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OSCILLONS:

ELECTRONIC ABSTRACTIONS

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Abstract—Oscillons *or electronic abstractions, as electronic oscillograms composed for art, are defined. The instrument used to display the* Oscillons, *the cathode ray oscilloscope, is described and its various functions discussed. Basic waveforms which may be displayed are illustrated and explained. Some of the means by which oscilloscope traces may be combined and controlled to form* Oscillons *are briefly outlined and several examples are shown. The kinetic nature of many* Oscillons *is brought out. The author briefly describes methods of composing them as art forms and the photography of the electronic abstractions is explained, including some problems involved. Exhibitions and publications of the* Oscillons *are noted.*

A review is made of the author's interest in designs derived from mathematical, physical and technical sources which led up to his Oscillon *project. The first suggested use of them for design is mentioned, along with work of others in this field. They are compared to other kinds of non-figurative and mathematical art, and some relationships considered. A comparison is made to electronic music. The author concludes that the* Oscillons *are a good example of the use of technology for art and as manifestations of natural phenomena.*

I. INTRODUCTION

Since the technology of electronics has become such an important part of modern life, it is inevitable that it be employed in the creation of art. The subject of this article is the composition of electronic oscillograms as art forms. To distinguish these art forms from oscillograms as they are used in research, testing, radar displays and in other ways, I have chosen to call my own creations *Oscillons* or *electronic abstractions* and the technique of their creation, *Oscillonics*.

Oscillons are unique images in light composed of waveforms as they appear on the screen of a cathode ray oscilloscope. They may be monochrome or multi-colored, in motion or static on the cathode ray screen and they may be so displayed as art, either on an oscilloscope or on a television screen. They may be recorded as photographs in black and white or in color, or as motion pictures. They may also be shown as drawings or paintings. In the case of computer-derived oscillograms, they might be traced by electronic plotters.

II. THE OSCILLOSCOPE

The basic device for displaying the *Oscillons*, the oscilloscope (cf. Fig. 1), is an instrument widely used in research and engineering, as well as electronics service work. The screen is the face of a cathode ray tube, most familiar in its larger sizes as the television picture tube. On the oscilloscope screen may be displayed traces in light which are formed by electrical waves. To the technician, these waves may give various kinds of information, such as voltages, currents, frequencies, phases, pulse durations and other factors.

The electron beam within the cathode ray tube is actually the pencil or brush by which these traces are formed. It is focussed and deflected either by electrostatic fields within the tube, by electromagnetic fields outside the tube or both. It may be varied in intensity by signals applied to the grid of the cathode ray tube—in the way that the dark and light portions of the television image is formed. In the case of the shadow-mask television tube, the color image is formed by three electron beams impinging on the fine phosphor dot array on the inside face of the tube. Since the spot at the end of the beam moves very fast and retraces itself many times a second, the persistence factor of the phosphor of the cathode ray tube produces a continuous line or form on the screen, which can be seen by the eye or a camera.

The waveforms which may be displayed may be of various kinds. The basic types that I have used for the *Oscillons* are the sine wave, sawtooth, square wave (cf. Fig. 2), triangular wave and pulses. The sine wave is the familiar curve formed by the projection of a moving circle and is also the waveform made by an alternating current generator. As a pure wave, it is not of so much interest as an

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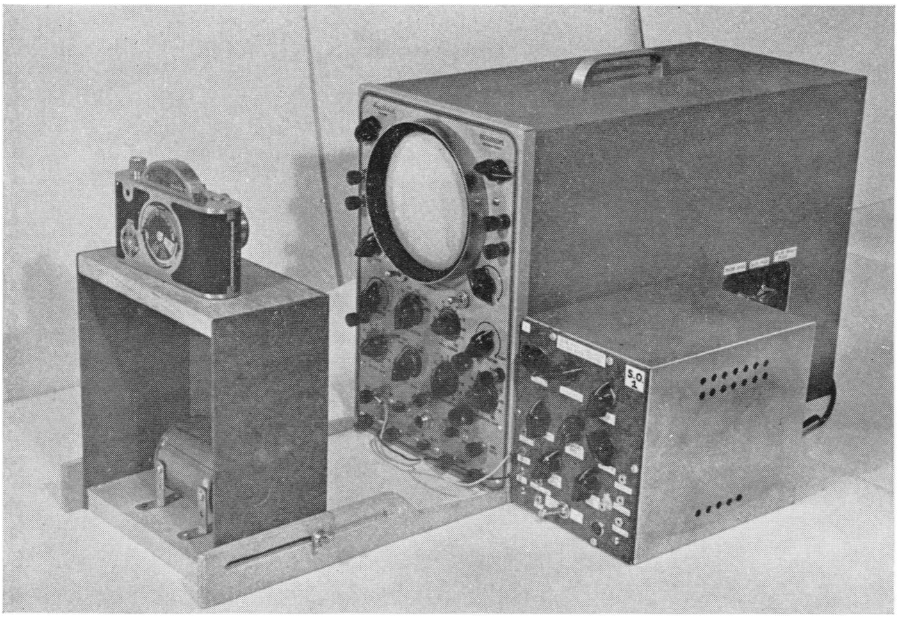

Fig. 1. *Modified oscilloscope with sine wave generator and photographic setup.*

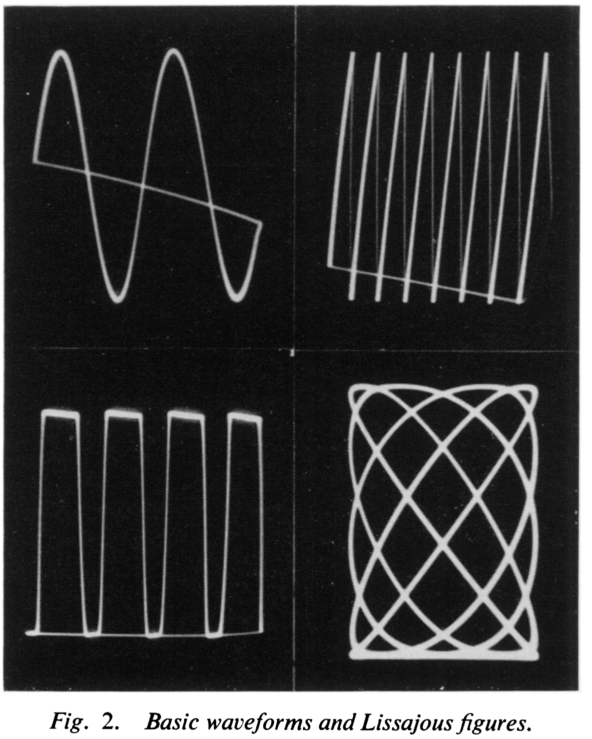

Fig. 2. *Basic waveforms and Lissajous figures.*

element of design, just as the pure sine wave in sound as a tone in music is likewise not so interesting to hear. This wave, as well as the others, may vary in its amplitude (size) and frequency or number of cycles per second. For *Oscillon* work, I have used sine waves from about 30 through 100,000 cycles per second. The high frequencies produce more solid appearing sheets and forms.

The sawtooth wave (second trace in Fig. 2) is not as simple in form as it appears. Mathematically and electronically it is the resultant of all the harmonics of the basic sine wave. That is, if successively higher multiples of the sine wave are plotted, then added and smoothed on a graph, the resulting form is a sawtooth wave. Another form similar to this is the triangular wave, which is the resultant of all the even harmonics of the basic sine wave.

The square wave has also been used to compose *Oscillons* (third trace in Fig. 2). This wave is considered to be electronically composed of all the odd harmonics of the sine wave.

Before going on to consider how these fundamental wave shapes are used to make more complex

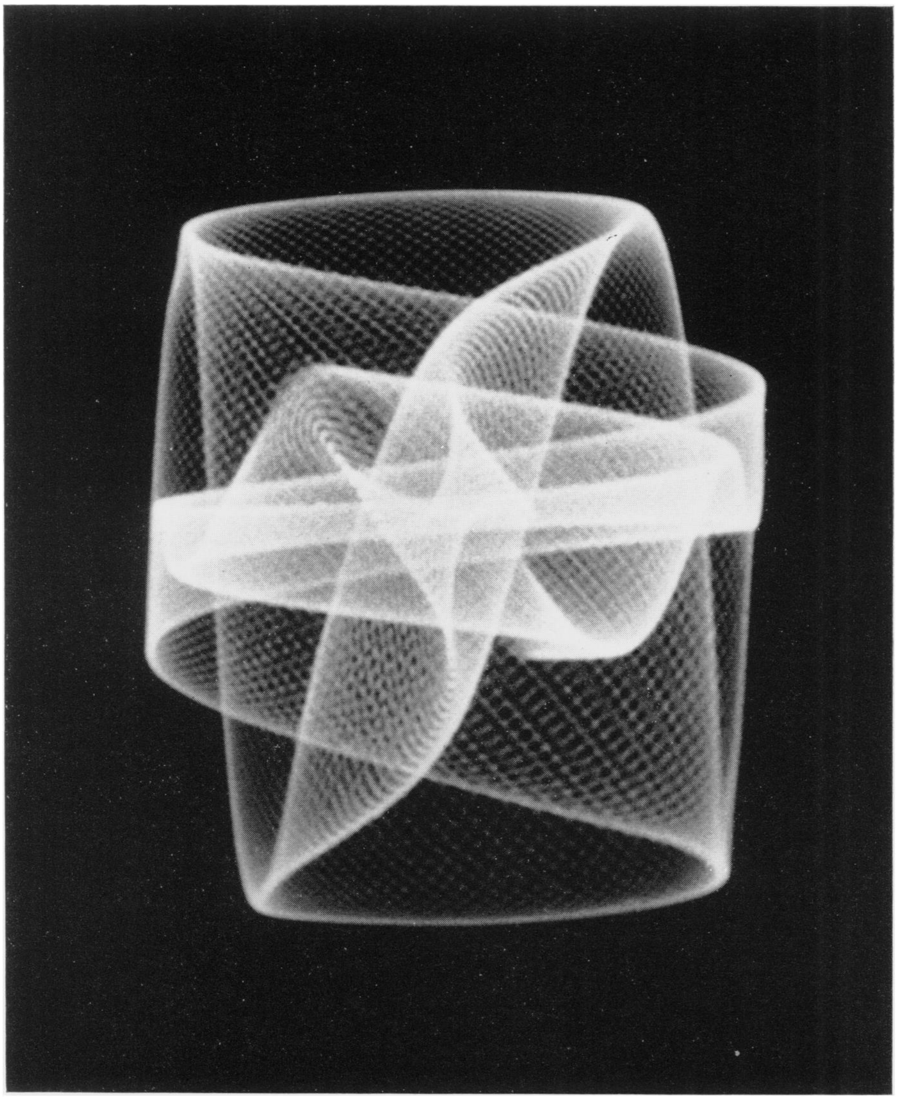

Fig. 3. *Oscillon* 19, 1952.

figures, more should be said about the oscilloscope itself. The basic oscilloscope consists of input amplifiers, controlling the deflection system; the electron beam circuits; a sweep circuit, which is usually a sawtooth waveform, and the necessary power supplies. The various controls make it possible to alter the shape and size of the figures on the screen by means of the horizontal and vertical amplifiers. The figure or trace may also be moved about on the screen by means of the horizontal and vertical positioning controls. Intensity and focus controls affect the brightness and sharpness of the spot or trace line of the electron beam.

III. OSCILLONS

The oscilloscope alone will not produce anything more than elementary figures, for it normally contains only the sweep circuit and a provision for using a 60 cycle trace (on American types.) These will display sine wave figures of varying frequencies, from simple lines to solid rectangles or rasters. So, to obtain more complex figures other waveforms, pulses and signals must be fed into the vertical and horizontal connections of the respective oscilloscope amplifiers or into the magnetic deflection circuits.

If a sine wave is fed into the horizontal input amplifier and another sine wave into the vertical one, it is possible to get a variety of figures. The simplest will be a circle or ellipse, if the input frequencies are equal. If they are other multiples, then Lissajous figures will result, one of which is shown (fourth trace in Fig. 2).

From this point on, many other electronic procedures may be employed to obtain other shapes and textures. Various waveform generators are connected to the oscilloscope inputs in parallel, in series or otherwise modulated. Electronic switches, which can display two separate figures on the screen (or other even multiples), may be used. Other modifications of the input circuits may produce spirals, roulette figures, rosettes and so on.

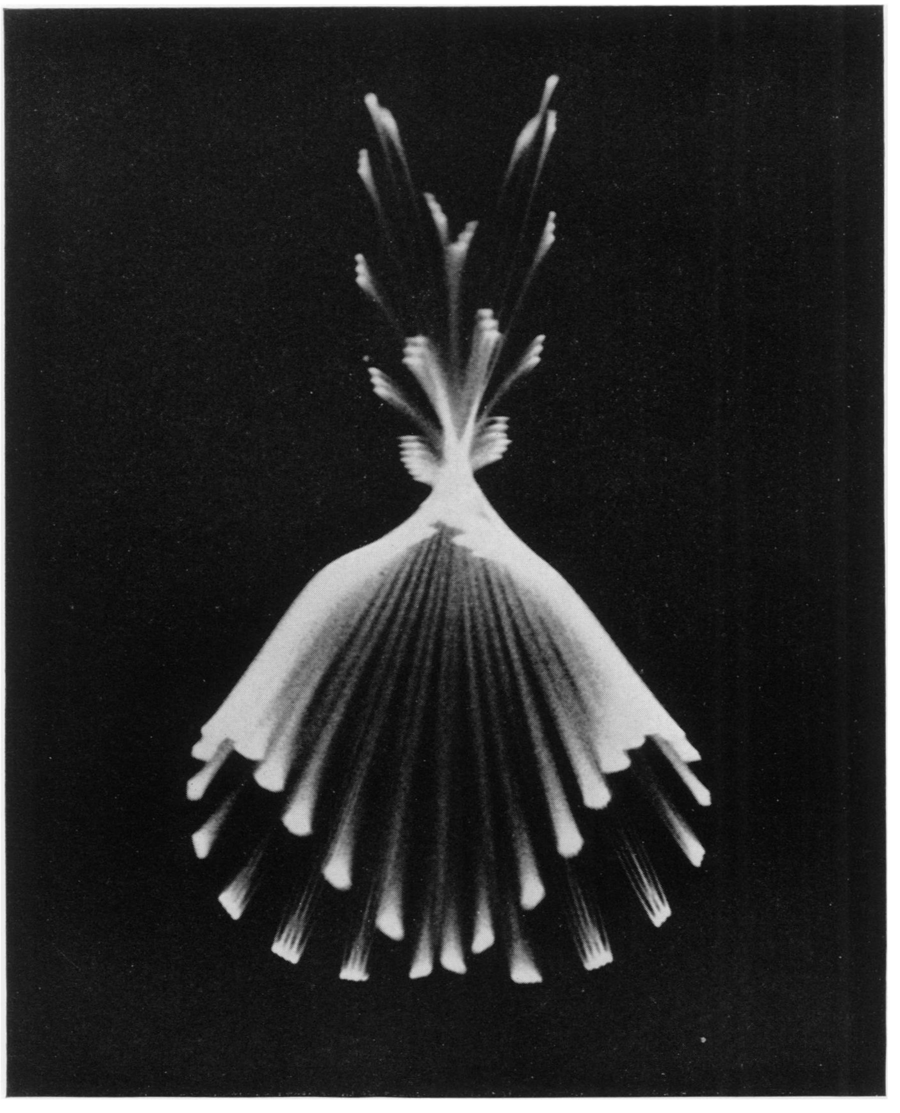

Fig. 4. *Oscillon* 3, 1952.

To obtain the wide variety of compositions I have created as *Oscillons*, additional special circuits were added to the four different basic oscilloscopes I used. Many of these were uniquely designed magnetic deflection circuits, to which were fed waveforms—especially low-frequency sine waves. These inputs were in addition to the normal horizontal and vertical inputs of the oscilloscope. Also waveforms were fed into the beam circuit, modifying the intensity of the electron beam itself, and also creating new figures or textures.

The resulting forms are often very complex as regards all their basic factors (cf. Figs. 3–8). Some *Oscillons* involve as many as 70 different settings of controls on the oscilloscope and of other combinations of input waveform generators, amplifiers, modulating circuits and so on. I have constructed and used over 60 different electronic instruments for this work, many of standard types, others of specialized design.

A very condensed description of the circuitry involved in *Oscillon* 19, shown in Fig. 3, is as follows: a sine wave generator output to a circular amplifier (as used in some radar-type circular sweeps) modulated by a sine wave generator output; with amplifier distortion, amplifier to oscilloscope and low frequency range of sine waves.

The screen of the usual type of oscilloscope has a glowing trace (P1 phosphor) but a number of other phosphor colors are available. For black and white photographic work I also used a blue trace phosphor tube (P11). For color work a white trace tube (P4) was employed—this is the same as the type in television black and white tubes.

IV. COLORED OSCILLONS

Color in the *Oscillons* may be achieved in three different ways. If they are set up on television screens, tri-color shadow-mask tubes may be used. However, there are problems of control, distortion, high voltages and so on, with this method; the figures will also have a half-tone effect. A second way is to use three different color cathode ray tubes

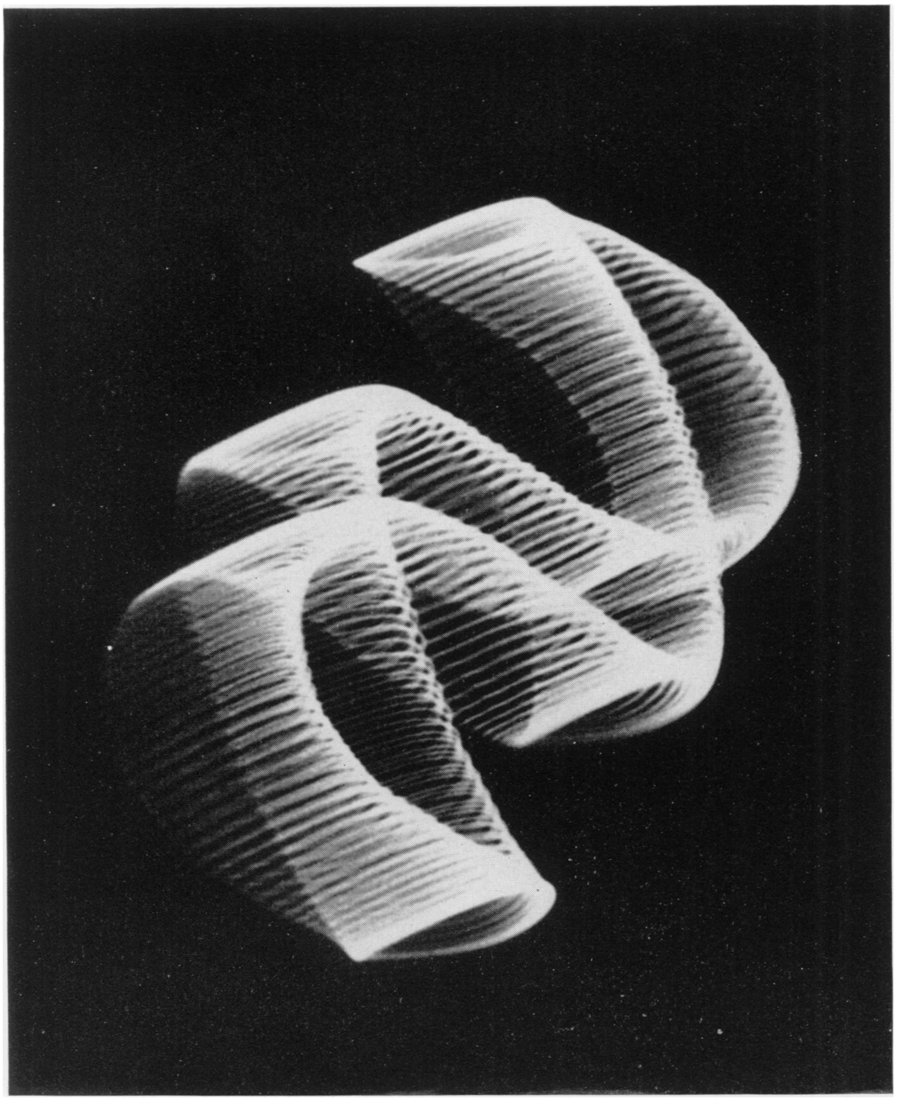

Fig. 5. *Oscillon* 7, 1952.

with red, blue and green phosphors. Then the images from these may be projected through dichroic mirrors and combined on a screen to produce multi-colored figures. This system, however, requires very precise registry and optics and was not used for the *Oscillons*.

The third and simplest method I used employed a white trace tube and color filters before the face of the tube to obtain an image in color. These filters were either stationary or rotating. By using a circular wheel with red, blue and green segments, and rotating this at variable speeds, multi-color images are obtained. (This method is similar to the first color television system which also used a color wheel in front of a white trace cathode ray tube. Practical considerations, such as the size of the wheel required for a picture of 10 inches or more in size, rules out this system in favor of the tri-color television tube, although it does produce excellent color images.)

The color in the image as seen at the plane of the rotating filter wheel will depend on the frequencies being used to form the *Oscillon* and the speed of the wheel. For instance, if the part of the moving trace which is on the screen at the same time that the green segment of the wheel is over it, then a green line will be seen. As the wheel revolves this line would change to red, or a part of it would be red, then blue, as the wheel revolves. All this happens in very small fractions of a second.

Besides the basic red–blue–green color wheels, I have used other combinations as well, such as various sized segments and different sequences of the colors arranged on the wheel. The speed of the wheel and resulting chromatic effects are controlled by a rheostat. (In the television setup, it was synchronized with the television image in order to get the correct color placing in the picture). In this way, varying color effects could be obtained (cf. Fig. 9).

I have experimented with polarizing filters with birefringent plates to produce color results in place of the segmented color wheels. However, low light transmission of the polarizing filters raised problems

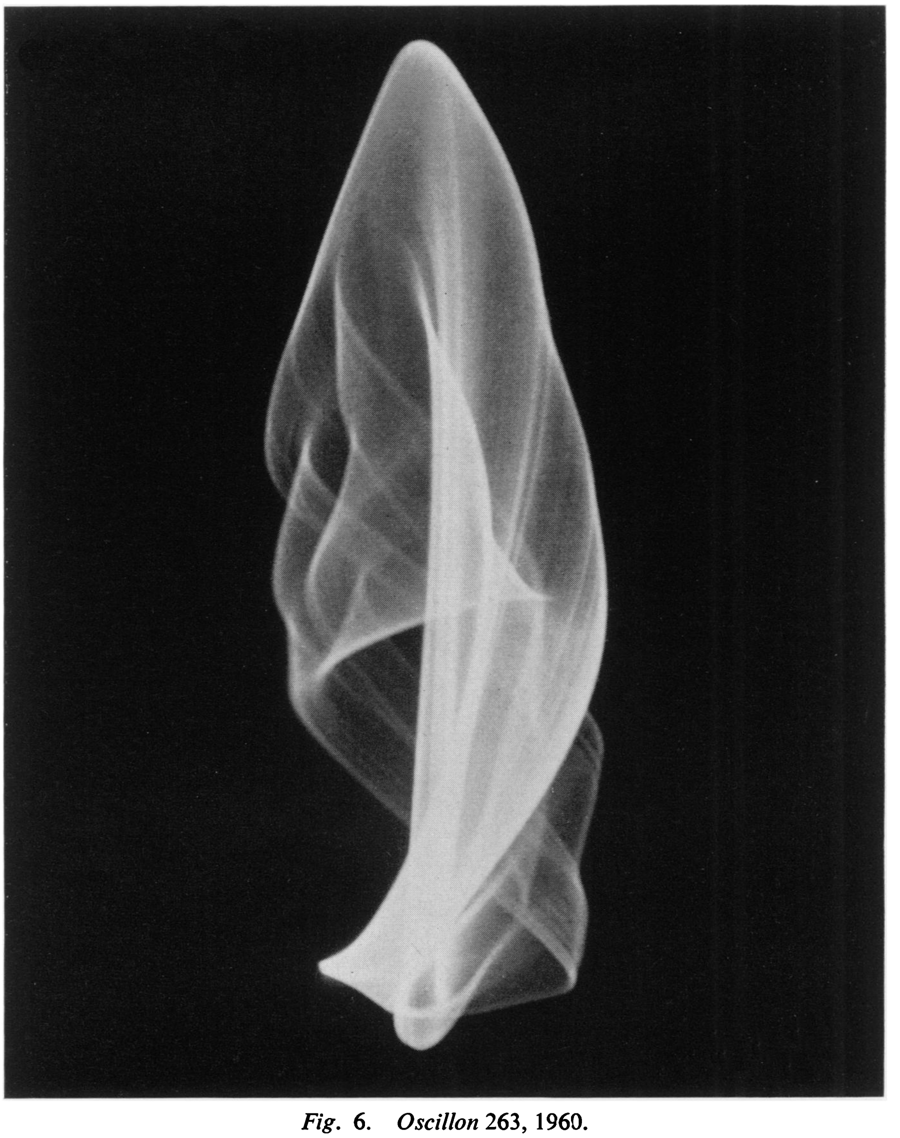

Fig. 6. *Oscillon* 263, 1960.

with color photography, so it was not further employed. The possible refinement or development of other types of filters, such as Kerr cells, electromagnetic color filters and the new liquid crystal filters, which can be electrically modulated may be of use in this technique at some future time.

Since the *Oscillons* in color are formed by transmitted light, additive color effects are obtained. For example, a red trace superimposed over a green trace produces yellow and all three basic colors will result in a white area.

V. DESCRIPTION AND DISCUSSION OF OSCILLONS

The forms seen on the oscilloscope screen (or in the plane of the color filters) are kinematic entities. They are traced by a constantly moving spot (the end of the electron beam as it impinges on the inside of the face of the cathode ray tube) which causes the phosphor to fluoresce wherever the spot is located. Besides that, the figures themselves may be kinetic—they may pulsate in their parts, expanding and contracting, or change back and forth between two shapes. Fine wave lines may undulate across the pattern. The shapes change as the forces and magnitudes of the electrostatic and electromagnetic fields within the cathode ray tube interact. All this, of course, may be altered either by the controls on the oscilloscope, by the input waveform or by other instruments.

What the final form of the *Oscillon* will be is determined, first, by the kind and number of input circuits connected to the oscilloscope and, second, by how these circuits are controlled in combination. The *Oscillons* are normally not accidental or naturally occurring forms—they must be composed by the conscious decision and control of the artist using the apparatus. Of course, aesthetically interesting traces sometimes accidentally show up during the normal use of the oscilloscope for technical purposes. In some cases, it is possible to get such traces either by the chance selection of input circuits or the chance setting of various controls but this is not the usual way. Of the great number of possible traces, only a small portion will

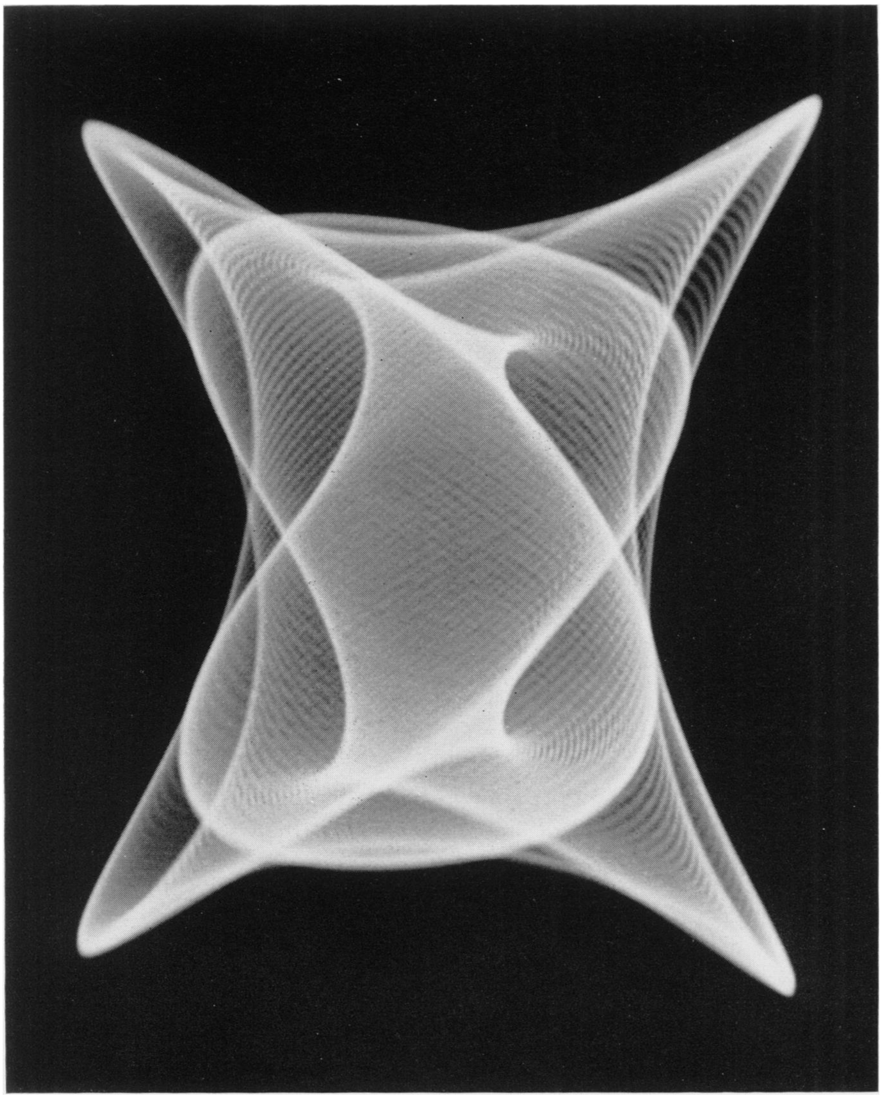

Fig. 7. *Oscillon* 281, 1960.

be of value as abstract art or as designs. What can be done must be learned by observing the results of combining various basic waveforms and shaping these figures with other deflection and modulating fields. An entire system or theory of composition could be worked out for the oscillonic medium but I believe that this might lessen the often spontaneous creativity which is possible by the method I have used so far.

It may be asked whether a particular figure or kinetic cycle can be exactly repeated on the screen after a period of time. This will depend on the accuracy of the circuitry used. Precision components, such as close tolerance resistors and capacitors, and very fine controls would have to be employed—all of which would affect the cost of the equipment. Accurate voltage regulation, crystal controlled oscillators, fine vernier tuning and so on would also be required. A complete record of all control settings would be needed—this can run to many factors. I did not find that the economics of the situation justified all of the additional refinements. Once I had composed and photographed a particular *Oscillon* composition, I did not feel the need to repeat it exactly, although records were kept of much of what was done, in particular, instruments used, approximate waveform frequencies and other factors.

Since it would be costly to arrange a separate oscilloscope or television screen with all of the necessary accompanying equipment for each composition, for public exhibitions, except in special situations, I chose to record the *Oscillons* by photography. Because of some factors, such as working at close-up distances, motion in many of the *Oscillons*, low light intensity of the oscilloscope traces and low film speeds, some special procedures had to be used in the initial stages of my work. High speed lenses (such as an f 1·2) and Linagraph 35 mm recording film were used for the black and white photographs of the first group of electronic abstractions. Later 4 × 5 inch films were used, especially some of the newer very fast black and white types.

In the case of color work (started in 1956), I first used an aerial color film, as this was the fastest

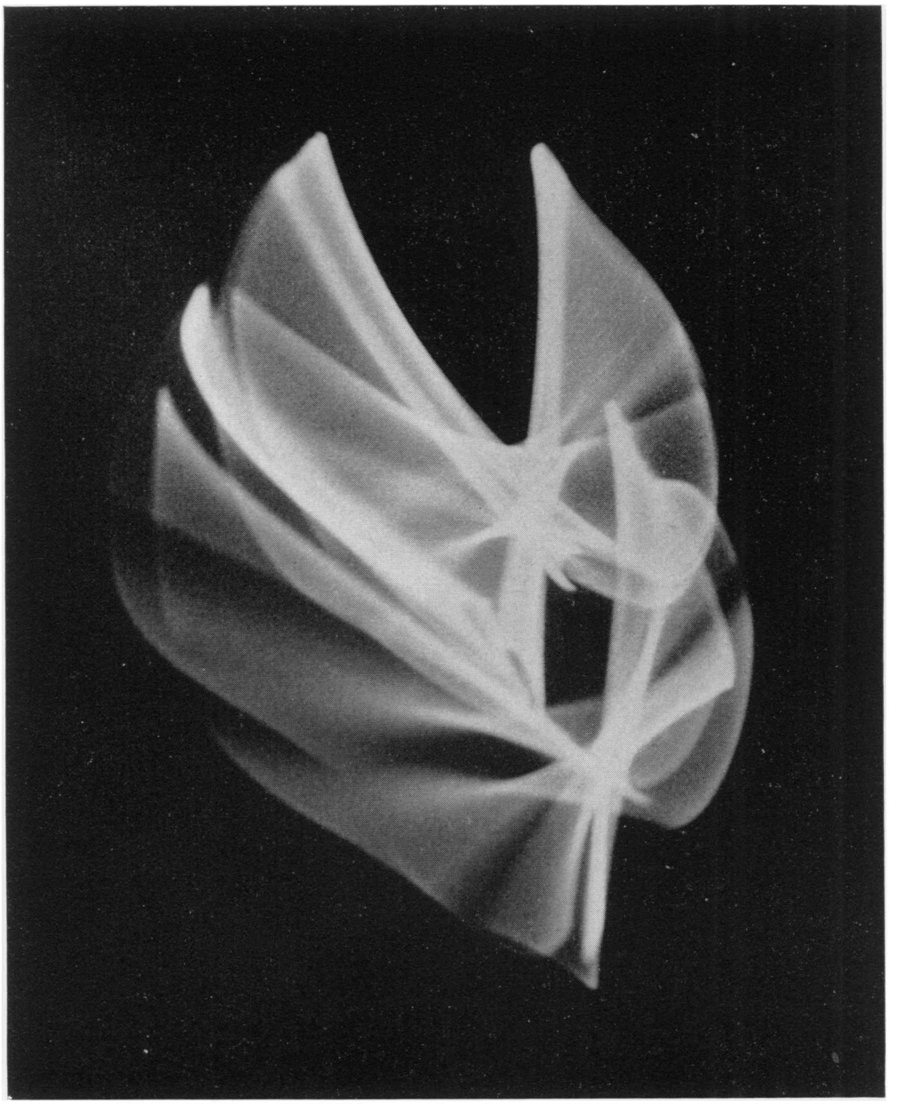

Fig. 8. *Oscillon* 1049, 1960.

then available and it also had a high contrast and could be forced in development. Since then, higher speed color films of other types which became available have been used. The use of a 4 × 5 inch camera with an f 2 aerial lens necessitated time exposures of up to one-half a second. This required that motion of the *Oscillons* be stopped on the oscilloscope screen. The movement of the figures can usually be stopped by employing 'sync' circuits, which will stop the formative motion of the trace. However, in some cases this did alter the shape of the *Oscillon*. Since in the color compositions the various colors would also shift, close control of the rotating filter wheel was necessary in order to hold color to the desired areas. The traces could not be held static on the screen for too long a time, as this would result in destructive burn spots on the phosphor of the cathode ray tube, requiring replacement of the expensive tube.

Out of over 10,000 black and white traces photographed and several thousand in color, the best were selected and printed for use in exhibits, for publication or for artwork in commercial applications. The black and white [1] and color *Oscillons* have been widely shown in the United States and abroad, in all over 160 times. A variety of publications have carried articles or illustrations of them—some of the publications are listed in References 2 to 18.

I have produced *Oscillons* of a wide variety of shapes, textures, multi-color harmonies and contrasts, undulating lines and interpenetrating planes. While non-figurative in intent, many suggest, for example, fantastic flowers, birds and fish. Some have mathematical precision, others are free-flowing in their curvatures and symmetries.

The emotional appeal of the *Oscillons* is perhaps similar to the abstract aspects of music—as is the appeal of other art using light. While giving impressions of sweeping rhythms, the pulsating trace of the oscillating electron beam reveals their formation. Like other types of kinetic art, they involve the factor of time, in addition to giving an illusion of three dimensions on a two-dimensional surface. Some of the oscillons have an almost sculptural quality. Because of the highly-contrasted, non-

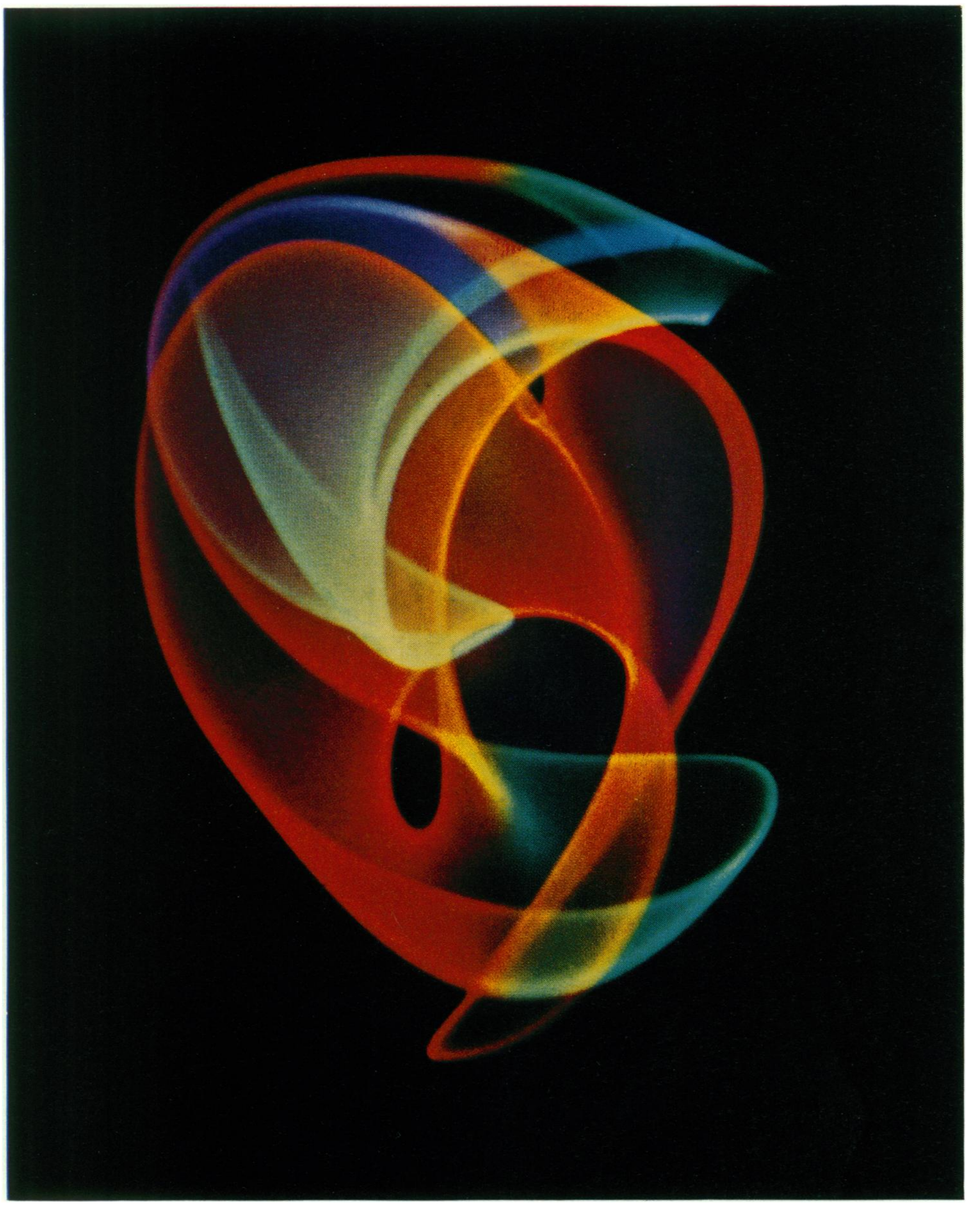

Fig. 9. *Oscillon* 1206, 1960.

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illuminated background of a oscilloscope screen or the black area of a photographic print, they may seem to be images of luminescent moving masses or suspended in space.

Other phases of the oscillon project which may be undertaken in the future include lighted transparency displays, motion picture sequences and direct displays, as on a large television screen controlled possibly by video-tape and other multichannel tape sources.

It was while investigating possible sources of non-figurative art in 'magic line' patterns from mathematical magic number squares and projections of geometric solids [19] some 30 years ago that I began to work out abstract compositions that eventually resulted in the *Oscillon* project. This earlier work included consideration of serial rhythms as expounded by Joseph Schillinger [20] and of Jay Hambidge's dynamic symmetry [21, 22].

The possibility of using electronic oscillograms for design was first suggested by the electronic engineer, C. Burnett, in 1937 [23]. However, it seems that little was done by artists in developing or exploiting the idea. I began work in 1950 on the electronic abstractions while experimenting with other related design sources from mathematics and physics, such as harmonograph tracing machines and pendulum pattern makers. This latter technique uses pendulum bobs to which are attached pens which trace intricate figures [24, 25], (cf. also *Leonardo* **2**, 267, 1969). Pendulums with a pinpoint light at the bottom have been suspended over photographic paper or a camera with an open shutter in a darkened room; many examples of these tracings have been published by others [26]. While these two methods gave a number of interesting designs, I felt that the electronic method had greater possibilities, especially in regard to control of the results and variety of possible forms.

Among others who have worked with electronic oscillograms have been Norman McLaren, who made a stereographic movie short for the Festival of Britain and Mary Ellen Bute of New York, who also made a hand-colored 16 mm motion picture, modulated by music, 'Abstronics' [27, 28]. Herbert Franke of Germany has also done some work with electronic oscillograms [29]. Examples by others are shown in Gyorgy Kepes' 'Vision and Value' series of books [30]. Recently John Whitney of California and other computer graphic engineers or technicians have also displayed oscillograms programmed by computer methods [31, 32]. Nam June Paik has displayed television images distorted by magnetic fields [33].

Oscillons are related to other types of light art, kinetic art, design derived from mathematical sources and Op art. The filmy or nebulous effects produced by various light devices, such as, for example, A. B. Klein's Colour Projector, Thomas Wilfred's *Lumia*, Frank Malina's *Lumidyne*, Jim Davis' abstract films, the *Luminola* of C. E. Singletary and Carl Rieback's *Lumia* [34–39] may be simulated in some ways by the oscilloscope, especially when high frequency traces are used. However, I believe that many of the above methods of using electric light may be much less costly than would be an electronic oscillogram apparatus assembled to produce similar results.

The roulettes and other spiral figures traced by harmonograph machines [40] can also be duplicated on the oscilloscope with appropriate input circuits; also the intricate traceries made by the pendulum and the geometric engraving lathe which make the patterns for currency, may be simulated. Op art illusion effects may also be obtained, including some kinds of moiré patterns [41]. By the use of special circular sweep cathode ray tubes, it may be possible to produce kaleidoscope figures.

The three-dimensional appearance of some *Oscillons* are due to phase differences in the waveforms that compose them. *Oscillons* are basically visual illusions, especially those in which the color effect lies only in the plane of the color filters in front of the face of the cathode ray tube.

There is an analogy between electronic music and *Oscillons*. Both are created by means of waveforms or vibrations—one affecting the aural, the other the visual sense; many of the same types of oscillators may be used for both. An input of musical waveforms into the oscilloscope can also create some interesting patterns in rhythmic motion. I have used several means to do this including filter systems and stereo recordings. However, these figures are usually not as aesthetically pleasing as those composed in other ways. They are also difficult to photograph exactly because of the very fast motion of the musical traces.

VI. CONCLUSIONS

Oscillons are, I believe, an excellent example of the possibility of employing modern technology in art and of demonstrating a relationship between science and art. They are also visual manifestations of some of the basic invisible aspects of nature, such as the movement of electrons and energy fields. The non-figurative art forms of *Oscillons* represent the reality of various intricate combinations of electricity and magnetism, such as fields, frequencies, phases, voltages and currents. Their composition from electrical vibrations is in accord with the waveform character of light, atomic interactions, sound and other phenomena of nature [42].

Les Oscillons: Des abstractions électroniques

Résumé—L'article décrit les *Oscillons* ou abstractions électroniques, en tant qu'oscillogrammes électroniques composés dans un but artistique. L'auteur décrit l'instrument utilisé pour représenter les *Oscillons* et étudie ses diverses fonctions: cet instrument est appelé oscilloscope cathodique. Il expose quelles sont les oscillations fondamentales pouvant être représentées et en donne des exemples, ainsi que de quelques moyens de combiner et de contrôler les oscillations pour former des *Oscillons*. L'auteur met également en relief la nature cinétique des *Oscillons* et expose brièvement les méthodes utilisées pour les composer sous une forme artistique. Il explique les procédés de photographie des abstractions électroniques, ainsi que quelques-uns des problèmes qui se posent. Les expositions et publications d'*Oscillons* sont mentionnées. Il explique que son intérêt pour le dessin provient de ses connassances mathématiques, physiques et techniques qui l'ont conduit à entreprendre le projet *Oscillons*, puis à suggérer de les utiliser pour le dessin. Les travaux d'autres personnes dans le même domaine sont décrits. Les *Oscillons* sont comparés à d'autres sortes d'art non-figuratif et mathématique, et en particulier à la musique électronique. Pour conclure, l'auteur pense que les *Oscillons* forment un bon exemple d'utilisation de la technologie dans un but artistique en tant que manifestations de phénomènes naturels.

REFERENCES

1. B. Laposky, *Electronic Abstractions: A New Approach to Design*, catalogue of a black and white photographic exhibit, Sanford Museum (Cherokee, Iowa: B. Laposky, 1953).
2. B. Laposky, Electronic Abstractions, *Scripta Mathematica* **18,** 305, 308, 315, 318, 319 (1952).
3. R. Hale, Passions and Pendulums, *Craft Horizons* **14,** 10 (1954).
4. B. Laposky, Electronic Abstractions, *Graphis* **55,** 426 (1954).
5. Abstract Oscillography, *Radio-Electronics* **26,** 59 (1955).
6. Complex Scope Patterns Form Art Studies, *Electronics*, pp. 3, 24 (July 1955).
7. F. Neugass, Elektronische Abstraktionen, *Photo Magazin*, p. 36 (April 1956).
8. G. D'Ayala Valva, Gli Oscilloni, *Civilta delle Macchine* **4,** 23 (1956).
9. Electronic Gaiety (color portfolio), *Fortune* **14,** 132 (1956).
10. A. Garrett, Space-Time Form in Visual Art, *Impulse* **2,** 37 (1957).
11. H. Franke, Photographic Experiments with Electronic Rays, *Camera* **8,** 359 (1957).
12. B. Laposky, Oscilloscope Art, *Electronics* **30,** cover (1957).
13. B. Laposky, Electronic Abstracts, Art for the Space Age, *Proceedings of the Iowa Academy of Science for 1958* (Des Moines: The State of Iowa, 1958) p. 340.
14. B. Laposky, Oscillographic Design, *Perspective* **2,** 264 (1960).
15. B. Laposky, Electronic Abstracts, Art for the Space Age, *Spirale* 8 **32,** 34 (1960).
16. D. Anderson, *Elements of Design* (New York: Holt, Rinehart & Winston, 1961) p. 195.
17. B. Laposky, Electronics Abstractions—Mathematics in Design, *Recreational Mathematics* **4,** 14 (1961).
18. B. Laposky, Communication on Oscillons, *Studio International* **174,** 131 (1967).
19. C. Bragdon, *The Frozen Fountain* (New York: Knopf, 1932) p. 74.
20. J. Schillinger, *The Mathematical Basis of the Arts*, (New York: Philosophical Library, 1948) p. 284.
21. J. Hambidge, *Practical Applications of Dynamic Symmetry* (New Haven: Yale University Press, 1932).
22. E. Edwards, *Dynamarhythmic Design* (New York: Century, 1932).
23. C. Burnett, Electronic Patterns, *Electronics*, p. 28 (June 1937).
24. J. Goold *et al.*, *Harmonic Vibrations and Vibration Figures* (London: Newton, n.d.).
25. C. Stong, The Amateur Scientist, (Pendulum patterns by Thomas Reed), *Scientific American* **215,** 128 (1965).
26. A. Palme, Pendulum Patterns, *American Photography*, p. 298, (May 1948).
27. N. McLaren and C. Beachell, Stereographic Animation for *Around is Around*, National Film Board, Canada, Ottawa (1950).
28. M. Bute, Abstronics, *Films in Review*, p. 261 (June 1954).
29. H. Franke, *Kunst und Konstruktion* (Munich: Bruckman, 1957) pp. 22, 30–33, section on *Oscillons* by Laposky.
30. G. Kepes, *The Nature and Art of Motion* (New York: Braziller, 1966) p. 10.
31. J. Langsner, Kinetics in L. A., *Art in America*, p. 108, (May 1957).
32. The Luminous Art of the Computer, *Life*, p. 51, (November 8 1968).
33. K. Hultén, *The Machine* (Greenwich: New York Graphic Arts Society, 1969) p. 197.
34. A. Klein, *Coloured Light* (London: Technical Press, 1937).
35. T. Wilfred, Composing in the Art of Lumia, *Journal of Aesthetics* **12,** 79 (1948).
36. F. J. Malina, Kinetic Painting: The Lumidyne System, *Leonardo* **1,** 25 (1968).
37. C. Grey, Rediscovery: Jim Davis, *Art in America*, p. 64 (November 1967).
38. C. Singletary, Color-Music, *School Arts*, p. 29 (September 1956).
39. E. Rieback, New York Review: Lumia 1967, *Studio International*, p. 105 (February 1968).
40. W. Rigge, *Harmonic Curves* (Omaha: Creighton University, 1926).
41. G. Oster and Y. Nishijima, Moiré Patterns, *Scientific American* **213,** 54 (1963).
42. G. Murchie, *Music of the Spheres* (Boston: Houghton, Mifflin, 1961).