Each phenomenon must speak for itself and must be studied in its own terms. If the examples adduced here are studied along these lines, they not only display periodicity as a general feature, but they also reveal that this periodicity has various aspects. Whatever comes to light by way of kinetics, dynamics, chemical reactions, and results in connection with Liesegang rings, whatever elements of hydrodynamics and hydromorphology are revealed in the experiments with concentration gradients, whatever mechanical forces



103

103 A red emulsion is introduced into a liquid which is stained black. The red emulsion begins to disperse according to the concentration gradient. Figure 103 shows some of the processes involving periodic hydrodynamics by which the dispersion takes place in an oscillating meandering pattern. It must be imagined that "everything"' is not only flowing, bul actually flowing in patterns and rhythms. (See color plate section.)



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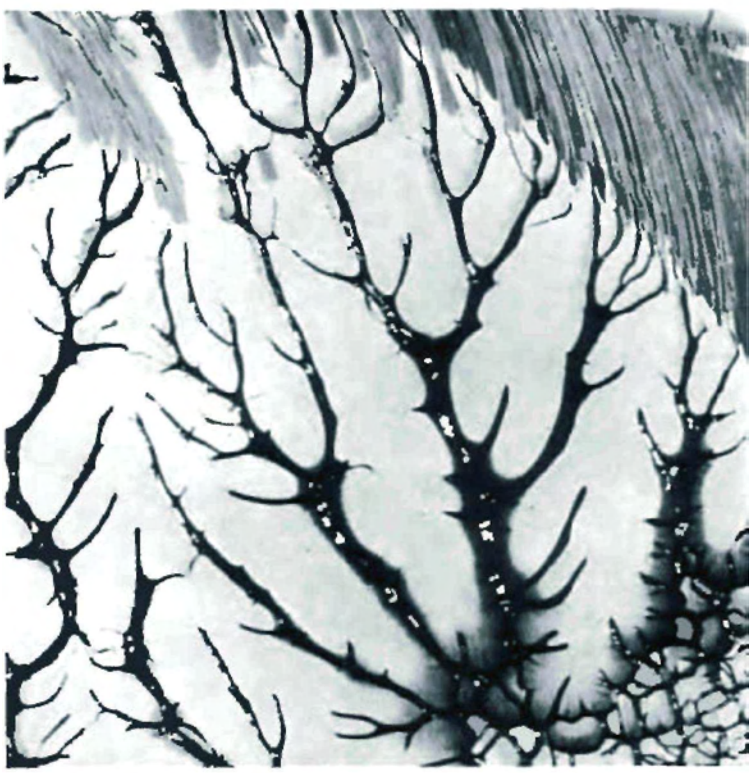


in

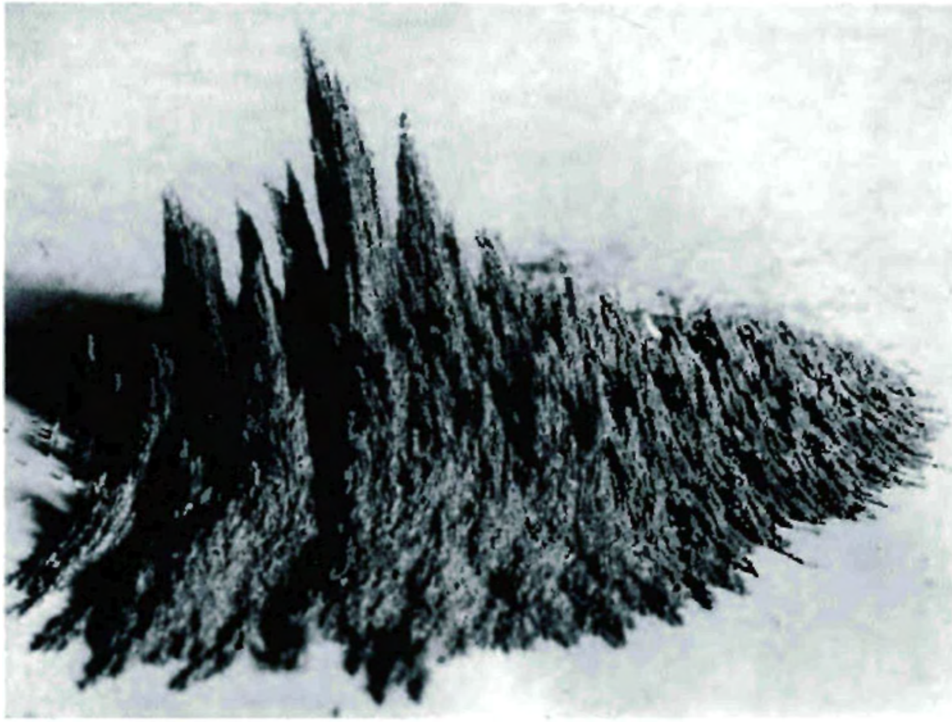
105

appear in the mass system in dehiscence — all these are inseparably and essentially associated with regular recurrences in the movement, dynamics, configuration, patterns, etc. Rhythm dominates the outward form. The systems and their phenomenal classifications are essentially periodic through and through. To trace these elements down to their minutest manifestation, to grasp what is really happening, to observe the pulse and formative rhythm in milieu and medium, recognize those aspects of the phenomenal world which are permeated by the essential nature of vibration, waves, and periodicity—these are the activities characteristic of the cymatic process.

Thus vibrational phenomena may be said to represent a prototypal chapter of cymatics; but, in the light of the three examples adduced, it may be said that there is also a general cymatics in the very widest sense.

104, 105 Examples of dehiscence. If doughy masses are torn apart, branched, ramified patterns are revealed. The formation is dendritic throughout. The pattern ranges from bush-like growths (104) to the most delicate tracery (105) with every variation in between. In the lower part of figure 104 there is even a cellular pattern. These phenomena are entirely periodic character. (Fig. 105 is a detail of Fig. 99.)

106,107 When a plate vibrates, adhesion to its surface is reduced by the movement of the plate and of the layer of air immediately above it. Iron filings placed on a vibrating diaphragm and at the same time in a magnetic field are in a constant state of motion. As a result of the reduced adhesion the filings dispose themselves in the magnetic field with certain degrees of freedom. The configurations in figures 106 and 107 move incline, and migrate as the magnetic field is changed.



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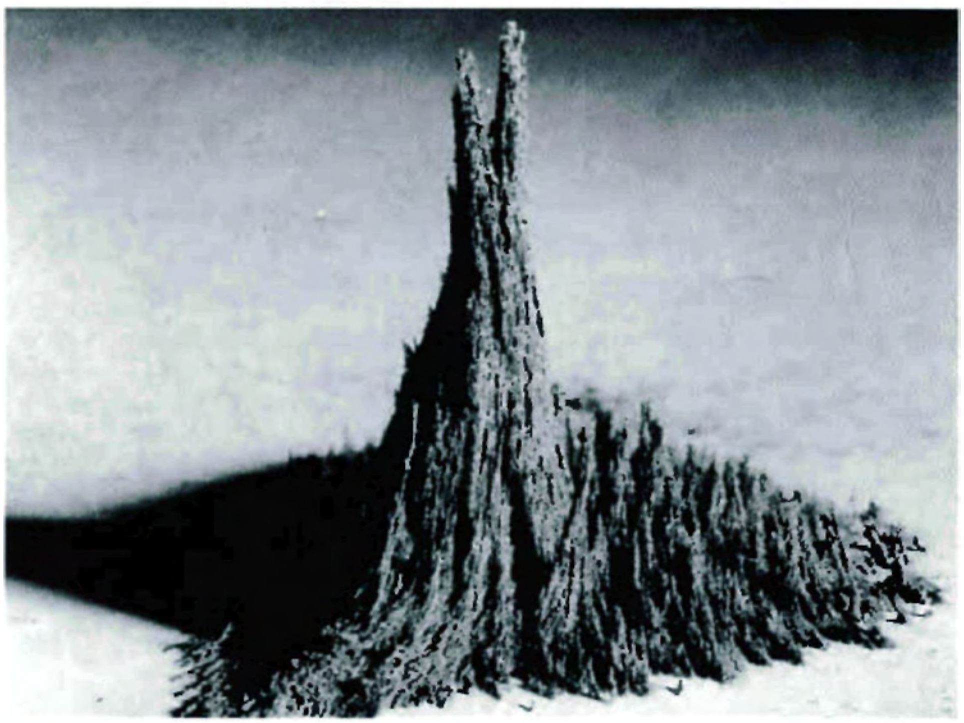

107

7

Sound Effects in Space
Spacial Sonorous Patterns

If a vibrating surface is not quite horizontal, objects resting upon it easily slide off. They start to move even when the angle of gradient is very small. The stroboscope reveals that some objects are, as it were, hovering, or at least that their adhesion to the surface under them is reduced. When iron filings are distributed on a vibrating diaphragm in a magnetic fieid, the reduced adhesion is revealed by the fact that iron particles acquire certain degrees of freedom and their arrangement in the magnetic field is a mobile one. Large polar figures are formed which move as the density of the magnetic fieid changes, but in addition to these, the iron particles also form figures which migrate together and, if the direction of the magnetic field changes, take up an appropriate disposition. Figs. 106 and 107 represent such patterns of iron filings. If the direction of the magnetic field in Figs. 106 and 107 is changed, the erect piles of filings are mobile enough to respond by a change of inclination. These processes and others like them, direct the attention to the environment of vibrating objects, to the space surrounding them. What happens when the sound impinges not on flat layers, but on more substantial masses? If a readily plasticized mass is placed on the diaphragm, the material is set in motion. The masses are pushed to-and-fro. Whereas the field empties in various places, in others the substance forms lumps. Whole landscapes are plastically molded; a kind of relief which is a reflection of the vibrational processes is shaped out of the material. The lumps formed frequently sidle to-and-fro, and also show rotational movements within themselves. This rotational piasticization leads to the formation of balls if the consistency of the material permits easy shaping. Material which is applied horizontally at the beginning begins to rotate around local centers and clumps into balls, so that finally there are a number of spherical formations which mass together and go on producing larger and larger globular shapes. Figs. 108 and 109 are photographs of these processes. The largest of the globes attained the size of a pigeon's egg.

The next step was obvious. It was to study the action of sound on a three-dimensional element. Because of their high surface tension, drops of mercury are globular elements which have a very strong tendency always to return to this ball shape and to maintain it. Under the influence of sound, large quantities of mercury show wave patterns, vortices, etc.; that is, hydrodynamic phenomena like other liquids. Drops of mercury on the other hand, always behave as homogeneous elements within certain limits: they only fly apart when the amplitude is high. What happens then to such a drop? It must be remembered that reflections make photography very difficult. The photographer had to take appropriate measures in order to photograph the whole phenomenon without dazzling reflections.

108

109

108,109 A plasticizable mass is formed into balls by oscillation. The material is first spread uniformly on the plate and then forms into balls when exposed to the effects of sound. Figure 108 shows a general view of this process and figure 109 a detail. When the plasticity of the material is exhausted, the balls (about the size of a pigeon's egg) roll about on the diaphragm.

110 A drop of mercury before acoustic irradiation. Mercury is difficult to pho ograph because of the reflections, in these photographs they were avoided by using diffused light. The black circle is the reflection of the lens. Changes in the surface were rendered visible by the resulting deformations in this mirror image.

111-113 The surface upon which the drop of mercury is resting is made to vibrate. Concentric waves are the first effects to be produced by a small amplitude (low tone). Figure 111 was excited by a frequency of 150 cps. and figure 112 by a frequency of 300 cps. A figure (triangle, hexagon) is already apparent in figure 113. At the same time, currents become evident in the drop, often in the form of twin vortices.

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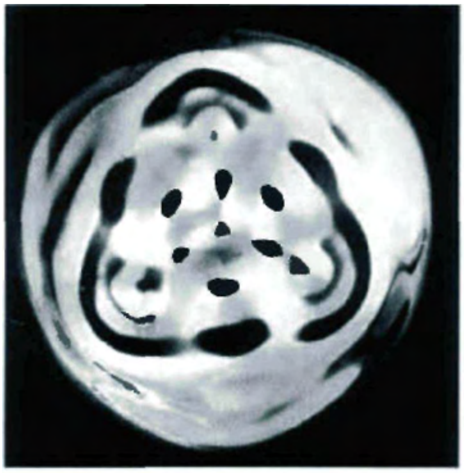
111

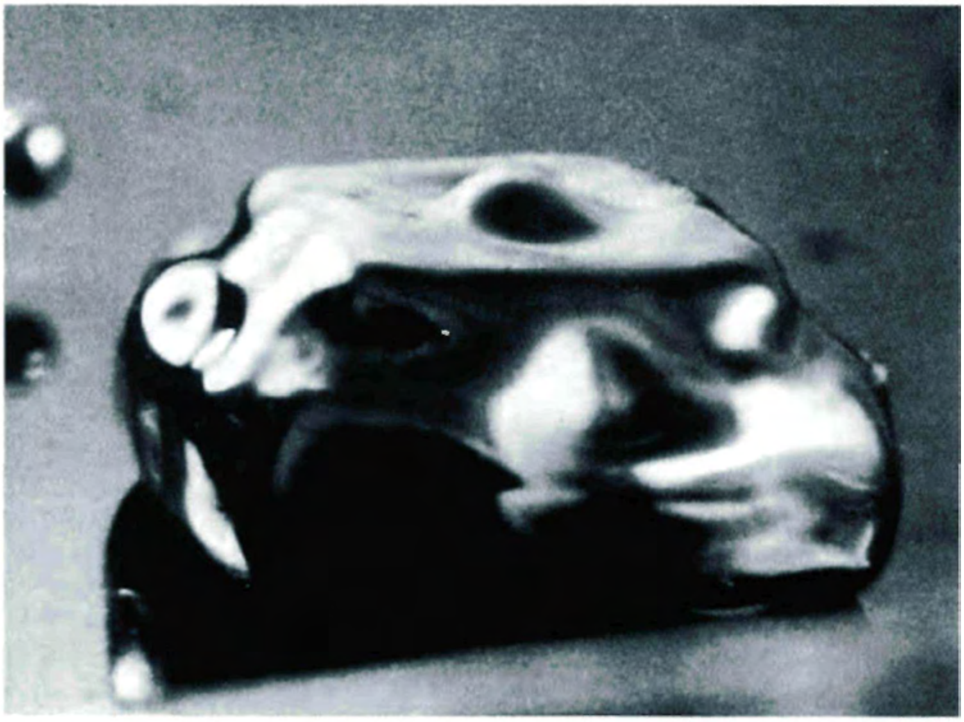


113

112

In Figs. 110-113, the lens is reflected in the drop as a dark, round circle. This is actually an advantage in that curvatures on the surface of the mercury are rendered visible by the distortion of the mirrored image of the lens itself. In Fig. 110 the resting drop of mercury can be seen. As sound is applied, concentric rings are formed (Figs. 111, 112). Then a carefully managed crescendo causes vibrational patterns to emerge (Fig. 113). If the action of the sound is more intense, the whole globe of mercury is affected, and since the whole coheres and remains a unit, the oscillation can be revealed as a formative factor. The series of figures 118-123 illustrates this phenomenon. We see spatial sonorous figures which are tetragonal, pentagonal, hexagonal, heptagonal and octagonal in shape, and there are many other forms. The production of these shapes is very accurate, but not rigid throughout. Here again the stroboscope reveals pulsations. For instance, a drop can move in such a way that two triangular figures pulsate through each other: the figure oscillates in these triangular forms. In addition to these pulsations there are also currents within the mass of mercury. A few lycopodium spores strewn on the surface make these visible. Here again we find ourselves concerned with a whole series of oscillatory activities within a system. Figs. 114 and 124 show a lateral view; the three-dimensional character is manifest. One might speak roughly of edge and surface characters. However, the cymatic mode of observation requires us to always keep in view the rhythmic beat, the circulation, the ever recurrent rotations, the vortices, etc. For these small mercury systems do, in fact, always present themselves as a whole entity which at the same time oscillates, vibrates, flows within itself, pulsates and moves to-and-fro, is a figure and an organized pattern, and thus appears to the observer as a sonorous figure in space.

In order to study vibrational patterns and dynamics in space, sound was applied to a stream of gas. Because its specific gravity is greater than the air and its temperature lower, the gas falls like a waterfall from a height of about 35 cm. This downward movement causes turbulences, which can be seen in Fig. 115. The gas flows in a complicated pattern with eddies and unstable wave formations. These turbulences are of particular interest in that they render the environment sensitive to the effects of sound. Sound-sensitive flames are known to become sensitized only by disturbance, i.e. by turbulence in the stream



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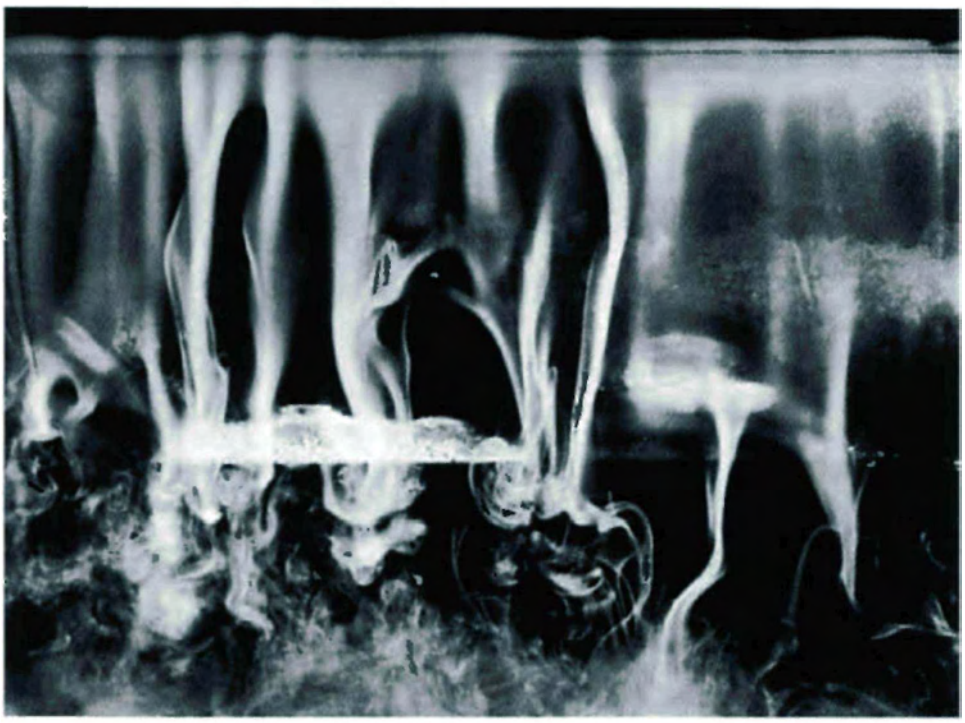
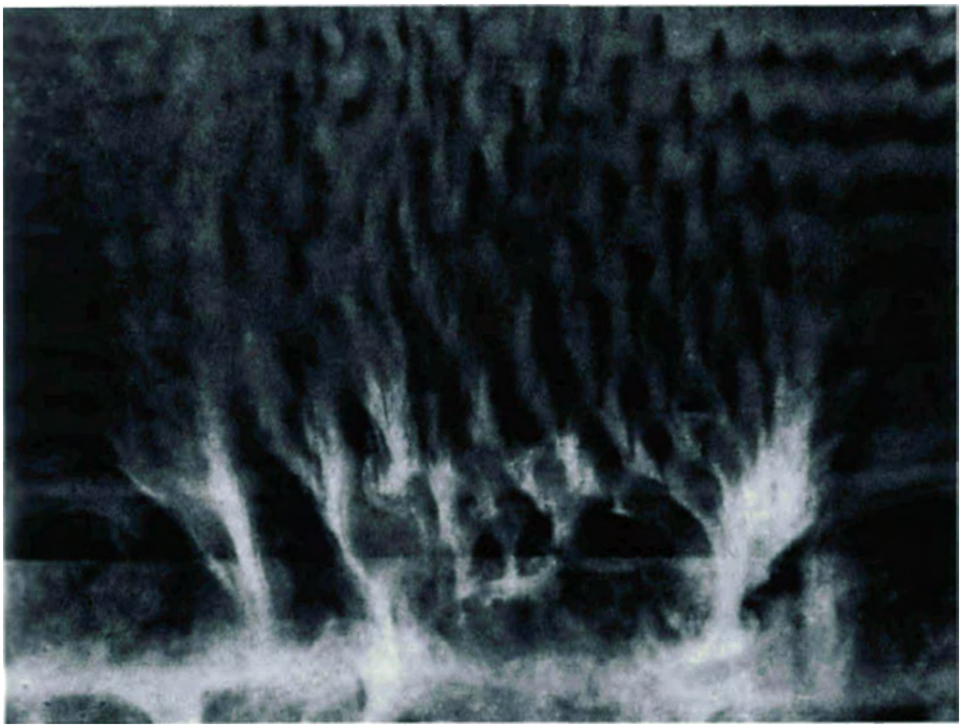


115

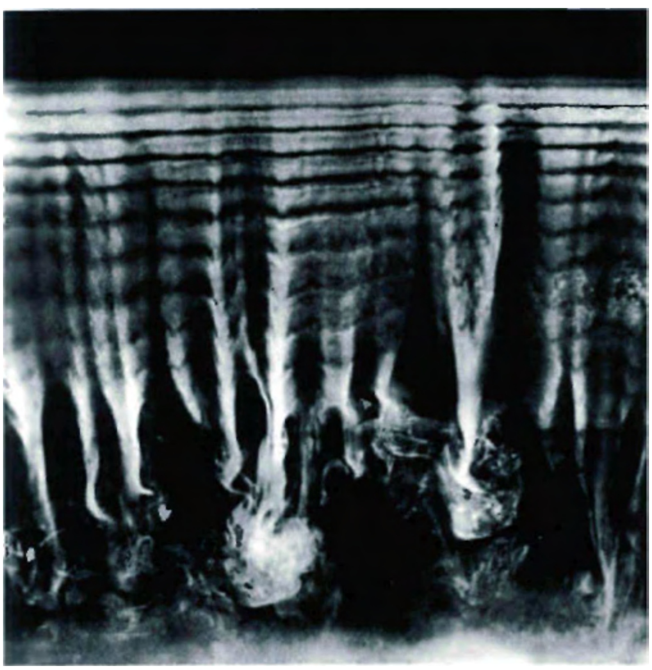
114 Figure 114 shows that the configurations obtained in these experiments are truly spatial in character. The drop might be said to be quadratoid in shape with protuberances in the facets of the figure as if an octahedron wore taking shape inside. Actually the whole pulsates within this spatial pattern.

115 A downward stream of gas with no acoustic irradiation. Turbulences and vortices are apparent in the flow.



116

116 Irradiation by sound results in texture-like patterning in addition to the formation of vortices.



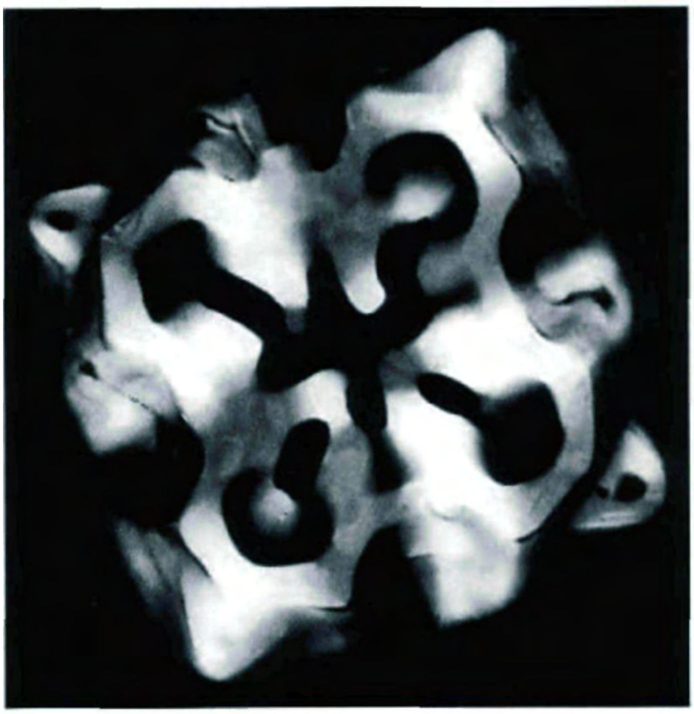
117

117 A downward stream of gas subjected to acoustic irradiation. The flowing veil of gas assumes a laminar patern under the influence of sound. Eddy and wave formations also appear as turbulences.

of gas (Zickendraht, 1932). A turbulent medium is sensitive to vibration; sounds can make their influence felt in a turbulent medium. Hence the turbulent gas reacts to acoustic irradiation. Fig. 115 shows the situation before acoustic irradiation. Figs. 116 and 117 show the picture under sound bombardment at various frequencies. Patterned elements appear as sequences of layers (Fig. 117) or as lattice-like arrays (Fig. 116), accompanied by vortical formations. Here again we are confronted by an exceptionally complex series of events: unstable currents, turbulence and vortex formations on the one hand, and an organized pattern on the other; both representing the effect of vibration on the stream of gas. It need hardly be stressed that Fig. 115 reappears when the sound is discontinued.

Even this small group of basic experiments will have shown that there exists here an extensive field for research. It is a question of studying the effects of vibration when they are transposed from more or less two-dimensional to three-dimensional experiments, or put more simply, of seeing what happens in the various experimental arrangements in space. It can hardly be doubted that a whole phenomenology will be revealed in vibrating spaces, in spatial vibrational fields, or in pulsing or oscillating spheres. Although the observations described in this chapter are only in the initial stage (the whole study is in a state of flux) mention was nevertheless made of them, for it is only when attention is paid to special vibrational effects that a proper picture can be obtained of vibrating systems in space. The oscillatory effects must be seen as forming a unit with the energetic processes. If it is possible to display standing, traveling and interfering waves and their effects in space, to render visible the creans/creatum relationship in large "masses" (dust, gas, plasma), to demonstrate in space organized patterns, dynamics and kinetics through the agency of vibration. the universe of astronomy will have to be studied from these points of view in regard to its morphology and dynamics. It is not a question of reading an interpretation into these phenomena; the observational work reported here must rather fertilize perception and, as it were, provide the nucleus for the formation of a perceptive organ sensitive to periodicity. This is not a matter of speculation, but of empiricism and of the thought inherent in this empiricism, "intuitive judgment" as Goethe so concisely expressed it.

Since we have made it our task to demonstrate vibrational phenomena in space, we have every reason to turn our gaze towards planetary, solar and galactic systems.



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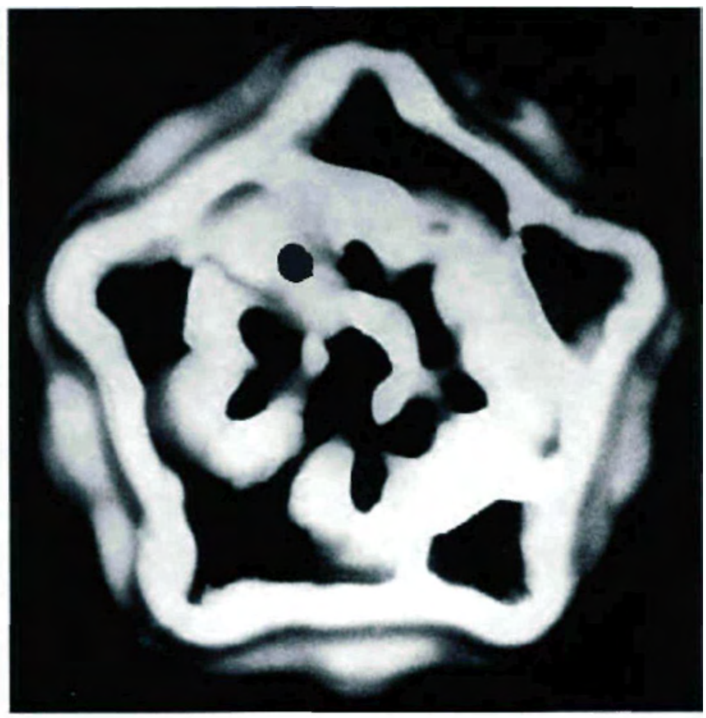
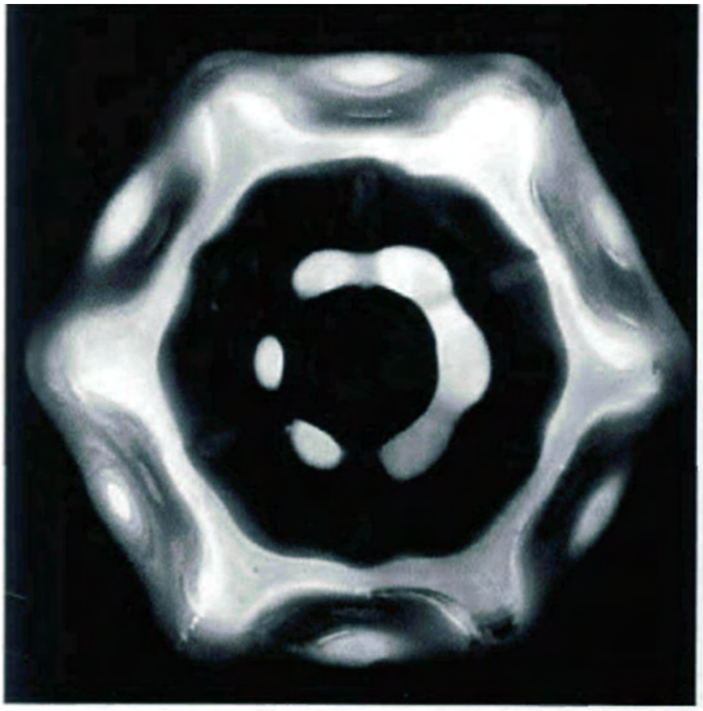


119

118-123 These photographs are of vibrating mercury drops. Since high surface tension causes mercury always to seek a spherical form, the drop does not disintegrate under the action of vibration. Instead the vibration becomes visible as a change of form. These pictures thus show true spatial configurations as seen from above. Tetragons, pentagons, hexagons and heptagons, etc., can be seen. The frequencies are between 130 and 240 cps. Increases in amplitude would cause the configurations to fly asunder. The processes are extremely complex: forms pulsate and interpenetrate in their oscillations; currents appear vortices form. These forms are a fascinating subject of study. They are reminiscent of the outlines of flowers with concentric circles containing different numbers of elements. Progressions of the same number such as 4,8,12,16 or 7,14 can be found.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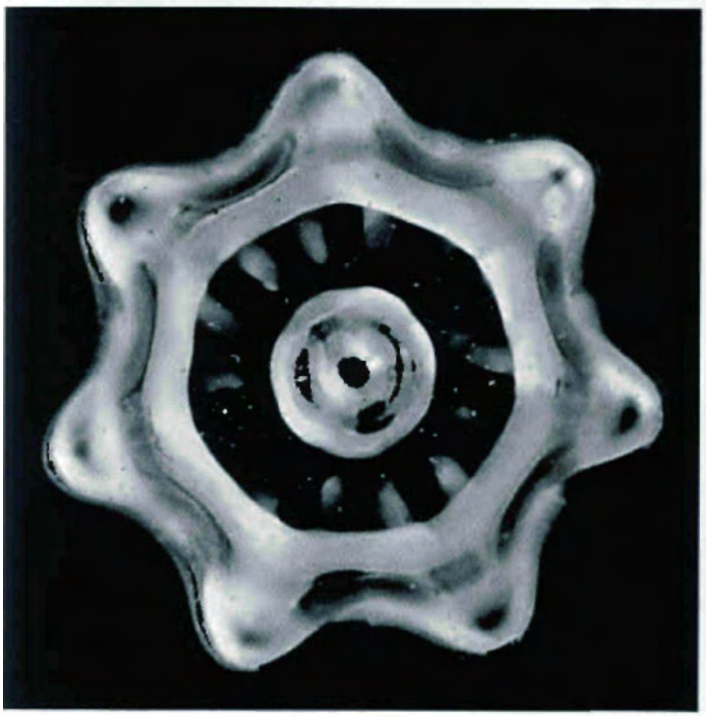
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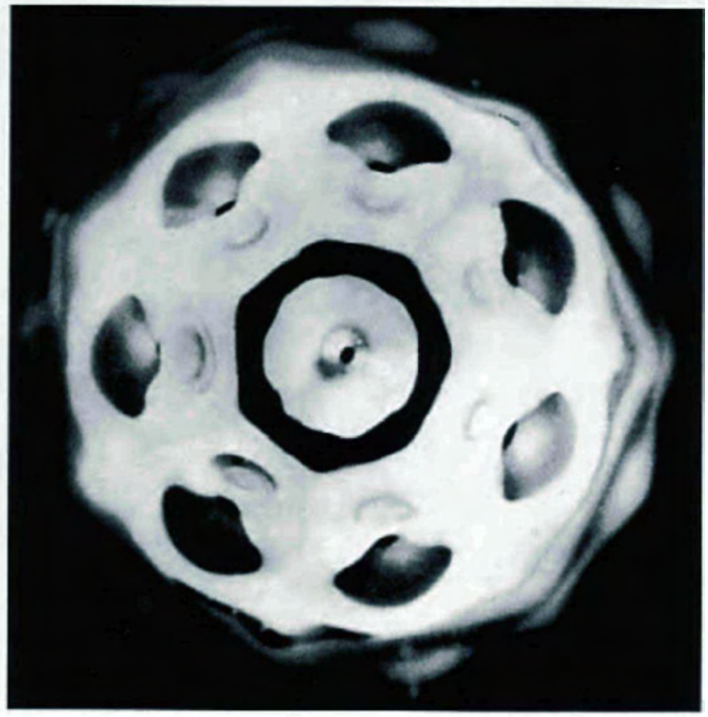
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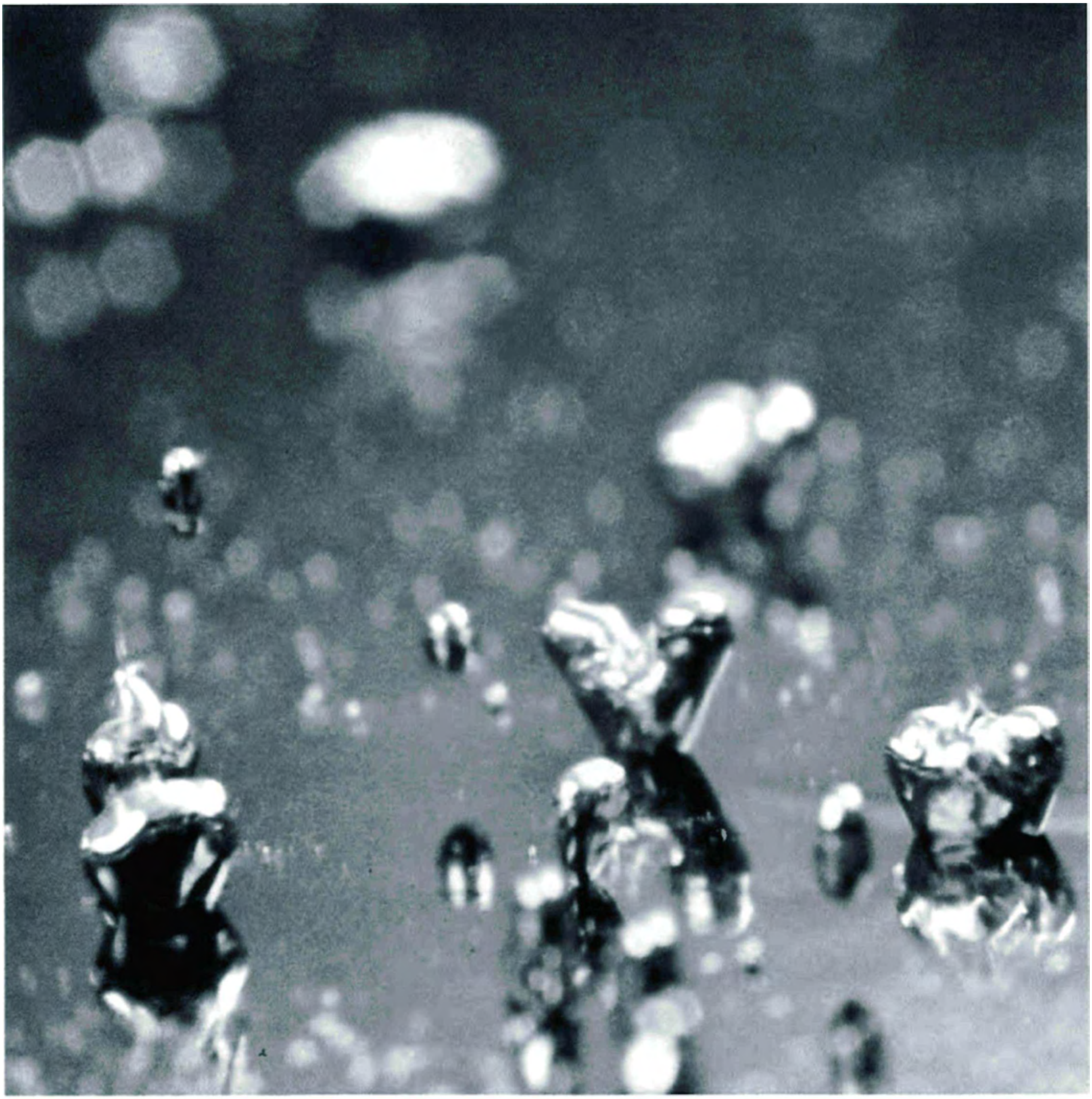
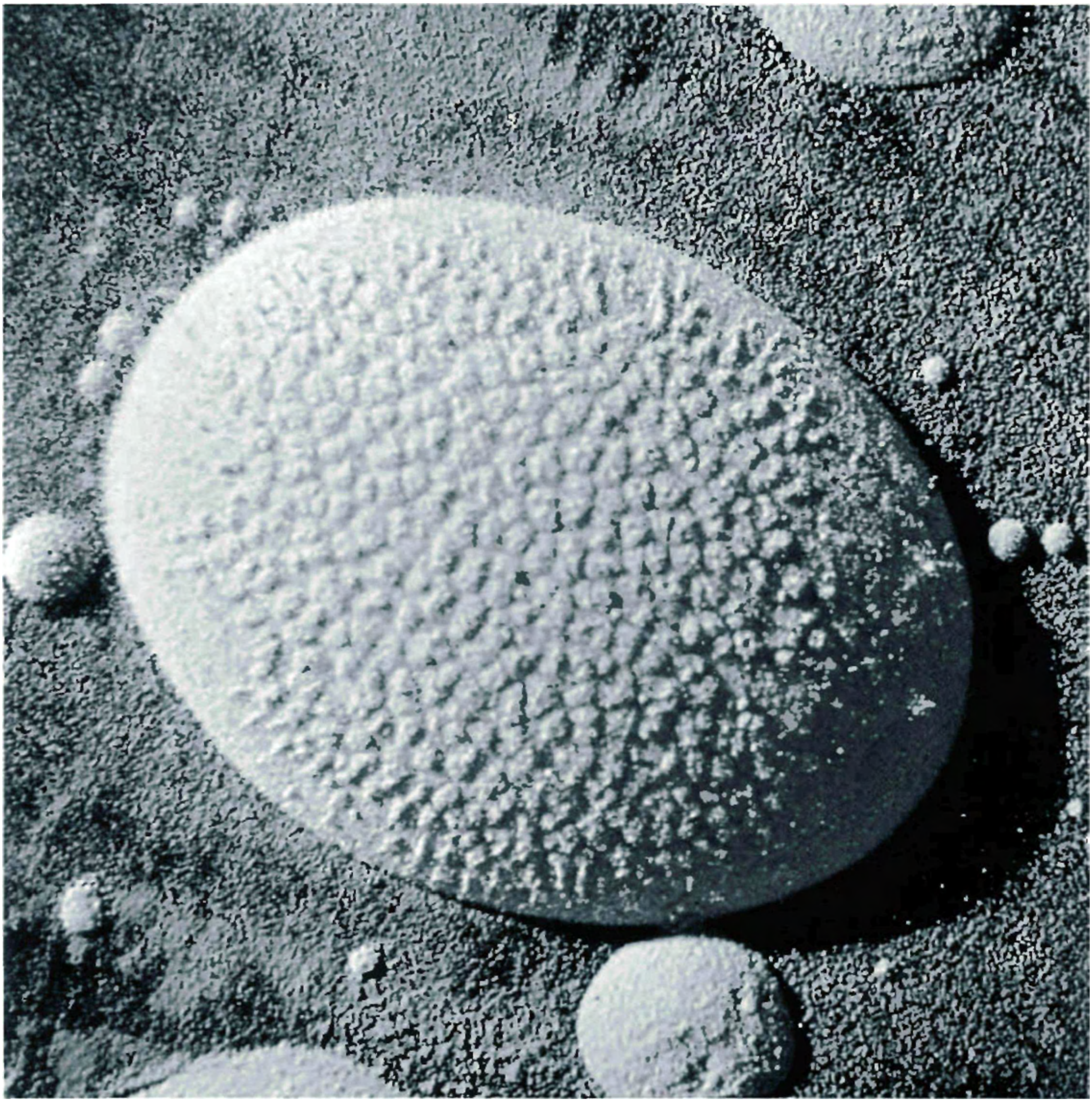


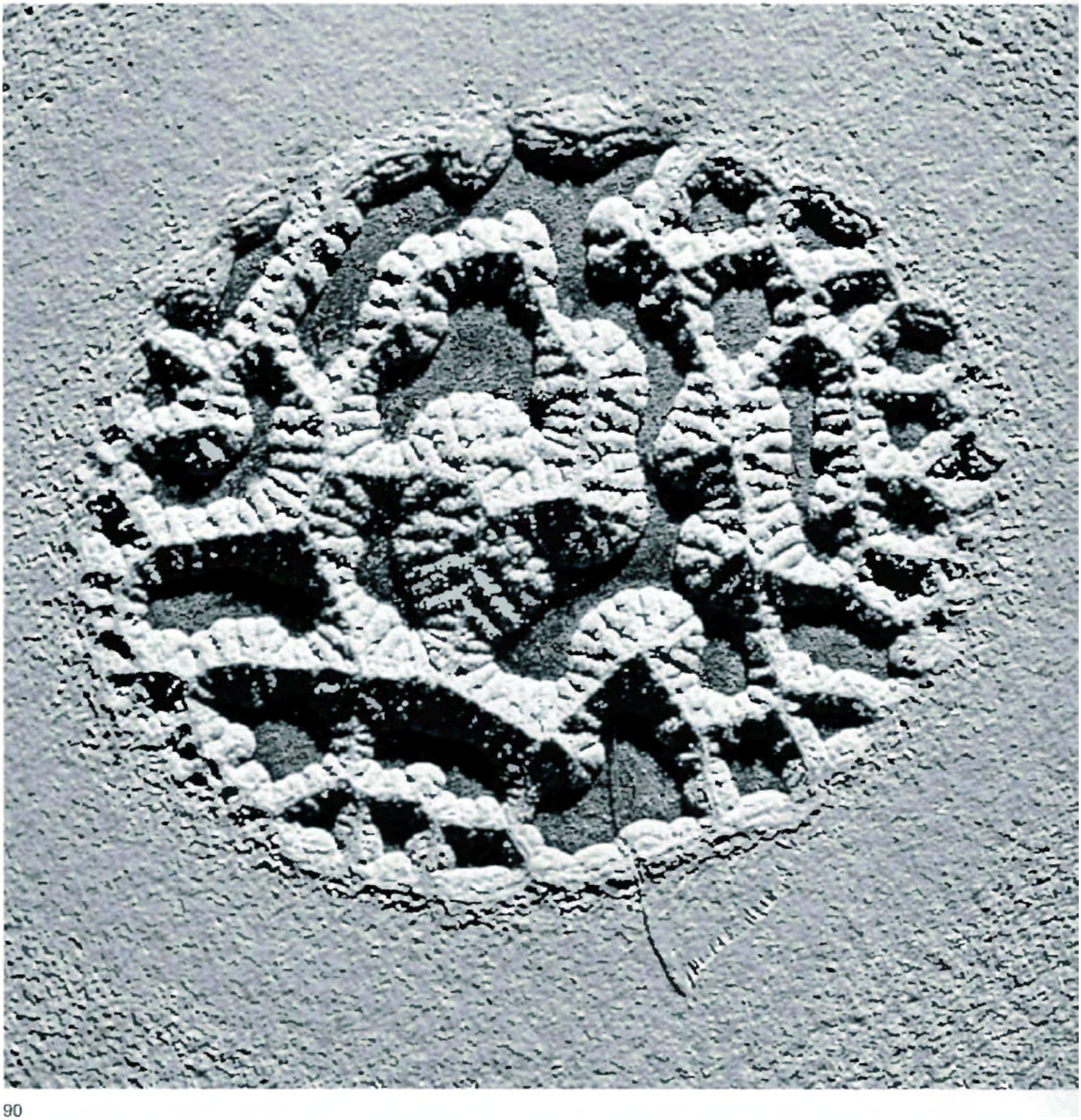
124

124 This lateral view clearly shows that figures 118-123 are really sonorous configurations in space. Here, they appear, as it were, in elevation. They tower up in their numerical progressions; one might speak of a law of numerical configuration.



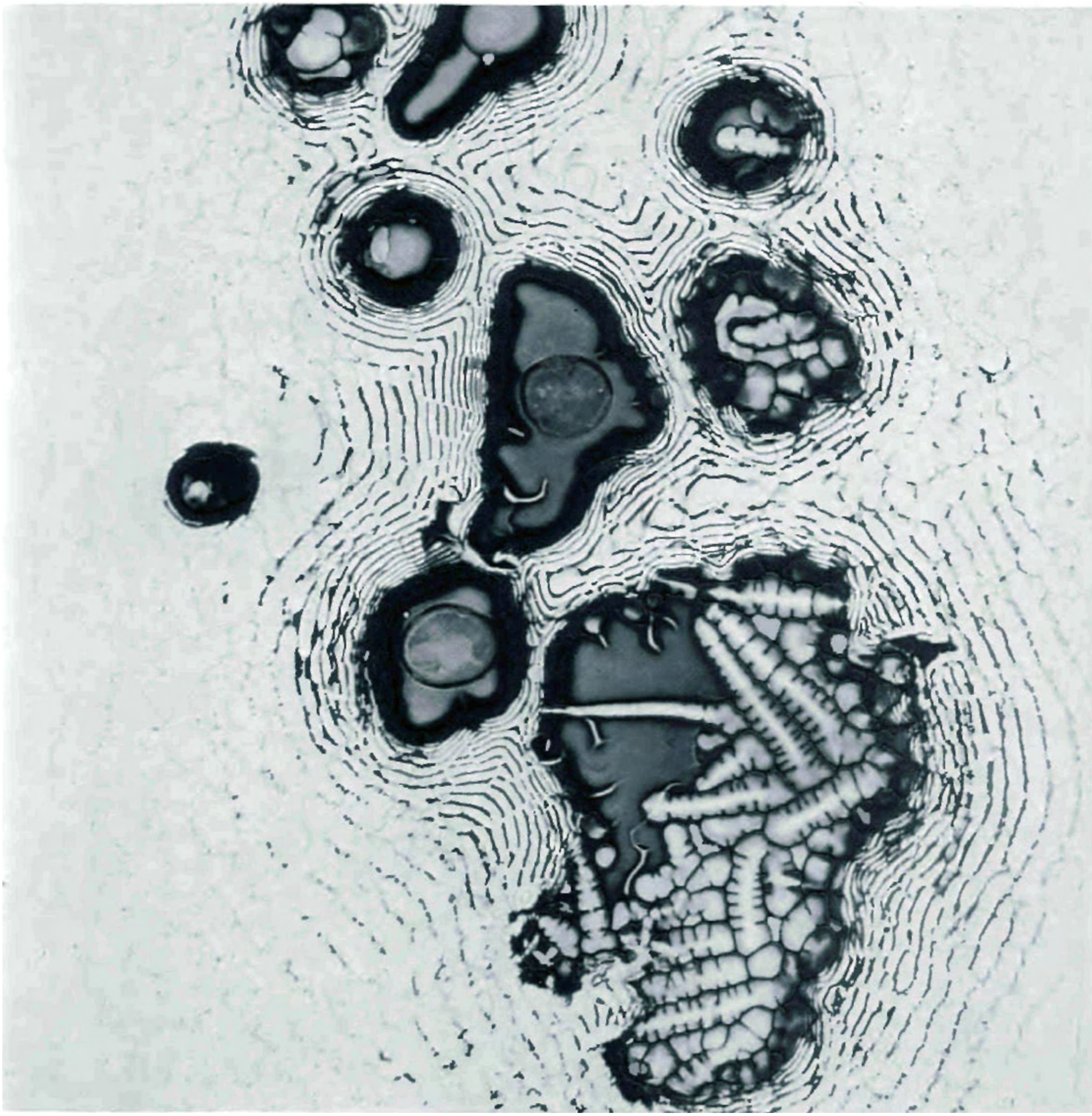
S5

85 Acoustic irradiation transforms a uniform layer of lycopodium powder into a large round form. At a frequency of 300 cps , this more delicate configuration emerges. (See page 77.)



90

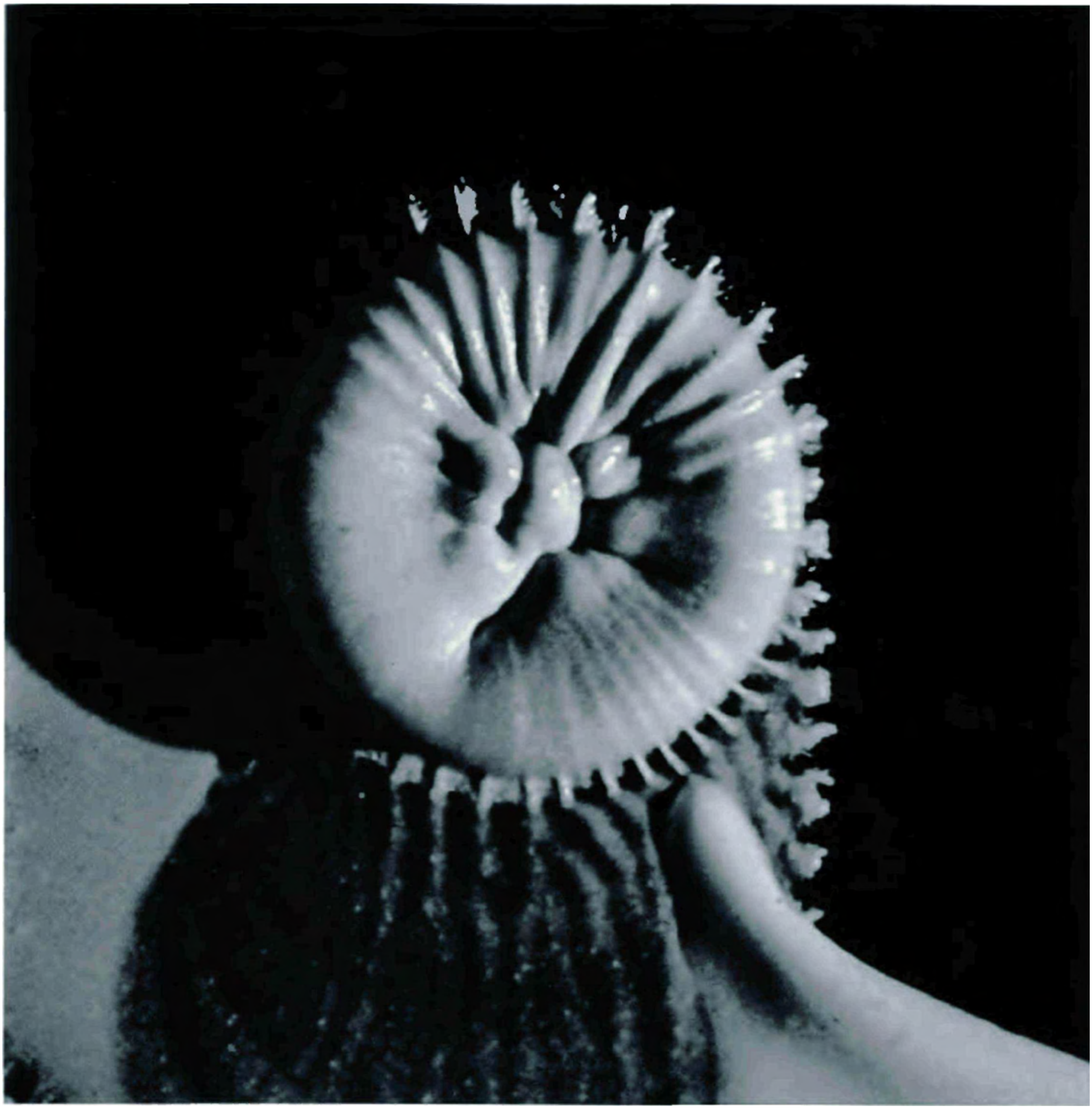
90 As the amplitude is varied, the pattern goes through a number of changes. The dynamics of the moving mass of lycopodium particles alter, depending on whether the tone is loud or soft. (See page 81.)



102 Precipitations with Liesegang rings have been started by dropping the silver salt at random on the plate. The zones of periodic precipitation reveal how the precipitates are arranged. Everywhere there is a tendency towards a rhythmic process. This tendency can be seen in each pool. (See page 89.)

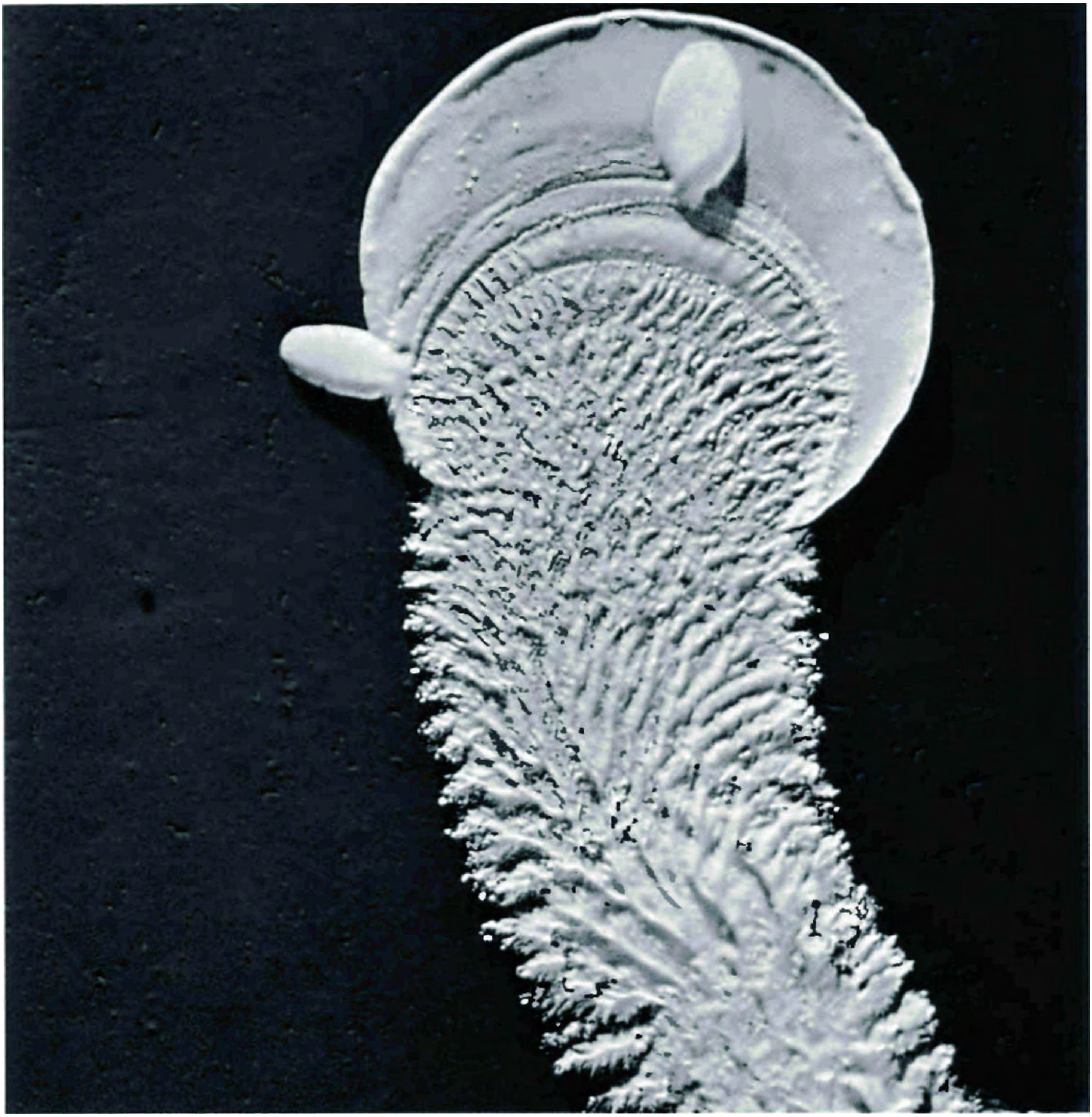
103

103 A red emulsion is introduced into a liquid which is stained black. The red emulsion begins to disperse according to the concentration gradient. This figure shows some of the processes involving periodic hydrodynamics by which the dispersion takes place in an oscillating meandering pattern. It must be imagined that "everything" is not only flowing, but actually flowing in patterns and rhythms. (See page 90.)



136

136 As liquid kaolin cools while under the effect of vibration, it begins to solidify, assuming a plastic. dough-like consistency. This round configuration arises in a state of constant circulation while also displaying radial patterns. (Photo taken from above.) (See page 106.)



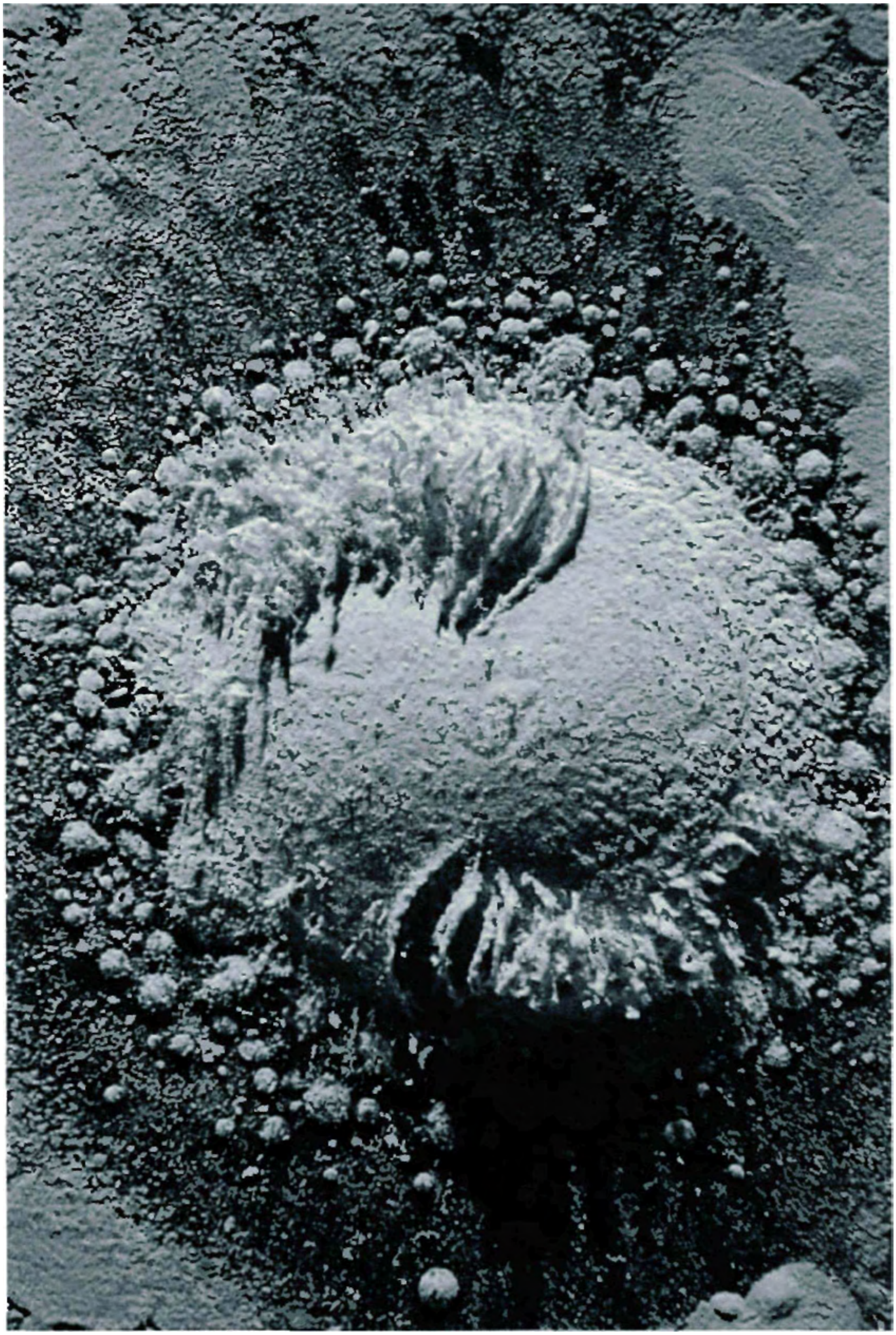
140

140 The mass has solidified. The patterns in the substance on the diaphragm are also rigid. They reveal a dendritic formation; they are not crystalline in character. (See page 106.)

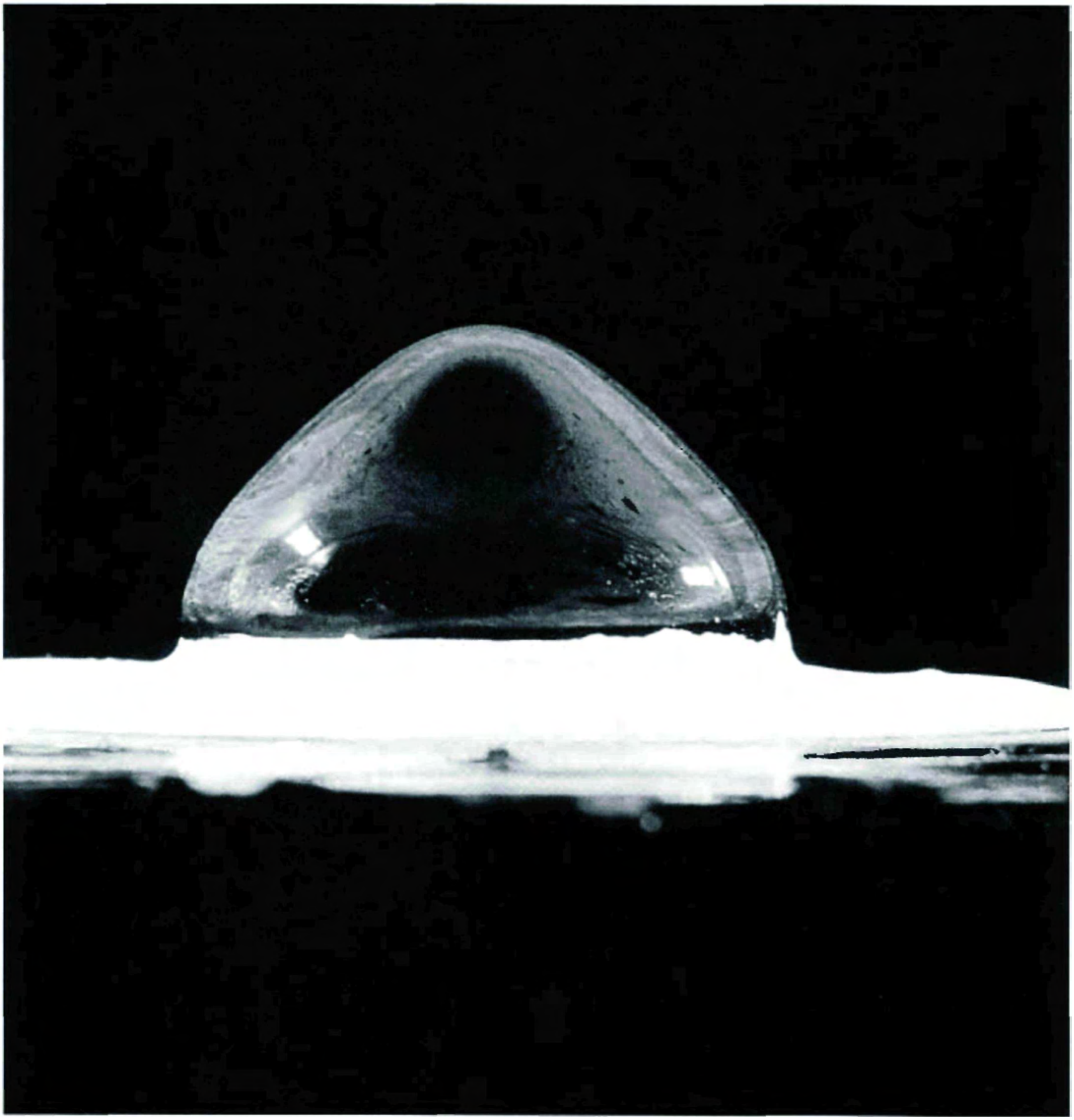
146 Round shapes of the greatest regularity appear. The one seen here is absolutely perfect in its form. It is not some finished design in porcelain but quite literally a "fluid configuration". Within this form everylhing is in a stale of circulation. The material ftows from the ceriphery to the center and from the center to the periphery. Everything is generated and sustained by vibration. Without vibration everything would be simply a uniform paste. (See page 113.) 146

42 A round heap of lycopodium powder (about 4 cm in diameter) is made to circulate by vibration. At the same time two centers of eruption rotate at diametrically opposed points of the pile. Rotating first in a clockwise and then in a counterclockwise direction, this wave produces a kind of to-and-fro effect. The two points where the powder is flung up must be visualized as advancing through the quiet areas of the periphery, the very next instant. In their wakes activity immediately ceases again. The processes of rotation and circulation proceed uniformly. Frequencies can be set at which the (rotation runs in one direction only, appearing as if a "diameter" were rotating. (See page 166.)

42

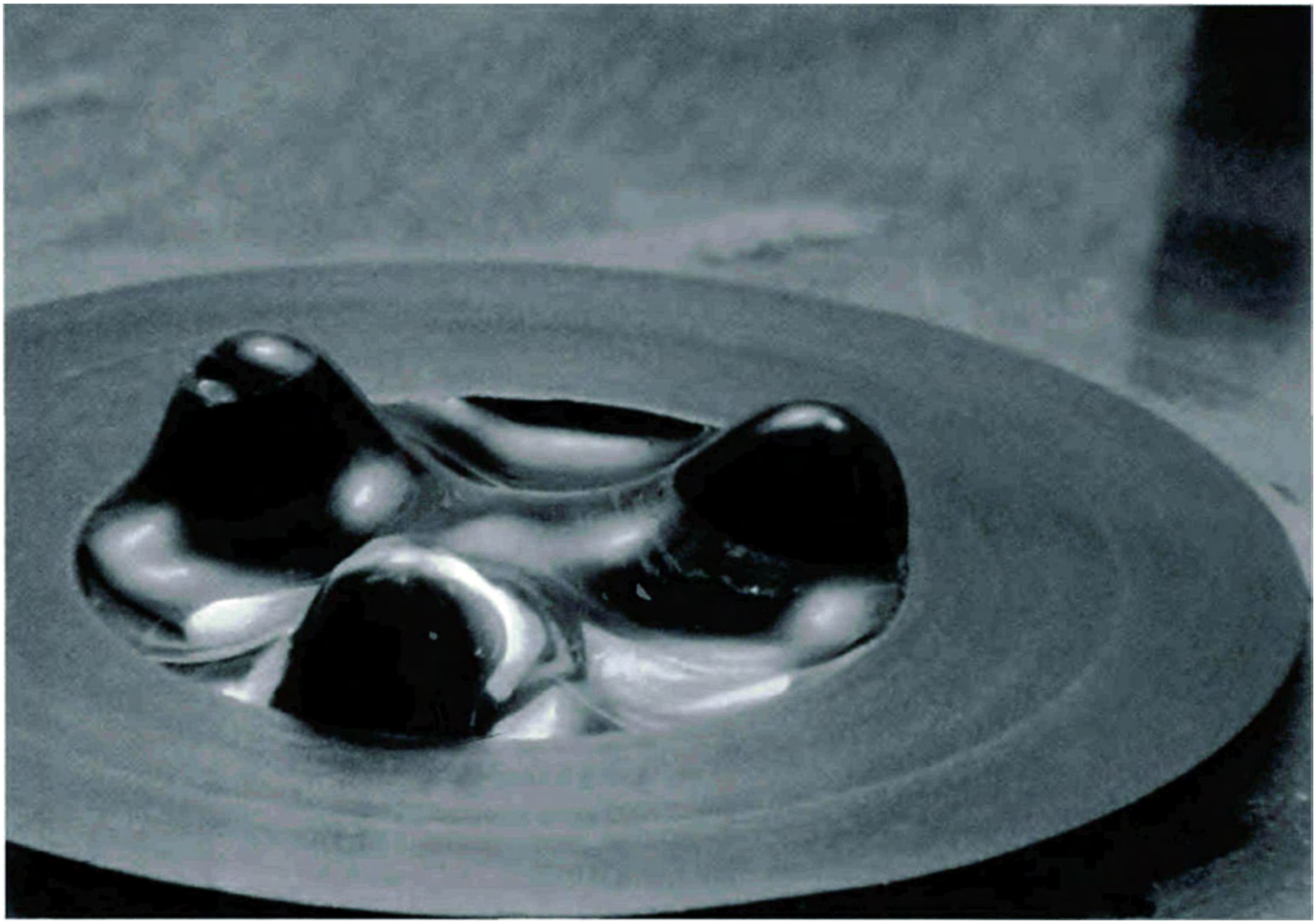


53 A ferromagnetic mass placed in the magnetic field can conform to the pattern of its lines of force when excited by vibration. Adhesion and cohesion are reduced. Under these conditions the characteristics of magnetic space are made visible. What we see here is not a rigid arch but, so to speak, a flowing piece of sculpture. (See page 174.)



80 80 Soap bubbles were used to show how three-dimensional shapes are structured by vibration. The zones of pulsation bulge and flatten alternately (Figs, 80-84). The higher the tone, the greater the number of pulsating 2ones to be seen (Fig. 80 is a lower tone than Fig. 83). The pulsations of the bubbles can be seen from the side and also from the top, and so it is proper to speak of regular polygonal vibrations in three-dimensional shapes. Figs. 85 and 86 show whole soap bubbles and again the impression created is one of pulsating "polygons"'. (See page 191.)

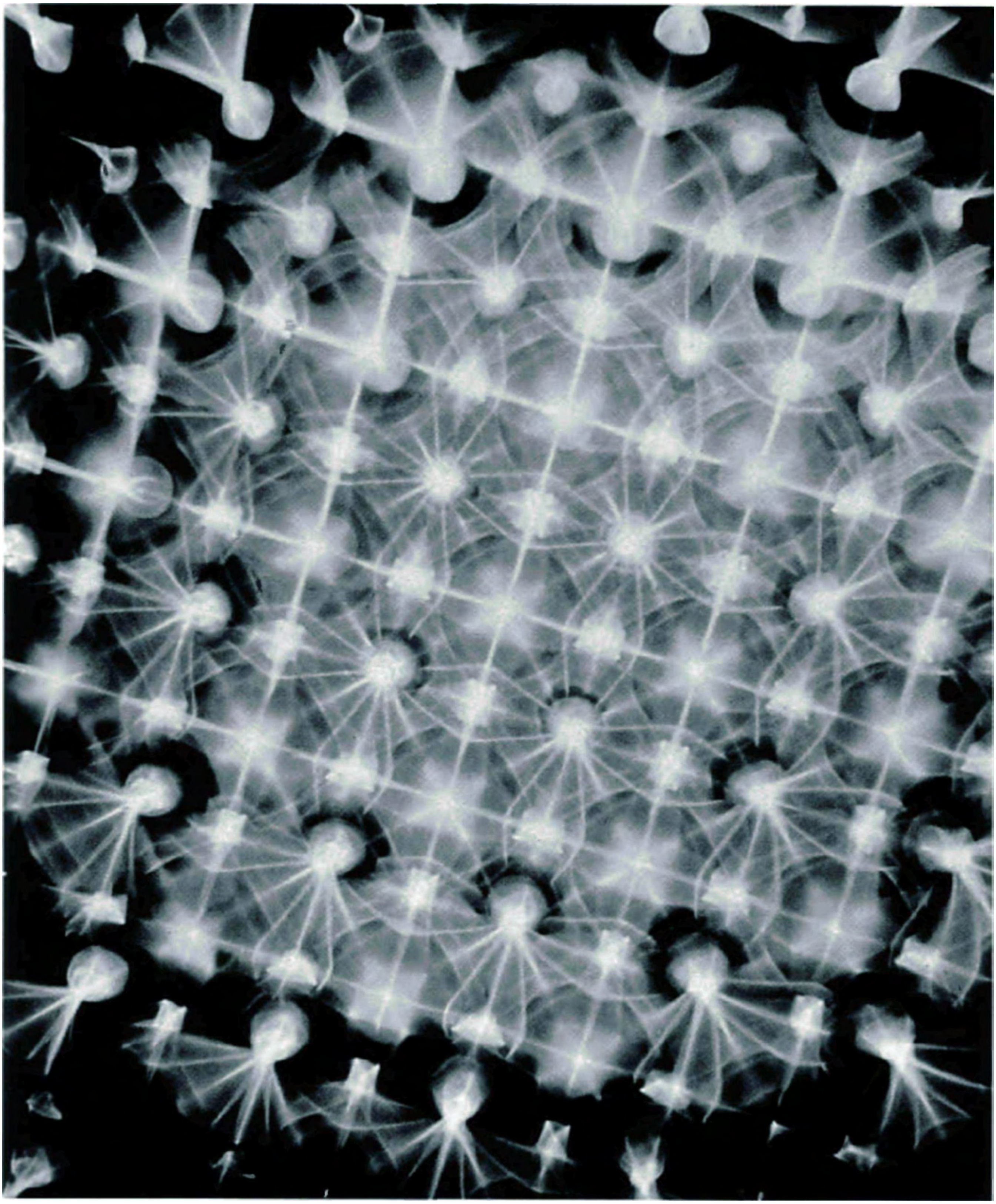
86 See preceeding color plate, Fig. 80. (See page 193.)

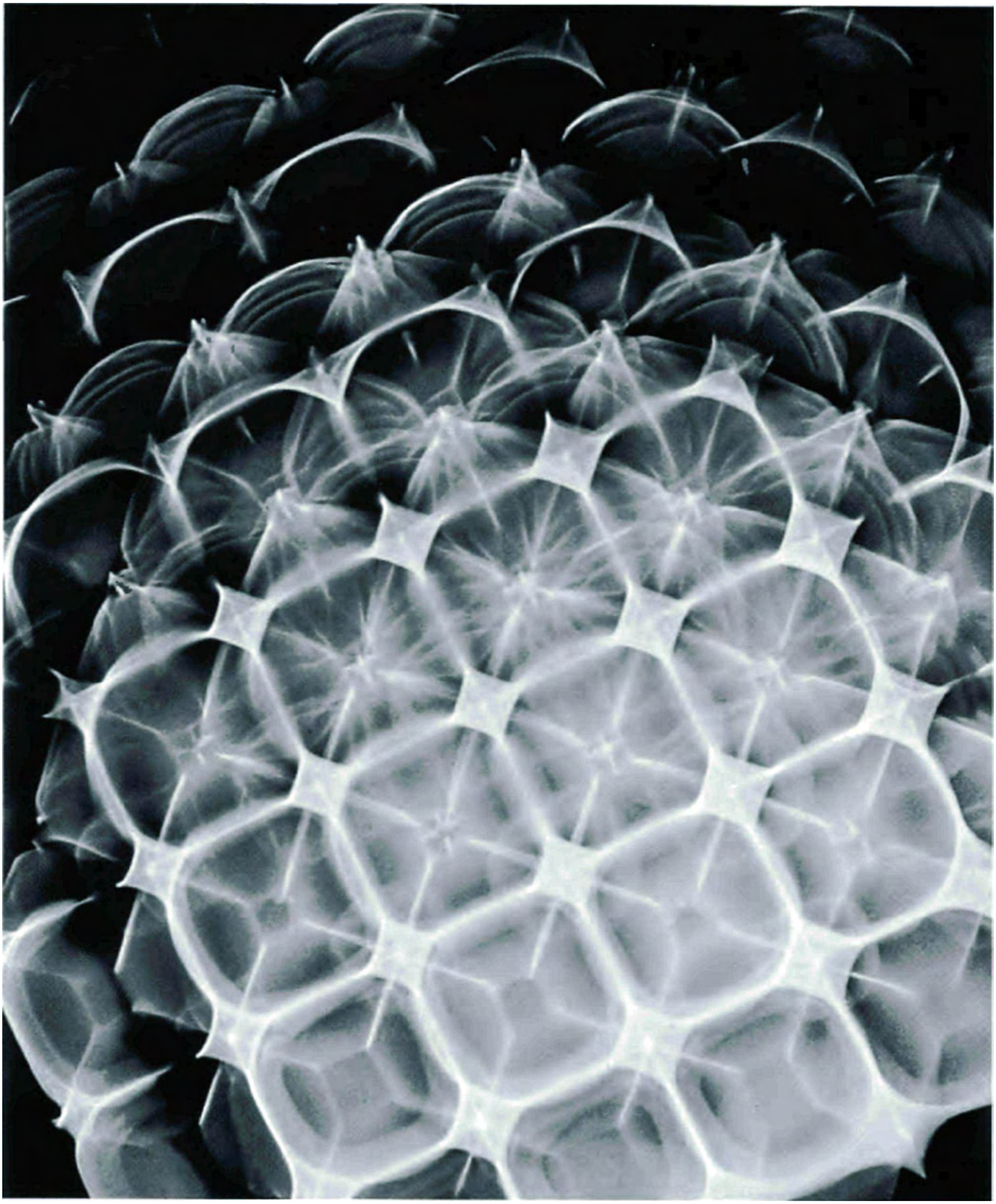


143

143 In this photograph we are looking at the surface of the pulsating liquid from the side. It must be imagined that, the next instant, the three hummocks will subside and three others will appear between them. The relief changes in time with the rhythm of the exciting frequency. If this process were to be viewed from above using the schlieren optical system, a trigonal structure (2x3, as seen in color plate Fig. 126.) would be seen. This lively play of plastic forms does not cause turbulence in the harmonic pattern; indeed, it is itself harmonic in character. (Diameter 2 cm.) (See page 219.)

165,166 If a film of liquid is irradiated by sound, patterns of the kind shown in Figs. 165-170 can be revealed by the schlieren method. A complicated lattice appears comprising squares, diagonals and perpendiculars. Curves, circles and radiating patterns result. But here again, number, proportion and symmetry prevail. In the experiments shown here, oil of turpentine was the substance used. Such harmonic patterns can be produced in films of many different liquids by means of vibration. The orderliness prevails down to the smallest corner, e.g. in Figs. 169 and 170. which reproduce details. Cymatic effects of this kind are also produced at the microscopic level and can be clearly recognized even after the original has been magnified several hundred times. We realize that these figures and processes appear in every dimension. (See page 231.)





8

The Spectrum of Cymatics

We shall now describe two examples of cymatic processes. In our account we shall record the various aspects of their outward appearance and make a compilation of them. It will then be seen whether there are any features of regularity between the various categories of phenomena revealed by this compilation and what the relationships between them may be. It is not a scheme we are looking for; the processes will be allowed to speak for themselves. They will show how they form into series and whether there emerges from the empirical field a spectrum of phenomena which stems entirely from their own essential nature.

From the numerous series of experiments, we will first single out "solidescence". What is involved here is the change in the state of matter wrought by vibration. In the present experiments the cooling process was used in order to observe the solidification of a substance. A kaolin paste is heated; it liquefies and is then poured onto a vibrating diaphragm. Wave fields are created and typically, standing, traveling and interfering waves appear. Figs. 134 and 135 afford views of these "wavescapes". During the cooling process, the picture begins to change. The mass becomes semi-solid. Depending on the vibrational topography of the diaphragm, the material masses together and forms round shapes (Figs. 136, 137). There is marked circulation in the sense that the material at the top is transported from outside to the center and at the bottom from the center to the outside. There is thus radial circulation within these round shapes themselves. In addition organized patterns appear, so that the whole presents a relief of ribs in radial movement (Figs. 136,137). At the same time the stroboscope reveals pulsations throughout the formation. It need hardly be stressed that these are the results of vibration. If the generating sound is discontinued at this stage, everything again becomes a semi-solid paste and cools to form an evenly distributed mass. But if vibration continues while cooling proceeds, the picture changes yet again. The material assumes the consistency of a tough dough. It begins to rotate around and around. It rolls, turns on itself like a ram's horn and is plasticized in volutes (Fig. 138). These processes and their formations are reflected in the figures which have formed on the diaphragm and are in the process of solidifying. Fig. 139 is a photograph of an area which has solidified completely. The areas where the substance has solidified under the action of vibration can be recognized. Fig. 140 shows a whole strip of solidification. Fig. 141 a detail of such a patterned field. Finally the masses solidify completely. The product is now in a solid state and is preserved. The patterns are of a peculiar nature. In the experiment performed with this paste, they are not in any way

125

126

125 A viscous fluid is poured onto a vibrating membrane. An annular wave is formed surrounding a hollow.

126 Continuation ot experiment 125 results in the formation seen in figure 126. A sequence of annular waves appears with a protuberance in the center. Two trends can be seen: one lending to more actual wave trains and the other to round forms.

127

128

127 The wave principle predominates. It might be described as a wave sculpture. The photograph is taken looking down.

128 Here a sort of rampart is added to the wave form; this is a nascent round form.

129 The round form predominates. There is nevertheless a concentric wave train as well. Acone protrudes in the center. The whole configuration is in a state of radial circulation.

130 This configuration combines the round form with marked wall-like waves in rings. The whole must be imagined as moving, flowing, circulating and pulsating, etc. During the experiment the tone producing these forms is, of course, audible.

129

130

crystalline. Instead they branch and ramify. The pattern runs from large thick branches to increasingly more delicate ones until finally there appears a kind of filigree. They are true dendritic formations which can be produced again and again in this typically serial configuration.

What exactly is revealed in this series of experiments with solidification? If we follow the course of events, we find first of all wave phenomena, which are the prototypes of periodicity. These are followed by formations and organized patterns. At the same time different forms of movement appear: rotations, circulations, to-and-fro motions, pulsations. But these processes are caused purely and simply by vibration and nothing else. Periodicity is inherent in them, it lies in their nature to be rhythmic, whether in form, in configuration, in movement or as a play of forces. Sculptural shapes are actually formed. It sometimes seems as if one is vouchsafed a glimpse into the origins of Baroque. All these phenomena take their rise in the field of vibration and owe their existence to vibration. They have therefore originated in vibration and are in some measure its specific effects; vibration produces a multiplicity of effects or is poiyergic.

In the course of these experiments pure periodicities appear which coact and interact; sometimes form is dominant, sometimes movement: sometimes the picture becomes organized as a pattern and there is real configuration, sometimes

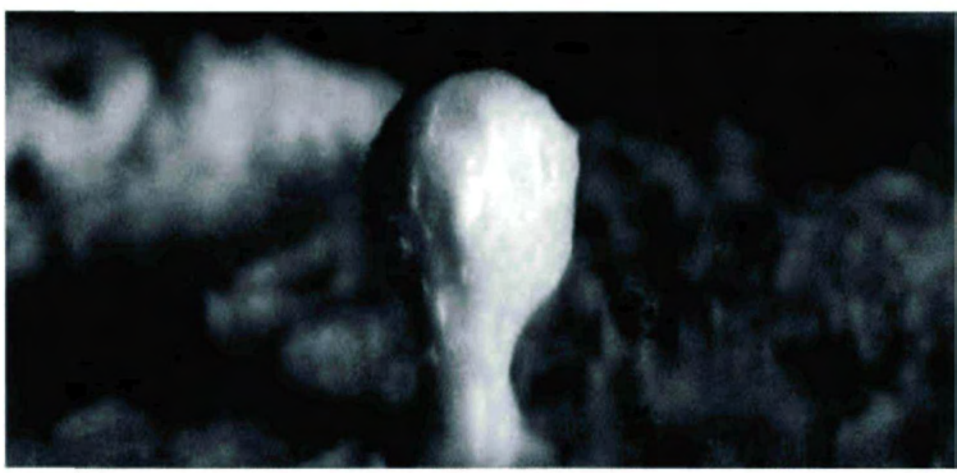
131 Minor changes in viscosity bring about changes in the forms seen. The liquid has been rendered more fluid. When greater amplitudes are used, the masses are flung high and ejected. The experiment can be continued in this direction until the liquid forms a spray. The waves also increase in height and look like cups or pots although they are also in a state of flow.

131

132 These fluid, flowing sculptures assume any number of different forms. Wall-like waves rise in some places. Where trains of waves interpenetrate in lattices, the waves rise in columns. Even these phenomena which persist for some time are "living". The mass flows and pulsates within itself. If the tone is stopped, the liquid returns to its uniform state.

132

133 If the liquid is of a more viscous character, figures of the most varied kind take shape. The club-shaped configuration seen here has actually been raised out of the mass by the vibration. It is not a finished sculpture but a configuration in a state of flux. The substance flows up the stem of the club and circulates. These figurines also pulsate in themselves. They may also move around depending on the topography of the vibration. Such processes are not purely adventitious but can be reproduced systematically.



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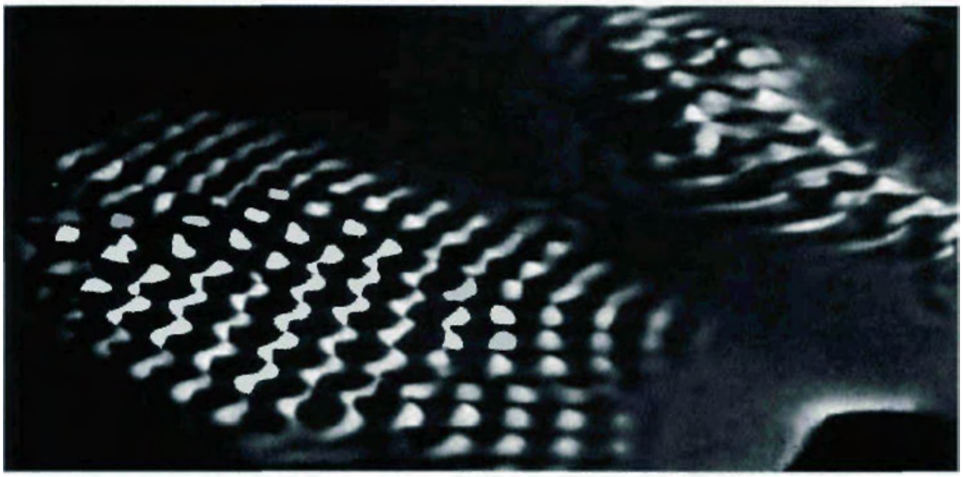


135

134,135 The transition from the liquid to the solid state while under the affect of vibration can be seen in this and the following figures. The process can be exemplified by cooling, evaporation, chemical rearrangement, etc.The liquid state is invariably taken as the starting point. Oscillation causes the substance to form waves. Figures 134 and 135 show wave fields of this kind. What can still be seen here as static liquid becomes solid and rigidities during the experiment.

everything is in a flux, in a plastic flow. A certain polarity becomes evident; for it is not inappropriate to speak of polarity when on the one hand the object assumes form, even a rigid form, and on the other hand, moves, finds itself in constant change, and appears as fluid form and as formative flux. Since alt these aspects are essential and necessary parts of the picture, since they all represent exclusively the effects of vibration and are caused by the same vibration, they fall, as it were, into a series of their own accord. Taking this idea of polarity as basic we have a spectrum of phenomena running at one end into the figurate, into shapes, into organized patterns and textures, and at the other end into movement, circulation, into streaming and flowing, into kinetics and dynamics, The whole is created and sustained by oscillation, the most explicit and typical expression of which is the wave in the widest sense.

What it all boils down to is this, we must keep on asking ourselves as Goethe did: "Is it you or is it the object which is speaking here?" If we were to establish rigid definitions and split up the various manifestations into sections, we should be artificially dismembering the phenomenon by applying the analytical instrument of the intellect. If the phenomenon is to remain vital, its spectrum must be grasped as a fluctuating entity. True, there are significant forms there; but what we have to evolve is the concept of moving form and formative movement.

Sharply defined patterns emerge, but they flow away into nothing. Rowing patterns and patterned flux appear before us. Thus, the problem of cymatics exists not only in observing in the experimental field but also in formulating concepts with which to press towards comprehension of the actual realities. In attempting to leave the cymatic phenomenon intact and unharmed in our intuitive vision, we can derive from it the following spectrum with form at one end and movement at the other: figurate, patterned and textural on the one hand, turbulent, circulating. Kinetic and dynamic on the other, and in the center, acting in either direction, creating and forming everything, the wave field, and thus as causa prima, creating and sustaining the whole, the causa prima creans of all — vibration.

So that we can describe and define conditions from many different points of view, we will illustrate and explain a further example. This time it concerns a viscous liquid. Here again the material is irradiated with sound. In this instance not only the frequencies and amplitude are modulated but the liquid itself is changed by modification of its viscosity. First of all wave

136

137

136,137 The consistency soon changes. The substance becomes plastic and dough-like. The round configurations which appear are in a state of circulation and also display radial patterns. Figure 136 is taken from above and 137 from the side. (See color plate section for Fig. 136.)

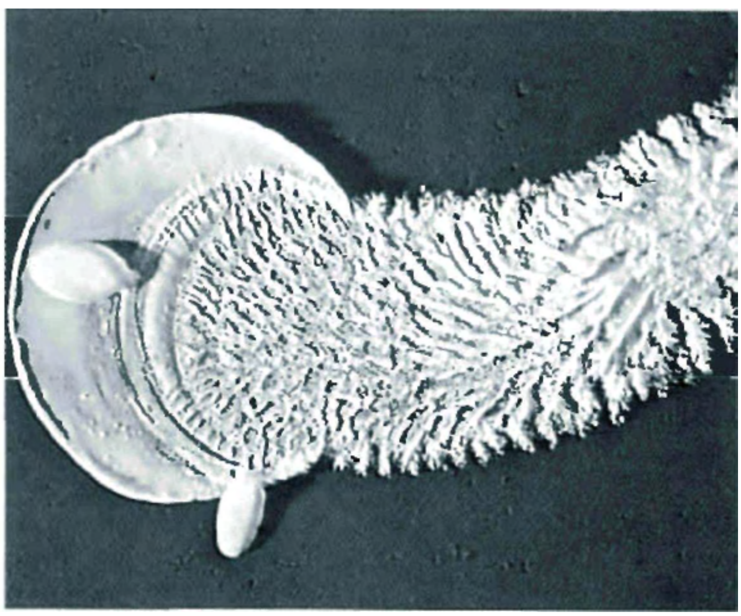
138

138 The process of solidification proceeds further The mass becomes a viscous paste. It is rotated into volutes and rolled into a shape like a ram's horn.

formations appear. Figs. 125, 126 and
143 are photographs of imposing wave crests. Fig. 144 shows a series of waves seen from above. Then round forms appear. Interesting transitions can also be found. Fig. 128 shows a picture in which the sequence of undulation is still clear, but already there are intimations of an encircling rampart which, as this process begins to dominate, flows together to form a round shape. These round shapes reveal a radial circulation within themselves. Yet, also inherent in them, is the wave principle which now however, appears as an annular for mation (Fig. 145) The ring form may appear with a high degree of perfection (Fig. 146). This double-ring form looks as if it has been turned on a lathe or a potter's wheel. In spite of its perfect shape, it must be imagined as constantly rotating. In other places on the vibrating diaphragm movement processes arise as amplitude and frequency are changed. The mass creeps around in vermicular forms. In Fig. 147 one can see such a formation which is readily derivable from the round shape (Fig. 146). If the vibraiion is now increased (corresponding to a crescendo for the ear), the round configurations rotate more rapidly. The processes are intensified. The wave rings rise up to form walls (Fig. 130). The masses lift up into peaks (Fig. 148). Crypts like honey-combs are formed while, close by, the waves rise high. There are pillar-like prominences: column waves and wave columns. The mass shoots up, is hurled

away in the form of spiculae (Figs. 149,150). Protuberances of every kind are thrust up, some with explosive dynamic force, others in apparent tranquillity. We say "apparent" advisedly because in all these objects, in the eruptive as well as the persistent, the stroboscope reveals pulsations, turbulences and currents. Figs. 131, 132 and 148-151 are a series of photographs showing these processes. The round shapes and their ring formations can be recognized; the process of intensification leading to wave walls and wave columns can be followed. The enormous dynamic force which ultimately causes the mass to atomize can also be seen. In everything we find the effects of vibration undergoing a series of changes. The highly specific character of the relationships between the factors involved is recognizable in the following pictures. Viscosity has been increased compared with the preceding series of experiments. The mass is now more gluey. Now organized patterns imprint themselves. The round shapes display radial ribs; so do the "worms"; they even undergo actual segmentation (Figs. 152, 153). If the amplitude is now increased, a process emerges which is entirely different from that witnessed when amplitude was increased in the experiment with highly fluid substances. The mass rears up; it assumes a shape like a figurine. Fig. 133 shows a club-like excrescence. What must be realized is that the mass flows up into the figurine, circulates, flows down, pulsates.


139


140

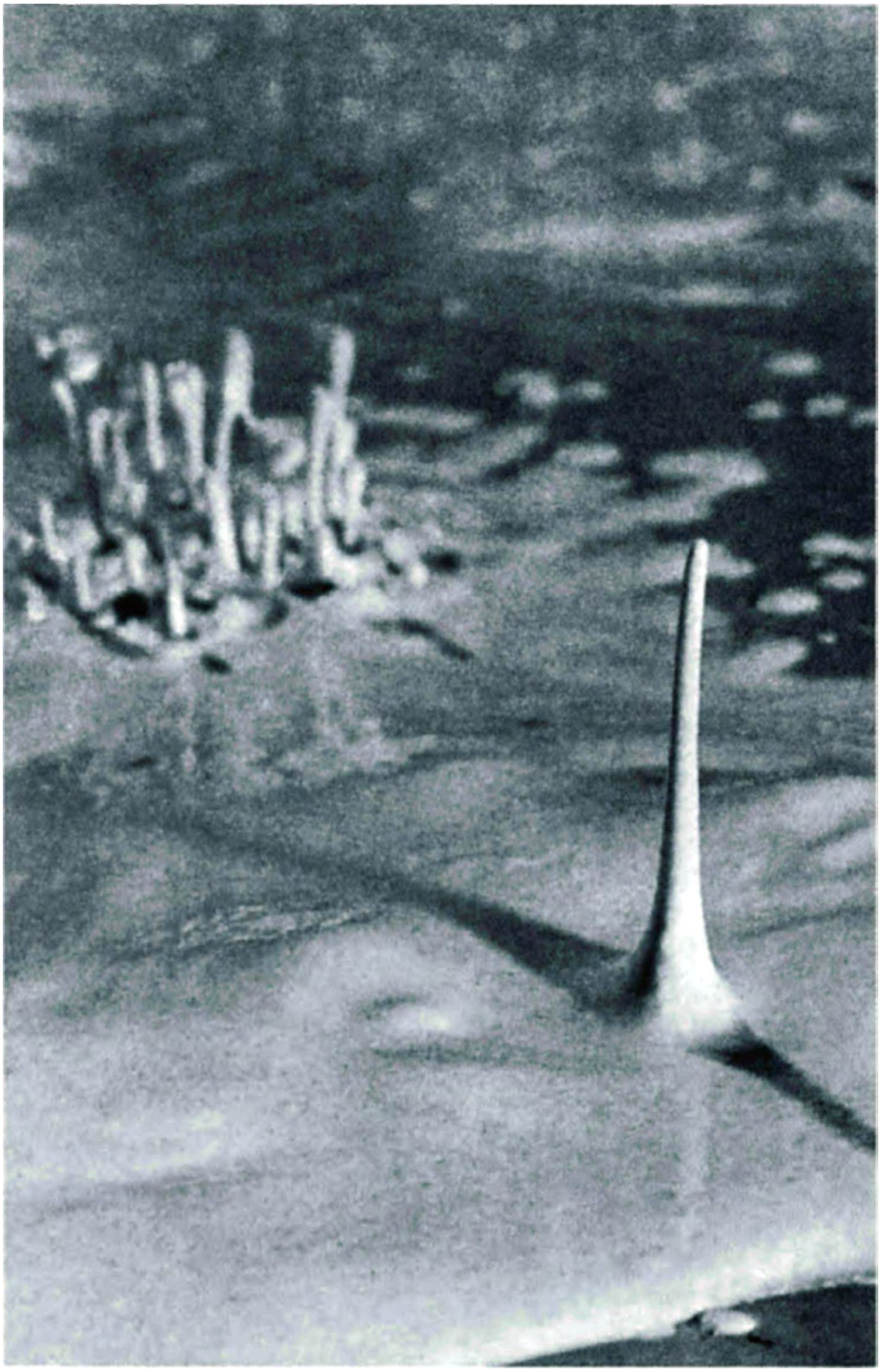
139-141 The mass has solidified. The partterns in the substance on the diaphragm are also rigid. They reflect those of the rotating round shapes (136. 137) and reveal a dendritic formation; they are not crystalline in character. (See color plate section for Fig. 140.)

141

But the shape of the figurine persists in spite of the turnover of material. At certain places on the diaphragm, depending on the different vibratory topography, they move around, and run to-and-fro in the vibrational field.

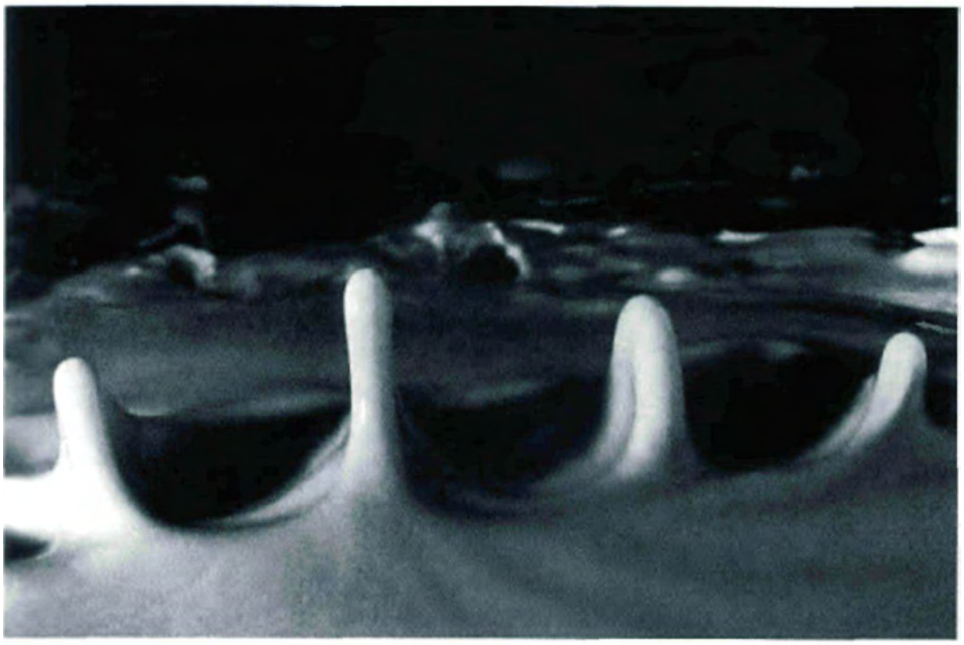
These descriptions, which take account only of the most important aspects, have a bewildering effect on many people at first. The "profusion of appearances" is difficult for the mind to grasp. But this is a stage which must be passed through. One can then, of course, proceed to analyze this or that category; but always one must return to the whole, otherwise one is left "holding the pieces in one's hand". Analysis is essential, but the eye and the brain must restore what they have dissected to the active phenomenon and reintegrate it with the complex reality so as to see it again in the nexus in which it is alone existent.

In order to get one's bearing, the processes here can once again be tentatively categorized without injury to their fluctuating character. Once again we have, on the one hand, figures, configurations, organized patterns and formations, textures and webs: on the

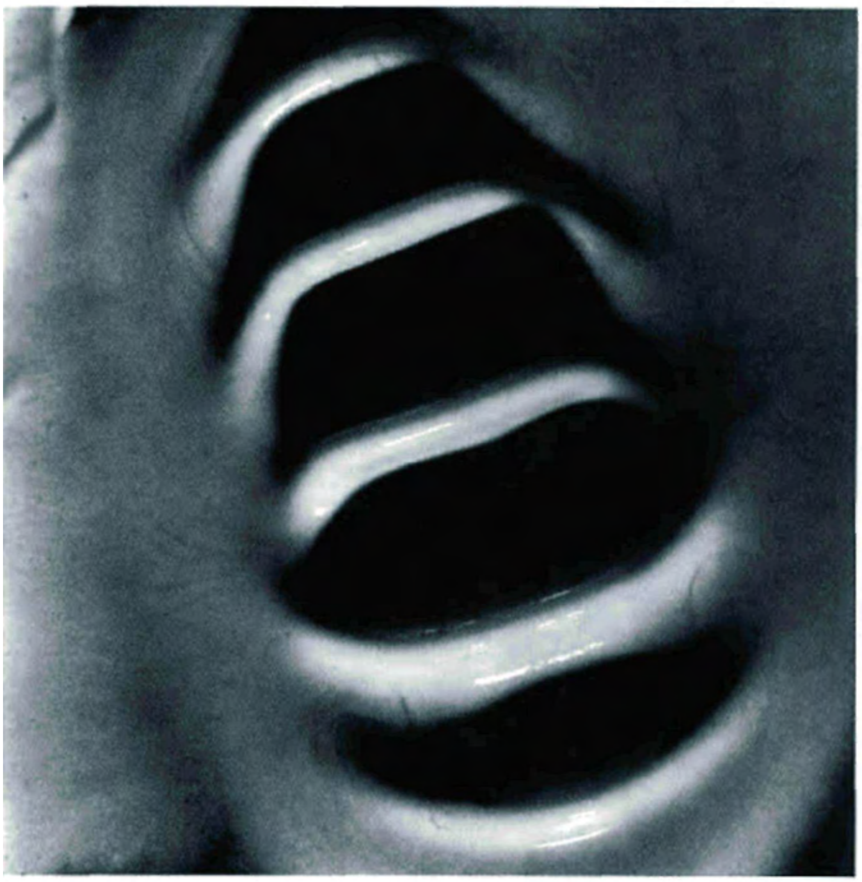


142

142 In experiments with "solidescence," curious effects resulting in figurines are repeatedly observed. The tall, columnar figure is driven up by vibration. At the time the photograph was taken, the mass was still viscous. Although the figure persists for some time it will vanish in the course of the experiment as the material enters the solid state. Other morphological elements will also appear as the result of vibration.



143



144

other we have turbulences, currents, movements, and the play of forces on and in the masses. Once again the waves are a kind of middle category; they are the periodic element par excellence. But here again it must be noted that it is the essential character of the waves, their characteristic periodicity, that is the basic causative factor throughout. For the whole drama of these phenomena is played by the vibrational orchestra of an oscillating diaphragm.

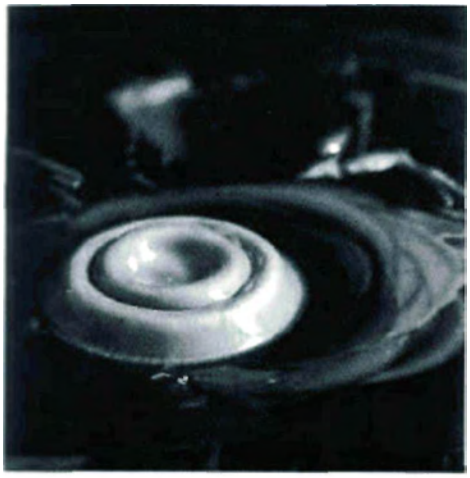
The phase we have reached in our study is characterized by the discovery of a spectrum of phenomena. It can be approximately described in the following terms: figures, organized patterns, texture, wave processes in the narrow sense, turbulences, kinetics, dynamics. These terms are not conceptual pigeon-holes: they do not package reality. They are derived from empirical perception. We will therefore leave the spectrum in this form for the time being. Whether it can be developed further, and if so, how, are questions to be dealt with in the next chapter.

143 In the following series of experiments the remarkable diversity of the phenomenology of vibration will be shown. Fundamental changes are produced not merely by variations of frequency and amplitude, the character of the material is also a factor. Very small differences in the viscosity produce entirely different formations. In figure 143 huge wave crests appear as a viscous liquid is poured onto the plate and vibration begins.

144 Photograph of the "wave trains" seen from above.

145

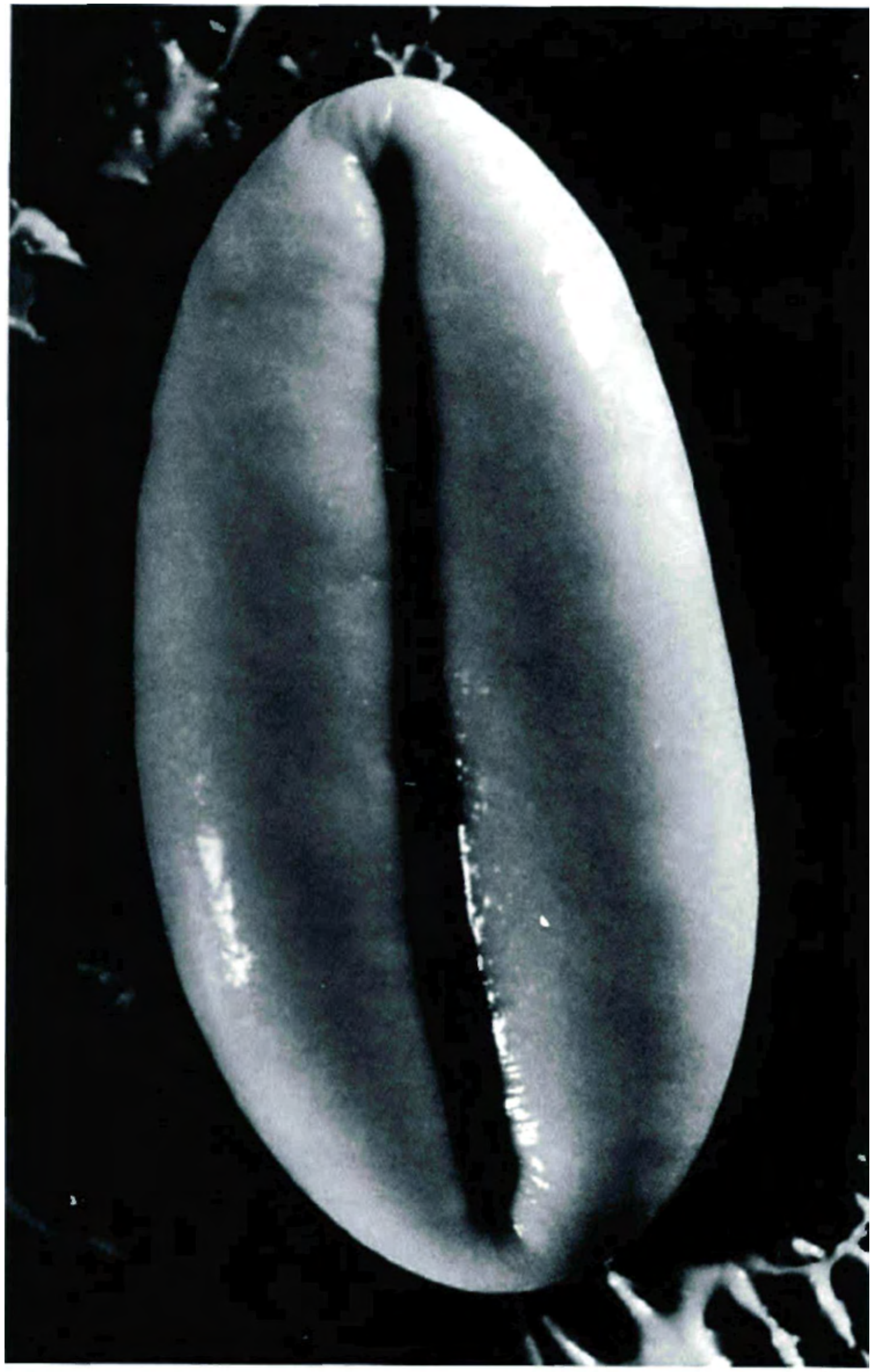
145 Round shapes appear in addition to the wave trains, all depending on the topography of the vibrating diaphragm. In figure 145, these waves trains appear in a concentric annular pattern.



146

146 Round shapes of the greatest regularity appear. The one seen here is absolutely perfect in its form. It is not some finished design in porcelain but quite literally a "fluid configuration". Within this form everything is in a state of circulation. The material flows from the periphery to the center and from the center to the penphery. Everything is generated and sustained by vibration. Without vibration everything would be simply a uniform paste. (See color plate section.)

147 In places of continuous movement these round shapes become elongated. Figure 147 shows such a stage in the nascent state. Even this long oval shape is still circulating within itself. The longitudinal fissure is the zone in which the mass flows in. If the amplitude is increased (a crescendo for the ear) the form creeps hither and thither like a worm. (See also 153.)

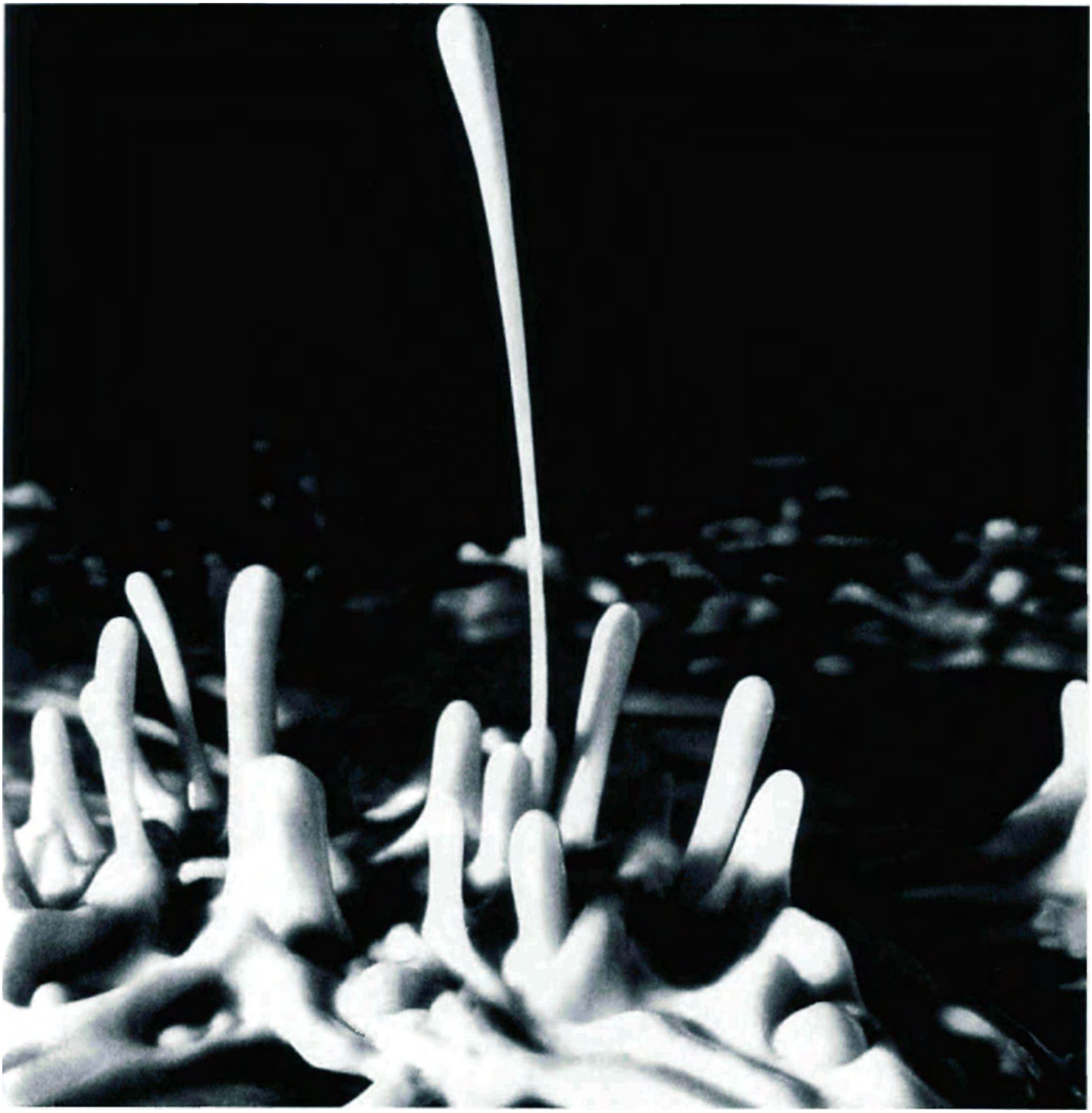


147

148 If the mass is made more fluid and a greater amplitude is used, a dynamic element appears. Waves rise and eddy up to form walls, plates, columns.

149-151 Figures 149 to 151 also show kinetic dynamics due to vibration. While on the one hand there is a moving world of forms in which the mass may even be ejected in the form of spiculae (149, 150), we may also find wave sculptures (151) ol a more persistent nature. But since shapes and patterns appear simultaneously, whatever the kinetics and dynamics, the cymatic spectrum is omnipresent and manifests itself consistently everywhere as the basic triadic phenomenon.

148



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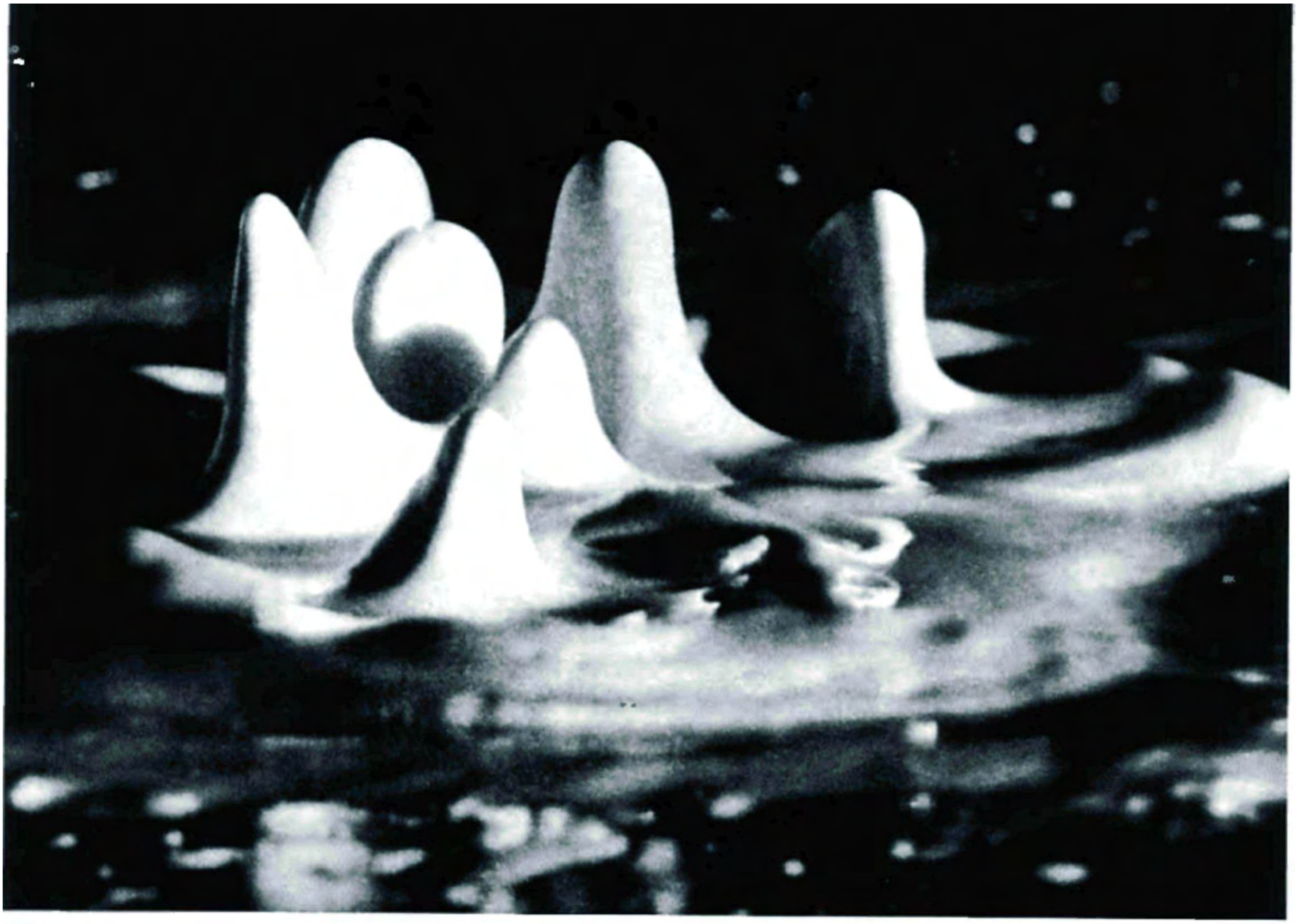

151

152

153

152, 153 We can again vary the experiment by making the mass more viscous. Again round and vermicular forms appear in a state of circulation and pulsation, but now the patterns are more marked with radial ribs in the round configurations and a kind of segmentation in the elongated forms. White the round shape remains stationary if the amplitude is unchanged, the elongated form creeps around, but always in conformity with the vibrational pattern.

154

154 Viscosity changes again. With increased amplitude the masses are driven up and shaped like figures. Compare figures 133 and 154. There is also a figurine there, but its stature is quite different. Thus slight changes of viscosity produce entirely different forms. The figurine seen here must be imagined to be In a state of flow and pulsation.

9

The Basic Triadic Phenomenon

Since the various aspects of these phenomena are due to vibration, we are confronted with a spectrum which reveals patterned, figurate formations at one pole and kinetic-dynamic processes at the other, the whole being generated and sustained by its essential periodicity. These aspects however, are not separate entities but are derived from the vibrational phenomenon in which they appear in their "unitariness". Even though one or the other may predominate in this or that phenomenon, we invariably find these three elements present. In other words, the series we have formulated is in reality confluent in homogeneous activity. It is not that we have configuration here and organized pattern there, but that every effect of vibration bears the signature of configuration, movement and a play of forces. We can, so to speak, melt down our spectrum and observe the action of its various categories as a continuous play in one and the same entity. If we wish to describe this single entity, we can say this: there are always figurate and patterned elements in a vibrational process and a vibrational effect, but there are also kinetic and dynamic elements; the whole is of a periodic nature and it is this periodicity which generates and sustains everything. The three fields — the periodic as the fundamental field with the two poles of figure and dynamics — invariably appear as one. They are inconceivable without each other. It is quite out of the question to take away the one or the other; nothing can be abstracted without the whole ceasing to exist. We cannot therefore number them one, two, three, but can only say they are threefold in appearance and yet unitary; that they appear as one and yet are threefold. All the examples in this book can be considered from this point of view. It will be seen from the selection shown in these pages that in every case there are formations, textures, and forms, we can see movements, currents, circulations, rotations, etc. and yet all these display throughout a rhythmic, serial, vibrational character. Hence we cannot say that we have a morphology and a dynamics generated by vibration, or more broadly by periodicity, but that all these exist together in a true unity. This can be seen from all the experiments described here; all the examples adduced are — whatever their variations — recognizable as this unitary element. It is therefore warrantable to speak of a basic or primal phenomenon which exhibits this threefold mode of appearance. It must be stressed that this is an inference made from appearances. The basic threefold or triadic phenomenon is not a preconceived conceptual form which is forced on the nature of things: these things themselves are the basic triadic phenomenon.

It might be argued and discussed that this is not really a true morphology, but only a vibrational form, not an inherent dynamics, but a vibrational dynamics, etc. If, however, we restrict ourselves to experience and speak its language, we shall find that we speak of every metamorphosis and variation in terms of the basic triadic phenomenon. But the few examples given here do not exhaust the phenotypes of this phenomenon. Using this basic phenomenon as a perceptive organ (not as a dogmatic formula) we can watch and observe the most varied fields to see whether the language of periodic triadism is also current there. As far as research has proceeded along these lines, it has been found that this basic model is fundamental to the most varied fields and constitutes an essential part of their nature. Contact with scientists and research workers in the most diverse areas of study has afforded wide vistas of this kind. We are thus confronted with the concrete research task of starting a monograph on periodic phenomenology which would cover many different fields. The basic triadic phenomenon is an empirical notion which comes to mind in the study of histology, cell physiology, morphology, biology and functional science; likewise in the study of geology and mineralogy, and atomic physics, astronomy, etc. This does not mean that this basic theme should be inflated to be a model of the universe; the interpretation of phenomena calls for subtlety of mind and love of research. Rather than blunt the reader's mind with countless references, we shall describe in detail one example to show how this basic phenomenon appears in a specific case and how appropriate it is as an instrument of knowledge for probing into fields of research. This one example will serve for many. It is concerned with liquid or water physics. In order to give the reader some idea of the subject we shall quote some appropriate passages on hydrophysics. First we quote from Wolfgang Finkelnburg's Einfuhrung in die Atomphysik, (1954): "Since it is at first sight surprising to claim that liquids have a quasi-crystalline structure, we will look first of all at the most important evidence supporting this contention. Direct evidence is provided by Debye's method of X-ray diffraction in liquids. If the molecules and the distances between them were completely irregular, the intensity of scattering would decrease uniformly as the scattering angle increased; if the molecules are in a regular arrangement, the X-rays scattered by the various molecules would show peaks and dips in the intensity plotted against the angle of scattering, and these have in fact been observed. If the scattering curves are obtained for the various geometrical arrangements (i.e. liquid structures) which might be considered possible and compared with those found empirically for a liquid, the particular molecular arrangement in the liquid can be ascertained with some accuracy provided the case is not too complex. Recently the distribution of atoms in liquid mercury has been accurately studied by Hendus by means of monochromatic X-ray irradiation. At a temperature of 18°C he found an atomic arrangement which was almost exactly the same as that of the crystalline state and substantially different from the densest packing of particles expected in liquids."

Further evidence for a quasi-crystalline arrangement in liquids can, according to Sauter, be found in the fact that the specific electric resistance of pure metals increases surprisingly little on the melting point being exceeded. The measurements appear to be consistent with the existence of crystalline groups of 50 to 150 atoms.

"Another no less cogent proof of the semi-crystalline structure of liquids is to be found in the fact that a value of 6 cal./Mol. degrees has been obtained for the atomic heat of monatomic liquids such as mercury and liquid argon, which is twice the value to be expected for freely movable atoms whose three degrees of translational freedom each contribute R/2 to atomic heat. In crystals, on the other hand, the building blocks vibrate around a position of equilibrium so that there is added to the contribution of the kinetic vibration energy of 3R/2, the same amount again for the potential energy of mean equal magnitude generated by harmonic oscillation. The atomic heat of solid bodies is consequently (on all degrees of freedom being excited) 2x3 R/2 = 6 cal./Mol. degrees. The fact that this value is found for monatomic liquids can be explained only by assuming that here again there is a three-dimensional oscillation of the atoms around a position of equilibrium with the difference that, in contrast to solid crystals, these centers of oscillation themselves perform a translational movement which depends on the temperature.

"There are a number of other optical and electrical measurements which afford equally cogent evidence in favor of a crystalline-like arrangement of the molecules of a fluid." In order to make the example more specific, we will give further extracts from Finkelnburg's Einfuhrung in die Atomphysik dealing with the constitution of water. "In general the existence of strong dipolar or quadrupolar factors brings a complication into the normal structures of liquids by reason of the formation of chains of molecules (e.g. in the alcohols) or clusters of molecules in the 'associated' fluids, whose anomalous behavior is due to the formation of these molecular clusters. By far the most important associated liquid is water, whose anomalous behavior has long been attributed to association. Whereas ideas have hitherto been focused on polymeric molecules of the type $(H_2O)n$, whose degree n has been held to be constant and impossible to determine, it has recently been concluded on good grounds that what is actually involved is molecular clusters of indeterminate size. The precise crystalline structure of these molecular clusters was ascertained by comparison of theoretical X-ray scattering curves and those actually observed: they were found to be tridymite-like in structure with each 'O' atom surrounded in tetrahedric configuration by four 'H' atoms. However, as might be expected for bonding reasons, two of the 'H' atoms were bound rather more firmly to an 'O' atom and hence more closely to it than the two others which were bound to it only by hydrogen bridges. This special geometrical arrangement of the H_2O molecules, i.e. the semi-crystalline structure, is the reason for the special position water is generally known to occupy. Similarly the change in the structure, and thus the characteristics, of water, by the introduction of relatively few ions (or the addition of a little alcohol) is now understandable: the tridymite structure of water, which is determined by typical secondary valency forces (van der Waals forces) is seriously disturbed by the electrostatic forces of the ions or the addition of even a few large foreign molecules, and at least the size of the molecular cluster is influenced. Conversely, the addition of a few H_2O molecules to pure alcohol has no noticeable effect on its chain structure, and indeed the properties of alcohols are scarcely affected by the addition of small amounts of water. Other more subtle properties of liquids ascertained empirically can thus be understood by reference to their crystalline structure in terms of atomic theory." From Pohl's Einfuhrung in die Physik. (1959) we quote: "A liquid is a crystal in a state of turbulence with very small but still crystalline elements of turbulence. As 'individuals of a higher order' these elements are in a state of constant change and go through movements and rotations which proceed in common."

What impressive insights this affords us! One must realize what an epochal change this represents in our idea of liquids and particularly of water. The problem that concerns us here is the way in which physicists are striving to obtain a conceptual picture of water. Let us look at the facts: pattern (crystalline-like, quasi-crystalline, semi-crystalline) on the one hand, and on the other turbulence, movement, both in a flux of constant change.

It would be wrong to state that what we have here is the basic triadic phenomenon. All we can say is this: the search for a conceptual picture moves along the lines suggested by this basic phenomenon (periodicity, pattern, kinetics). From the very nature of things this aspect must be continually recurring in research and constantly confronting the astonished eyes of the researcher.

How extensively the triadic nature of vibration is found, is brought home to us when we realize that the complex organizations of movement, of rhythmic systems (circulation and respiration), and of nerve physiology become evident to us as frequencies and modulations including amplitude modulations. We spoke at the beginning of striated muscle and its real vibration; cardiology is, of course, "rhythmicity" par excellence. Neurology is a field of frequencies and the laws to which they conform (cf. the wave bands of electroencephalography). These systems have patterns of a serial nature and a dynamic of rhythmic impulses. The electrograms are, of course, only the bioelectric expression of processes which are of a chemical, thermal, energetic, kinetic and structural kind. The dominant role of the periodic in other organs and their functions is merely mentioned in passing. (Protein synthesis, the model of genetic information in the living cell, respiratory enzyme chains, catalysis, etc.)

And now into the organization of the locomotive system, of the circulation and the respiration, and of nerve activity — all of which have their being in rhythmicity — living, experiencing man now implants himself. He lives in these fields in that he grasps them and acts

with them

in them

on them

through them

and only thus takes on a tangible appearance himself. We used the term "implant". In point of fact in. say the vibrational field of skeletal muscle, man has developed to the point where he can now manifest himself in and through this medium (facial expression, gesture, gait, dance). The same holds true for breathing, the stream of breath, the formation of sound. The physiological periodicity of nature is raised to a higher plane by the development of rhythmic activities on the basis of physiological fields of rhythmicity. An example of this elevation to a higher plane is the way in which organic periodicity develops into speech. Speech is a pure field of rhythmic phenomena; here again we have kinetic dynamics, here again there is configuration (tonoscope).

By drawing attention to these relationships, the natural scientist is in no way straying from his proper domain; indeed it is in this way that the phenomenon of man can be grasped by the senses and by the intellect through the operation of the empirical method. For how could man develop and operate a speech organ unless he himself were a manifestation of the basic triadic phenomenon at a different level.* Series are revealed leading from the vibrating to the dancing muscle fiber from respiration to speaking or singing, from the frequency modulation of the ganglion cell to the scientist's formation of ideas,

Again and again, and in ever new forms, the cymatic method reveals the basic triadic phenomenon which man can feel and conceive himself to be. If this method can fertilize the relationship between those who create and observe, between artists and scientists, and thus between everyone and the world in which they live, and inspire them to undertake their own cymatic research and creation, it will have fulfilled its purpose.

*In actual fact these studies lead by their very nature into fields which are beyond the scope of this work to discuss. Contact with artists, sociologists, psychologists, jurists and historians has shown us that not only the idea of general periodicity, but also the notion of a triadic world model (the trinity of configuration, wave, power) have validity in these fields. Rhythms in history; resonances, interferences, standing and traveling waves in human relations; the wave-like rise and fall of memories, thoughts and emotions in a periodic manner; poetry and music — all these are themes which have been illuminated by this concept of the basic triadic phenomenon during our conversations with numerous personalities. These views must be described elsewhere. But it must be stressed that these affinities are not merely metaphors or analogies, but involve the recognition of homologous systems.