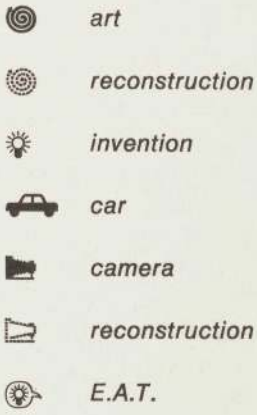
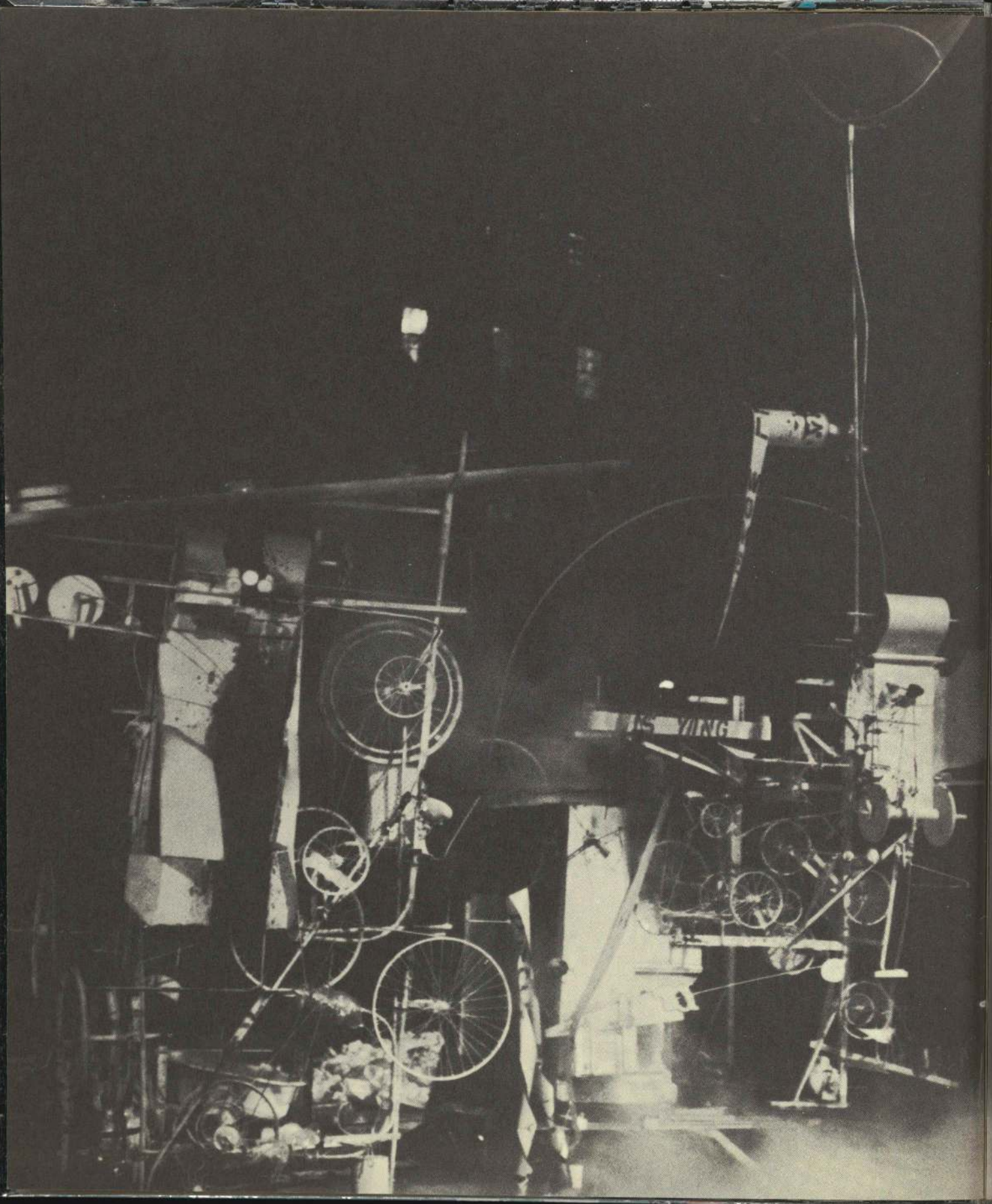

The Museum of Modern Art
"The Machine"





K. G. Pontus Hultén

The machine

as seen at the end of the mechanical age

The Museum of Modern Art, New York

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works in the competition that they organized. The awards were generously donated by the American Foundation on Automation and Employment, Inc., first prize; the Mc Crory Corporation and the Trans-Lux Corporation, second prizes.

I am particularly indebted to Märta Sahlberg, the secretary of Moderna Museet. In addition to carrying the burden of her many regular duties, she has given unstintingly of her able assistance throughout. My colleagues at Moderna Museet have helped and shown patience.

My thanks also go to Emilio Bertonati, William Camfield, E. C. Goossen, Franz Meyer, Beaumont Newhall, Georgia O'Keeffe, George Riabov, Alan Solomon, and Kate T. Steinitz; and to the International Business Machines Corporation, which offered to make new models of Leonardo's flying machines for this occasion.

With respect to the catalogue, I wish to express my gratitude to Ulf Linde of the Royal Academy of Art, Stockholm, for allowing me to publish his important discoveries about Marcel Duchamp and alchemy, and to Billy Klüver for permission to include his essay on Jean Tinguely's *Homage to New York.*

Françoise Boas of the Department of Publications, The Museum of Modern Art, was helpful both in initial plans for this book and in coordinating arrangements for its printing in Sweden. Katja Birmann in Stockholm and Anne Dahlgren Hecht in New York assisted in research, and Barbro Sylwan of Moderna Museet carried out research in Paris during the days in May and June, 1968, when conditions were very difficult. Yvonne Frendel also aided in bibliographical research.

The book has been expertly edited by the Museum's Senior Editor, Helen M. Franc. She has added many important facts to it and has been untiring in her efforts to prepare the complicated manuscript for printing. In this task, and especially in compilation of the index, she was assisted by Christie Kaiser.

John Melin and Gösta Svensson of Stig Arbman AB, Malmö, designed this book and have worked on the project with great devotion for many months. They have been assisted by a number of their colleagues.

This exhibition could not, of course, have been realized without the generosity of the artists, collectors, museums, and galleries who kindly made loans available. On behalf of the Trustees of The Museum of Modern Art, the University of St. Thomas, and the San Francisco Museum of Art, I wish to express thanks to all the lenders listed here, as well as to several who preferred to remain anonymous.

K. G. P. H.
Stockholm,
September 1968

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Foreword and Acknowledgments

This exhibition and its catalogue make no attempt to provide an illustrated history of the machine through the ages. It is a collection of comments on technology by artists of the Western world. During many centuries, there seem to be few such statements; at other times, they have been quite numerous. Generally speaking, our own century has been more productive than any other in this respect. This may be because we are now far enough removed in time from the early stages in the development of the mechanical age to be able to see more clearly some of the problems involved and to realize some of the implications, both for individuals and for society. It may also be because intensive exploitation of the earth's resources by a rapidly expanding technology has created a situation that is now altering our way of life if not actually endangering our survival.

Moreover, technology today is undergoing a critical transition. We are surrounded by the outward manifestations of the culmination of the mechanical age. Yet, at the same time, the mechanical machine — which can most easily be defined as an imitation of our muscles — is losing its dominating position among the tools of mankind; while electronic and chemical devices — which imitate the processes of the brain and the nervous system — are becoming increasingly important.

The works in this exhibition have been selected because they seem to demonstrate a particular interest by artists in aspects of the world of machines. They have been ranged in roughly chronological order. Some of the earlier items have been included for their relevance as precedents for manifestations today, or to illustrate attitudes of their time toward technology.

Two kinds of functional mechanisms — the automobile and the camera — are represented by a few examples, again with no intention of summarizing the complicated evolution that either of them has undergone. The car and the camera (like motorcycles, boats, aircraft, and guns) are machines with which many people feel a strong emotional tie, as intimate extensions of their bodies. The car was chosen both because it is probably the most typical machine of the twentieth century and because it is almost certainly the mechanical device that most affects our private, everyday lives. As such, it not only fulfils a practical purpose but has become a symbol, a focus for our fantasies, our hopes, and our fears. The camera, together with some photographs and films, was chosen because it is a picture-making, mechano-chemical device, which has provided the basis for much of our way of seeing and is therefore particularly appropriate in an art exhibition. (A special film program has also been organized to complement the showing of THE MACHINE in New York.)

It seemed essential that an exhibition concerned with artists' attitudes to technology should have the greatest possible openness toward the future, the more so since many artists today are working in close collaboration with engineers. For this reason, Experiments in Art and Technology (E.A.T.) agreed to arrange a competition and kindly made several of the entries available for inclusion in the exhibition at the Museum. The others will simultaneously be on view elsewhere.

The plans for this exhibition were begun several years ago; the first letters discussing it were exchanged in 1965. When René d'Harnoncourt, the late Director of The Museum of Modern Art, asked me whether I should like to organize an exhibition on kinetic art for his institution, I proposed instead to concentrate on a part of that subject and expand it. Although there had recently been several shows of kinetic art, surprisingly little had been done with regard to the theme treated here. Mr. d'Harnoncourt and his successor, Bates Lowry, continued to show interest throughout and made themselves available to help in many ways.

I wish to express my gratitude for the assistance and cooperation I have received from many people and institutions in the preparation of this exhibition and its catalogue. In discussing initial plans, Troels Andersen, Copenhagen, Ronald Hunt, Newcastle upon Tyne, and Kasper König, New York, made important suggestions. William A. M. Burden, a Trustee of the Museum of Modern Art, placed his knowledge of automobiles at our disposal; he, David Rockefeller, Chairman of the Board, and Monroe Wheeler, Counsellor to the Board of Trustees, were instrumental in helping to obtain some especially difficult loans.

The first staff member of the Museum to work on the exhibition was Jennifer Licht, Associate Curator of the Department of Painting and Sculpture. She has been a key person ever since, making essential contributions at all levels; without her devoted interest, this project could never have been fulfilled. She was assisted by Jean-Edith Weiffenbach, who gave admirable care and attention to organizing the voluminous correspondence involved. Among the many other members of the Museum's staff who helped in various ways, I should like to thank especially William S. Rubin and Sarah Weiner, of the Department of Painting and Sculpture; Eila Kokkinen of the Department of Drawings and Prints; and Bernard Karpel and Inga Forslund of the Library. Wilder Green, Director of Exhibitions, has helped to solve several important practical problems, particularly with relation to the installation of the exhibition. Dorothy H. Dudley, assisted by Betty Burnham, was responsible for the complicated arrangements required to assemble in one place such a large number of disparate objects. Margareta Akermark and Adrienne Mancia of the Department of Film undertook the selection and organization of the film program.

Francis Mason, Billy Klüver, Amy Martin, and the staff of Experiments in Art and Technology were of unfailing help in connection with providing information about the

This exhibition is dedicated to the mechanical machine, the great creator and destroyer, at a difficult moment in its life when, for the first time, its reign is threatened by other tools.

It would be childish to believe that the greatest geniuses of our time have amused themselves with illusory games and have wilfully disguised their thought. However bizarre their great games may seem, they have made apparent in fiery characters the major myth in which is written the fourfold tragedy of our age: the Gordian knot of the clash among mechanization, terror, eroticism, and religion or anti-religion.

These are the portentous alarm signals that they are sending out to us, from the heights of their observatories erected atop high towers, at the heart of the modern tempest.

— *Michel Carrouges,* Les Machines célibataires

Upon this faith in Art as the organic heart quality of the scientific frame of things, I base a belief that we must look to the artist brain, of all brains, to grasp the significance to society of this thing we call the Machine . . .

— *Frank Lloyd Wright,* address to the Chicago Arts and Crafts Society, March 6, 1901

Introduction

A machine generally means to us something with a practical purpose, a device that substitutes for or extends man's own forces. The word itself has the same root as "might." We take the machine's usefulness for granted; yesterday's new invention, no matter how amazing, quickly becomes the commonplace of today.

This limited concept, however, is relatively recent. Historically, machines have often been regarded as toys, or as agents of magic, marvel, and fantasy. For philosophers, they have served as symbols and metaphors. Since the beginning of the mechanical age and the time of the Industrial Revolution, some have looked to machines to bring about progress toward utopia; others have feared them as the enemies of humanistic values, leading only to destruction. Most of these contradictory ideas persist, in one form or another, in the twentieth century and find their reflection in art.

Machines may be loosely defined as tools composed of several parts working together. They have a twofold ancestry. On the one hand, they develop from the practical experience of laborers or artisans seeking new ways to ease their work or perfect their skills. Their other line of descent leads from abstract thought and pure science to applied science and invention.

The Greeks, heirs of the technics of earlier civilizations, were the first to develop machines. All the simpler mechanical principles were known to them, such as the wheel and axle, the wedge, the lever, the gear, the screw, and the pulley; and they had a great knowledge of hydraulics and pneumatics. They applied these principles as occasion required but never adapted them for mass production. (The producing machine, in fact, appeared relatively late in the history of technology.) Siegfried Giedion has gone so far as to state: "In a practical direction, the sole systematic application of the ancients' physical knowledge was to warfare."

It was the Greeks who first systematically investigated natural forces and formulated scientific laws. Freed from the domination of a priestly class, which in earlier Mesopotamian and Mediterranean cultures had guarded for itself all learning, they joyfully pursued knowledge for its own sake, irrespective of its practical uses. The same word, *techné,* meant both art and technics. In spite of their love of the beautiful and the practical, the Greeks nevertheless ranked artists and technicians far below philosophers in their hierarchy.

Aristotle took a wider view. He, or his pupil Strato, wrote the *Mechanica,* the oldest engineering textbook. Its opening passage well illustrates the Greeks' attitude to applying their knowledge to nature: "Nature often operates contrary to human expediency; for she always follows the same course without deviation; whereas human expediency is always changing. When, therefore, we have to do something contrary to nature, the difficulty of it causes perplexity, and art has to be called to our aid." Further on in the book, there is a good example of the

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ars considered themselves the heirs of the ancients, with a responsibility for the revival of lost knowledge. This is apparent in the words of Roger Bacon (1214—1294), who in his *Epistola de secretis operibus* set these goals for engineers:

"We can construct for navigation machines without oarsmen, so that the largest ships on rivers and seas will be moved by a single man . . . We can construct vehicles, which, although without horses, will move with incredible speed. We can also construct flying machines of such a kind that a man sitting in the middle of the machine turns a motor to activate artificial wings that beat the air like a bird in flight. Also a machine of small dimensions to raise and lower enormous weights, of unequalled usefulness in emergency . . . We can also make machines to move through the sea and the watercourses, even to the bottom, without danger . . . These machines were constructed in ancient times and they have certainly been achieved in our time, except, perhaps, the flying machine, which I have not seen and I do not know any person who has seen it, but I know an expert who has perfected the means of making one. And it is possible to build such things almost without limit, for example bridges across rivers without cords or supports and unheard of mechanisms and engines."

Bacon was far in advance of his time, both in such visions and in his defense of empirical investigation and free experimentation. It was not universities like Oxford, however, which were to provide the training ground for the engineers of the Renaissance, but the courts of Europe, and particularly those of the Italian princes. Besides summoning into their service the most expert men they could find to stimulate manufacture, build towns, canals, palaces, churches, and fortifications, arrange spectacles, and advance military techniques, they also formed great libraries, ordered translations from the classics, and commissioned the writing and publishing of new treatises.

Leonardo da Vinci, therefore, was very much the product of his age and environment, though his genius and the universality of his thinking have led to his being regarded as unique. What sets him apart is the systematic manner in which he attacked so many branches of knowledge. His may be considered the first modern mind. Leonardo's endless curiosity led him, though largely self-taught, to assimilate most of the scientific and mathematical learning of his day; his imagination led him to attack problems that others had not even discovered; and his intuition led him to many conclusions beyond those then susceptible of proof. He was the first to realize that mathematics can provide the basis for scientific statement and proof: "There is no certainty in science where one of the mathematical sciences cannot be applied." Leonardo incessantly made experiments to establish facts that could be verified numerically.

His direct observations, his formulation of theoretical principles, his scientific studies, and his art, all had a common goal: the better understanding of life and nature. When the body of his work is taken together, Leonardo should be considered primarily as a scientist and engineer rather than as an artist. His technical drawings, however, are far freer than those of his contemporaries; they are neither working drawings nor scientific illustrations. His projects are related to him in an exceptionally personal way. This is especially true of his studies for the invention that most preocupied him — a flying machine.

With the Renaissance, two currents essential for an advanced technology flowed together. Theoretical scientists were more disposed to check their theories by experimentation; craftsmen and engineers were eager to grasp abstract principles that might explain and help to expand their techniques. The key to further scientific development lay in a more exact and advanced mathematics and its application to mechanics. With Galileo and others, giant strides in this direction were made during the sixteenth and seventeenth centuries.

Mathematical methods could deal only with quantitative, not qualitative, phenomena. During the seventeenth century, such methods were nevertheless applied to all human experience. Only the properties of matter that could be objectively measured — its dimensions, mass, and motion — were regarded as real. Those that depended on the subjective senses — color, taste, and odor — were considered to possess no external reality. In his *Discourse on Method* (1637), Descartes attempted to reconcile deductions from mathematics with the concept of a universe created by God. A fixed amount of matter and motion had been put into the world at the time of the Creation by the Deity, who once having decided upon the mechanical laws that should govern all nature did not interfere with the self-running machine that He had made. This idea corresponded well both with the theological concepts of the Calvinists and with the current political doctrine of absolute sovereignty.

In the Cartesian system, all material things — human beings, animals, plants, and inorganic nature — are machines, ruled by the same inexorable laws, and so susceptible of analysis by the quantitative methods of mathematics. In *Human Robots in Myth and Science,* John Cohen has pointed out the irony of the fact that the highly rational Descartes should have come upon his idea of the universal laws of mathematics in a dream, which he had on November 10, 1619, "a day at least as memorable as the day the Battle of Hastings was fought." This concept would ultimately lead to the modern computing machine. Descartes' contemporary Pascal (1623—1662) did in fact invent a calculating machine that could add and subtract. Somewhat later, Leibniz (1646—1716), whom Norbert Wiener has suggested as "the patron saint of cybernetics," expanded these ideas and constructed an even better calculator. Leibniz foresaw a machine that would be able to reason so well that it could ultimately formulate a complete mathematical system of the universe.

Descartes had faith that there was no situation in

Greek ideal of collaborating with the forces of nature for man's benefit. The author observes that in keeping to their course in an unfavorable wind, the sailors and the steersman adjust the sails and turn the rudder, so that: "The wind then bears the ship along, while the rudder turns the wind into a favoring breeze, counteracting it and serving as a lever against the sea. The sailors also at the same time contend with the wind by leaning their weight in the opposite direction."

During the Hellenistic period, Alexandria supplanted Athens as intellectual capital of the ancient world. Throughout the Hellenistic empire, technology advanced rapidly as newly discovered principles were put into practice in enormous engineering projects and the construction of great cities.

The Romans, intensely practical in their outlook, were little concerned with the advancement of theoretical science but made extensive use of what was already known, applying this knowledge in warfare, navigation, and gigantic building projects, and systematizing it in treatises. Vitruvius' *De architectura* is the only important work on civil engineering to have survived. Its tenth and last book is entirely devoted to mechanics. Among the few devices it describes that make use of any form of power other than human or animal labor is a geared mill, with a paddle wheel turned by water.

The ancients not only formulated the laws of mechanics and put them to practical use but also devised ingenious machines whose only purpose was to serve as marvels. In the Golden Age, the Greeks produced elaborate stage effects; for example, a hoist enabled an actor representing a deity to appear from on high at a climactic moment and resolve all difficulties — the *deus ex machina.* During the Hellenistic period, mechanical marvels proliferated. We read of temple doors operated by warm air that opened automatically when a fire was lit on the altar and closed again as the flames died down. Philo of Byzantium (third century B. C.) describes in his *Pneumatics* siphons that allow vessels to empty and refill themselves automatically, or pour wine and water alternately. There are also washbasins worked by counterweights and pulleys, which make a bronze hand extend a pumice stone to the user, disappear when he takes it, and reappear to receive it again after enough water has flowed out of a spout to allow him to wash his hands. A major part of a treatise on mechanics by Hero of Alexandria (c. 100 A.D.) is devoted to similar gadgets. Some of the wonder-working apparatus was put at the service of the priesthood of Alexandria, for example a coin-in-the slot device combined with a holy-water dispenser that flowed only when money was put into it. Many of the mechanisms described in these books had great potentialities for practical purposes, such as a water wheel, a wind vane, and even a rudimentary steam engine. But the steps to develop these from toys to power machines was never taken in antiquity. The uses that Hero suggests for his "ball rotated by steam" are to blow on a fire, to cause small statuettes to dance, a mechanical bird to sing, or a Triton to sound his horn!

Automata were the most famous of the wonder-working mechanisms of the ancient world. They exerted a powerful spell on the imagination, and even if they were meant to be amusing rather than awe-inspiring, they could cause a certain uneasy speculation. A fascination with automata was inherited by the Byzantines. There is a detailed sixth-century description of an elaborate water clock, housed in a tower at Gaza, in which the hours were marked by small statues of Hercules performing his twelve labors. The Arabs, besides developing instruments such as the astrolabe, concentrated much of their technological interest on intricate automata. They transmitted the tradition of mechanical vessels and water clocks to Western Europe; the ambassador of Haroun al-Raschid presented a clock with automatic figures to Charlemagne. No actual Arabic automata have survived, and the manuscripts that describe and illustrate them deal only with their performance and outer appearance, so we know little of how their mechanisms worked.

The early Middle Ages did not offer a favorable climate for the development of science and technology. Scholarly speculation was diverted from abstract science to theology, and respect for authority inhibited experimentation. There was also a tendency to equate scientific learning (which continued to flourish chiefly among the Arabs and Jews) with heathenism, if not actually with black magic. Hard manual labor was regarded as man's destiny after his expulsion from Eden, and even as an attribute of holiness, so there was no incentive for developing labor-saving devices.

The Middle Ages nevertheless gradually made increasing use of animal-, water-, and wind-power. The water wheel and windmill helped to raise the production of food beyond the mere subsistence level. Between the thirteenth and fifteenth centuries, water power gradually came into use also for saw mills, grind stones, forges, pumps for draining mines, and blast furnaces. In Northern Europe, especially, there were important advances in sailing: the stern-post and rigging that made it possible to tack closer into the wind. These and the magnetic compass extended the scope of navigation and trade.

Technological advances were also made by artisans in many crafts such as masonry, metalwork, and weaving. As the guild system grew, crafts became more specialized. Towns increased in size and number. The life of the community began to be regulated by mechanical clocks, which appeared in the latter part of the thirteenth century and were perfected in the fourteenth. Set high in public places, they replaced the variable liturgical hours with a secular division of the day into twenty-four equal hours. Besides this utilitarian function, many of them, for example the famous clock at Strasbourg Cathedral, continued the marvelous pageantry tradition of the earlier water clocks. Clockwork mechanisms were also adapted for elaborate spectacles at festivals.

With the rise of the universities, there was a steady advance in the scholarly tradition. The medieval schol-

ster that Mary Shelley created in *Frankenstein* (1817) was another symbol of the fear that the machine, instead of being man's slave, might become his master and destroyer.

In the nineteenth century, it was finally realized that a perpetual machine was impossible; machines would always require great labor to keep them functioning. The tremendous increase in manufacture also demanded that more material be constantly sought to keep the machines fed. A reckless exploitation of the earth's natural resources resulted. Whole geographical areas came to be regarded as nothing but providers of raw materials — sources that could be used and depleted. This attitude was transferred from materials to whole continents and classes of people. Karl Marx defined the situation in a speech he gave in London in 1856:

"Machinery, gifted with the wonderful power of shortening and fructifying human labor, we behold starving and overworking it. The new-fangled sources of wealth, by some weird spell, are turned into sources of want. The victories of art seem bought by the loss of character. At the same pace that mankind masters nature, man seems to become enslaved to other men or to his own infamy."

By the mid-century, opinions about machines and their potentialities were completely confused. Optimism and belief in progress existed side by side with great despair. Which opinion one held depended largely on one's position in society. For the entrepreneur, laissez-faire policies meant a golden age. For the working classes, freedom was extremely restricted; they bore all the hardships of exploitation and received almost no benefits of production.

In literature, the most optimistic exponent of progress and of technology's unlimited possibilities was Jules Verne. Science opened up all paths before his heroes — solitary geniuses who with the aid of miraculous inventions could force any environment to yield to their will. A completely opposite view is that of Samuel Butler in *Erewhon* (1872). Three chapters of this book, which describes an imaginary state ("nowhere" spelled backwards), deal with its technology. Butler foresaw a human race that had become parasites of the machine, making man "an affectionate machine-tickling aphid." In a reversal of La Mettrie's concept of man as machine, Butler depicts machines as human beings with intelligence and initiative. He argues that animals and vegetables have taken millions of years to evolve to their present state, whereas machines so far have had only a few hundred years in which to develop.

It may be surprising to read what Norbert Wiener had to say in his pioneering book, *Cybernetics* (1948), about Butler's vision, with reference to the computer:

"I have said that this new development has unbounded possibilities for good and for evil. For one thing, it makes the metaphorical dominance of the machines, as imagined by Samuel Butler, a most immediate and non-metaphorical problem. It gives the human race a new and most effective collection of mechanical slaves to perform its labor. Such mechanical labor has most of the economic properties of slave labor, although, unlike slave labor, it does not involve the direct demoralizing effects of human cruelty. However, any labor that accepts the conditions of competition with slave labor, accepts the conditions of slave labor, and is essentially slave labor. The key word of this statement is *competition*. It may very well be a good thing for humanity to have the machine remove from it the need of menial and disagreeable tasks; or it may not. I do not know."

The phenomenal changes that technology and the Industrial Revolution brought about in man's social and political life were frequently treated in literature but largely bypassed in art. The few pictures that deal with any aspect of the subject tend to be illustrative or anecdotal. When new industrial themes appear, they are usually rendered purely pictorially, as in Turner's *Rain, Steam and Speed*, Monet's *Gare St. Lazare*, or Seurat's somewhat later drawings of industrial cityscapes. Even paintings by artists who were concerned with the worker's situation — Courbet, Millet, Pissarro — make no profound statement on his social condition. As Klingender has observed: "The alliance that had grown up in the later part of the eighteenth century between science and art was based on a common foundation of optimism. When political economy abandoned the humanist standpoint for a sophistical defence of property, the link between science and art was broken."

From the Renaissance to the late eighteenth century, science and art had interacted, and great scientific discoveries had their counterparts in art. The interplay between art and science may be regarded as one of the most significant factors within any culture. In ancient Greece, both arose from a common inspiration; there was no more opposition between nature and the application of natural laws in technics than there was between technics and art. Man was perceived as a part of nature, a microcosm of the universe, or the highest species in an ascending scale of beings. Everything could be brought within the sphere of human comprehension, and the world regarded as an ordered unit. But as scientific knowledge became more complex, rational, and secular, it also became more specialized. Man's idea of the world could no longer be contained within a unifying framework but became increasingly fragmented. The specialization of science also meant that it became more professionalized and directed toward utillitarian ends, and so further removed from the humanities. (Since Einstein, however, modern scientists have once again been thinking in terms of unified fields.) The more man sought to bend nature to his will by force, the more alienated from it he become. In Giedion's words: "In the nineteenth century the path of science and art diverge: the connection between methods of thinking and methods of feeling was broken."

human life, no problem facing mankind, that could not be solved if one applied the infallible, all-encompassing laws of mathematics. There is a story that he constructed a mechanical woman, Francine, on mathematical principles. During a sea voyage, a prying fellow-traveler opened his luggage, discovered Francine, and brought her to the captain, who threw her overboard as a product of black magic. In any event, Descartes declared that the mechanistic theory of the human body should not "appear at all strange to those who are acquainted with the variety of movements performed by the different automata, or moving machines, fabricated by human industry.... Such persons will look upon this body as a machine made by the hands of God, which is incomparably better arranged, and adequate to movements more admirable than in any machine of human invention." The body of a human being was differentiated from that of all other created beings, however, because God had placed within it a rational soul. Through this, man alone could participate in the incommensurable, spiritual world.

This dualism of man's nature was transformed into a mechanical monism in the following century by Julien La Mettrie, whose book *Man as Machine* (*L'Homme machine,* 1747/8) greatly shocked his contemporaries. Believing that men and animals alike function as machines, he drew an analogy from time-pieces, which at this period were being much refined: "Man is to the ape, to the most intelligent of animals, as Huygens' planetary clock is to a watch of Leroy." La Mettrie allowed no place for such factors as intuition, imagination, creativity, or biological time — hence, no place even for death. (His adversaries thought it a great victory when he proved his materialistic soullessness by dying of overeating.) In spite of his limited outlook, he dominated intellectual discussion during the third quarter of the century and greatly influenced the thought of such men as the encyclopedist Diderot.

The development of clockwork and other kinds of precision instruments, together with the concept of the universe as a great time-machine that had been wound up and set in motion by God, led to the making of increasingly intricate automata. No longer merely toys or marvels, they corresponded with the philosophical preoccupations of the time. As symbols or as works of art, however, they are quite uninteresting. They imitate the faces and hands of human beings and are dressed in real clothing. The essential factor — the mechanism — is completely concealed. Thus the problem of creating an integrated image remained unsolved.

The paradox within the Age of Reason is well illustrated in the case of Jacques Vaucanson. Unable to earn his living in the sciences, he created an elaborate artificial duck and two musician automata, which immediately attracted the interest of the public and the learned men of the day. Because of his knowledge of machinery, he was made the government's Inspector of the Silk Manufacturies. He proposed many advanced schemes and made many inventions, including a machine for fabricating patterned materials, but he met with constant checks in his career; and none of his ingenious devices won him nearly the fame he had attained with his automata. Vaucanson scornfully declared that though an inventor "would never be regarded as an artist by the Academicians but would be despised as a mere maker of machines, these gentlemen would be more humble if they were to reflect that this solitary mechanic has done more to assure man's well-being than have all the geometricians and physicians in their entire Society!"

This is a perfect expression of the idea, prevalent at the time, that advances in science and invention were necessarily beneficial to mankind. The rationalist thinkers were all firm believers in progress. They were convinced of man's perfectibility. New medical discoveries would make him not only healthier but wiser than before, and improved education would complete the process. Enlightened opinion would lead to improvement in the institutions by which men are governed, thus creating still more enlightened opinion; and so mankind must continually advance. Voltaire, for example, in 1756 declared his belief that: "reason and industry will progress more and more, that useful arts will be improved, that the evils which have afflicted men and prejudices which are not their least scourge, will gradually disappear among all who govern nations."

At the beginning of the nineteenth century, the initiative in technological advance passed to England. It was there that the great drama of the Industrial Revolution, which dominated the century and completely changed society, was principally played out. Steam power was now used extensively for mining, transport, and manufacture. Factories multiplied, and new industrial towns grew up. In America, the shortage of skilled labor for the task of settling an entire continent stimulated the invention af labor-saving devices and the use of power machinery.

Not everyone observed these changes with the same optimistic belief in progress that had characterized the Enlightenment. There was great disillusionment when, after the French Revolution, hopes for better governments were frustrated by the establishment of new tyrannies. Workers, finding their livelihood threatened by accelerated mechanization, were rioting, breaking the machines, and being put down by force. Living conditions in mining regions were dreadful. In the towns, as people left the countryside to find work in factories, population grew at an unprecedented rate, and slums spread quickly. A mood of despondency replaced the earlier hopes for science and technology. As Klingender has pointed out in *Art and the Industrial Revolution:* "Milton's Satan was readily accepted as the symbol of the new scientific forces in society, because he embodied intelligence, ingenuity and science in the cosmic struggle and was at the same time a symbol of man's self-destruction and inevitable doom." The mon-

before, he transmitted his ideas about machines to the Dadaists, who had previously taken no particular interest in the subject.

The positions of the Dadaists toward machines varied widely. In Cologne, Ernst and Baargeld felt ambiguously about them. When they used mechanical forms, it was usually for poetic purposes, and in an ironic way, to express a subjective attitude. They intermingled the rationality of machine forms with irrationality to create paradox and confusion. In Hanover, Schwitters, though more philosophical and detached, took a related position. Heartfield and Grosz, in Berlin, soon abandoned their initial Dadaist skepticism for an almost unlimited admiration for Constructivism and "machine art."

The concepts of machine art held by the New York Dadaists and by the Russian Constructivists working in Leningrad in the years following the Revolution were extremely different. Tatlin was eager to put his art at the service of the Revolution. He saw the future of the new society in the development of science and industry, and he wanted his art to be a spontaneous expression of that new society's dynamism and to reflect the spirit of machine culture. His greatest work, the model for a Monument for the Third International (1920), was a fusion in one structure of architecture and sculpture with motorized elements. Though Tatlin had a clear, strong vision, he avoided giving it a definite theoretical formulation. To someone seeking to change society, yet unable to foretell what the eventual result of the revolution may be, the exact way in which changes are brought about is not essential. What is important is respect for the properties of the materials used, and the logical structure that arises out of them, which determine the content of both art and society. In the aircraft — one-man gliders — that Tatlin began to construct late in the 'twenties, his intention was to combine his artistic concept of truth to materials with his ideas about utility and society. He concluded that "the most aesthetic forms are the most economical"; but his complex thought goes far beyond this statement and involves, as he said, "art going out into technology" — the fusion of art and life.

Tatlin's influence was strongly felt in theater, film, architecture, furniture design, posters, and typography. (A newspaper clipping of about 1927, reproduced in a book by the Italian Futurist Depero, reports that the Charleston had been banned in the Soviet Union in favor a a new "machine dance" inspired by mechanical movements!) The philosophy of the "culture of the machine" survived in debased form under Stalin, to give birth to representations of happy factory workers and tractor operators.

Tatlin's chief followers in Germany were Lissitzky and Moholy-Nagy, who founded a Constructivist group in Berlin in 1922. His influence was further spread through Moholy's teaching at the Bauhaus, which built its program mainly on Tatlin's ideas. The atmosphere of the Bauhaus reflected a generally optimistic point of view toward machines, but the original ideas soon became a diffused belief in the possibilities that technology offered for artistic use, and the desirability of applying principles of good design to manufactured articles.

A similarly optimistic attitude prevailed in France at about the same time. Léger, who in the late 'teens had manifested an interest in the impressive plastic forms of artillery, came under the influence of the more theoretically minded founders of machine aesthetics, Le Corbusier and Ozenfant. The Purists, like the Russian Constructivists, wished to unify all the arts in the service of society and recognized that modern society must be increasingly dependent on technology. But it was the clarity, precision, and elegance of machine forms that the Purists — unlike the Constructivists — particularly admired. This admiration was accompanied by a glorification of the role of the technician in society: "Engineers are healthy, virile, active and useful, moral and happy," Le Corbusier wrote in *La Peinture moderne* (1925). In this book, he and Ozenfant, like new Darwins, postulated a law of mechanical, rather than natural, selection. It "establishes that objects tend toward a type which is determined by the evolution of forms between the ideal of maximum utility and the demand of economical production, which conforms inexorably to the law of nature." Having very little actual knowledge of how machines worked or what they could do, Le Corbusier and Ozenfant based their mechanolatry on a confusion between functionalism and the mere absence of unnecessary decoration. In *Theory and Design in the First Machine Age,* Reyner Banham has shown the weakness of the Purists in founding their machine aesthetics on pictorial values — qualities which, as he points out, "are conditional attributes of engineering, and to postulate them as necessary consequences of machine production was to give a false picture of the engineer's methods and intentions." What interests engineers is mechanical tolerance, not finish; a high degree of polish nearly always has to be achieved by hand. Most objects reproduced in the publications on machine aesthetics were expensive, specialized, handmade articles, such as the wheel of a Bugatti car. The theory nevertheless had worldwide influence.

The worship of machines that prevailed in the late 'teens and early 'twenties had changed into an opposite attitude by the 'thirties. Confidence in man and in man's capacity to be the rational builder of a better world, which had been the basis for Constructivism, was replaced by a different kind of faith — in "psychic automatism" and the powers lying hidden beneath the surface of an individual's seeming rationality. This new faith had been proclaimed in Breton's Surrealist Manifesto of 1924. When the Surrealists concerned themselves with machines, it was to depict them as the enemies of nature or to explore their erotic implications.

The growing rebellion against those who wished to

Faith in progress was debased into faith in production, and sentiment deteriorated into sentimentality.

William Morris, a man of strong social conscience, followed Ruskin in avoiding the problems of mechanization chiefly by dissociating himself from it. In his romantic belief, only renunciation of industrial production and a return to the guild system of medieval craftsmen could lead to the recovery of lost humanistic values. What Morris opposed was also that mass production had so fragmented manufacture into isolated processes that it robbed the worker of any identification with what he produced; he lost his sense of pride and purpose, and naturally design suffered as well.

But machines could produce many more articles far more cheaply than could individual artisans, and the growing middle class was increasingly eager for manufactured goods. Enthusiastically embracing the utilitarian, public opinion relegated Art to a small, isolated area. Art was placed on a pedestal, respectfully venerated, and consequently quite misunderstood. Architects continued to be trained in academies of the "fine arts"; it was in polytechnical institutes that engineers learned to use the new materials. What the engineer built might be admired for its ingenuity and utility but had nothing to do with popular concepts of Beauty. It was nevertheless in building that new methods and materials first won acceptance, even on aesthetic grounds.

By the year 2000, technology will undoubtedly have made such advances that our environment will be as different from that of today as our present world differs from ancient Egypt. What role will art play in this change? Human life shares with art the qualities of being a unique, continuous, and unrepeatable experience. Clearly, if we believe in either life or art, we must assume complete domination over machines, subject them to our will, and direct them so that they may serve life in the most efficient way — taking as our criterion the totality of human life on this planet.

In planning for such a world, and in helping to bring it into being, artists are more important than politicians, and even than technicians. But, of course, it is not artists in whom we ordinarily most place our confidence.

The story of how artists of this century have looked upon and interpreted machines is highly dramatic. Their attitudes have ranged from deepest pessimism and despair to devotion and even idolatry. It should be noted that such extreme positions have been taken by artists who are among the most significant of our time.

For the Futurists, technology represented the dynamic means by which they hoped to overcome the stagnant traditions of Italy — a country in which the glories of the past encumbered youth more perhaps than anywhere else. Before Marinetti decided on "Futurism" as the name for the movement he launched in 1909, he first considered "electricism" and then "dynamism." In spite of their enthusiasm for machines and their hopes that through them the whole world could be changed, the Futurists' view of them remained rather superficial. They inherited from the Impressionists the tendency to look principally at the appearance of things. It was the polished metals, bright colors, and noise of machines that the Futurists admired, and the heady sensations of speed and power that they enjoyed. But for the most part (with the great exception of Boccioni, as in his *States of Mind* series), they never tried to reach a deeper understanding of what machines represented in people's emotional lives; nor, in spite of their activism, did they ever clearly analyze what machines were bringing about in terms of social change.

The Cubists held very divided attitudes toward the mechanical world. Their use in collages of manufactured materials such as newspapers, nails, or twine was of course important in breaking down old concepts of what was acceptable in making works of art, and was to be carried much further by the Dadaists and Surrealists. But Picasso has never made any statement whatsoever about machines in his art, nor did Braque and Gris show any interest in the subject. On the other hand, Duchamp-Villon's *Large Horse* was an ambitious attempt to infuse into traditional sculpture the kind of energy found in engines; and Léger translated the impressive forms of machines into several beautiful paintings.

Duchamp, who began as the youngest of the Cubists, soon developed his concepts into a philosophical and metaphysical system — something which the Cubists in general did not attempt. His meditations on movement and machines led him into previously unexplored regions. He rapidly passed through his preliminary interest in the outward aspect of machines to create a new kind of visual metaphor. This enabled him to express complex ideas that involved, among other things, non-Euclidean geometry, chemistry, and alchemy. The machine-eroticism that we find in his work is a theme first elaborated in the writings of Poe, Villiers de l'Isle Adam, Roussel, and others, as an ironic blend of eroticism and sadism with ideas about magic powers and the superman. In *Surmâle* (1902), Jarry wrote: "In this age when metal and mechanics are all-powerful, man, in order to survive, must become stronger than the machine, just as he has to become stronger than the beasts." By using the machine and technological language in a new way to express his most complex thought, Duchamp did indeed dominate the power of the mechanical world. Many of his early discoveries about machines he passed on to Picabia, Man Ray, and Ribemont-Dessaignes, who developed them in their own works.

During the early years of the war, Duchamp and Picabia brought their initial ideas about machines from Paris to New York. Stimulated still further by the developed mechanization of the American environment, Picabia for a number of years concentrated most of his work on machinist subjects. In 1919, on a visit to Zurich, where Dada had officially been born three years

Catalogue of the Exhibition

All the objects other than comparative material reproduced in this catalogue are included in the exhibition, unless listed as lost or destroyed or represented by reconstructions, with the exception of those illustrated on the following pages: 15—16 (represented by facsimiles and models), 20, 21, 26, 35, 93, 98, 111, 143, 144—145.
Works listed on the following pages have been lent for the New York showing only: 18, 36, 57, 60, 61, 62, 63, 60, 70, 73, 75, 77, 78, 82, 87, 89, 95, 100, 103 above, 105 above, 113 (New York and Houston only), 127, 138, 141, 149, 153, 180, 187 right.
In dimensions, height precedes width. Drawings are on paper unless otherwise noted.

 *art*

 *reconstruction*

 *invention*

 *car*

 *camera*

 *reconstruction*

 *E.A.T.*

rule society by the blind application of technological principles is illustrated in Huxley's *Brave New World* (1932). This pictures a future in which children, produced in a scientifically controlled bottling factory, will be educated as to their position in the social order by broadcast maxims, drilled into them while they sleep.

The economic crisis of 1929 and the unemployment that it created intensified pessimism. Some of the most direct comments about machines can be found in films. The first Frankenstein film was made in 1931. The sentiments of the time find their keynote in Chaplin's *Modern Times* and *The Dictator*. In his final speech in the latter film, the little man says: "Machinery that gives abundance has left us in want. Our knowledge has made us cynical; our cleverness, hard and unkind. We think too much and feel too little. More than machinery we need humanity. . . ."

Chaplin did not share the popular belief that the introduction of sound was a great advance for the film. Some of the disillusionment that artists of the 'thirties felt about machines came in part from the experience of the sound film. There was a decline in quality, as attention was diverted from cinematic values to the novelty of spectacular musical comedies or plays translated into movies. Films now cost much more to make, and they became increasingly commercialized as producers sought to please mass audiences to ensure the return of their investment. It was a great disappointment to recognize that a technological achievement could have such a negative effect on an artistic medium.

The late 'thirties and the years of World War II are of no great interest for the theme of this exhibition. Dada had been born out of opposition to the culture that had fostered the first World War. No comparable movement now arose, for the obvious reason that for many years most of the artists had already been opposing Fascism in Italy, Germany, Spain and elsewhere. Military action, when it came, seemed a continuation of this struggle. On the other hand, the manner in which the war was conducted had little in common with the artists' earlier position; it was only a further exemplification of the principle of might against might. This resulted in a general sense of frustration that lasted long after the war itself was over.

The bombs dropped on Hiroshima and Nagasaki were the most terrible shock that the world has ever received. Fear and horror sapped the faith in technology and the confidence in rational behavior that might have been expected to follow a long period of destruction. When Vasarely and other artists began to develop a new Constructivism, it took its name from the earlier movement but focused largely on formal problems. Most of what Tatlin and his followers had tried to achieve in relating technology to life was lost.

This lack of content was felt by artists like Munari and Tinguely. From the mid-'fifties on, they have devoted themselves to an attempt to establish better relations with technology. Standing astonished and enchanted amid a world of machines, these artists are determined not to allow themselves to be duped by them. Their art expresses an optimistic view toward man, the creator of machines, rather than toward technology as such. They lead us to believe that in the future we may be able to achieve other, more worthy relations with machines. They have shown that while different aspects of our relations to machines may conflict, they are not necessarily contradictory. Not technology, but our misuse of it, is to blame for our present predicament.

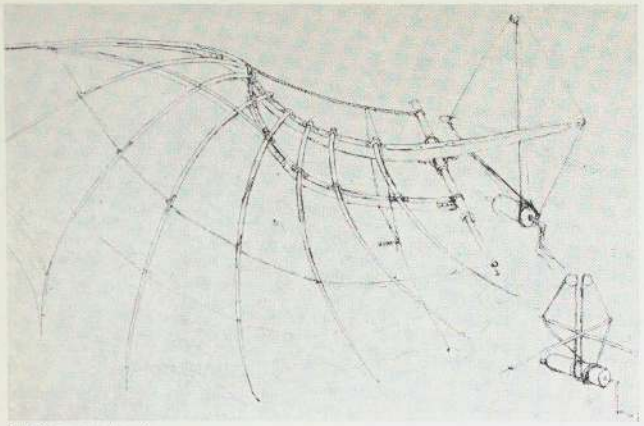
The Pop artists have also taken a step toward finding a way out of this alienation. They have tried once again to relate mass products to human will and show that they have been created by the human intellect, and are related to the human body.

For someone living today, there are obvious advantages in expressing oneself through art. There is great freedom of expression. Without much hindrance from forces external to oneself, one can construct models for the world as one would like it to be. At the same time, the artist is obliged to assume total responsibility for what he does; no one else can be blamed for his successes or failures. John McHale has described the present situation: "The future of art seems no longer to lie with the creation of enduring masterpieces, but with defining alternative cultural strategies. But in destroying the formal divisions between art forms, and in their casual moves from one expressive medium to another, individual artists do continue to demonstrate new attitudes towards art and life. As art and non art become more interchangeable, . . . the artist defines art less through any intrinsic value of the art object than by furnishing new concepts of life style."

Perhaps what is most frightening is the notion that modern technology has an evolution of its own, which is uncontrollable and independent of human will. Many economists and technicians speak as though they were merely explaining inevitable processes — deterministic laws, analogous to natural laws, that govern the development of technology. In their fatalistic view, the products and consequences of technology and mass production simply grow by themselves, like a landscape.

There is no doubt that if we are not to become the victims of what we ourselves produce, we must quickly attain a society based on other values than buying and selling. The amount of data involved in managing society at all levels is increasing at terrific speed, as is the quantity of justifications for decisions. The decisions that will shape our society in the future will have to be arrived at, developed, and carried out through technology. But they must be based on the same criteria of respect and appreciation for human capacities, freedom, and responsibility that prevail in art.

To paraphrase what Tristan Tzara said about Dada: "No one can escape from the machine. Only the machine can enable you to escape from destiny."

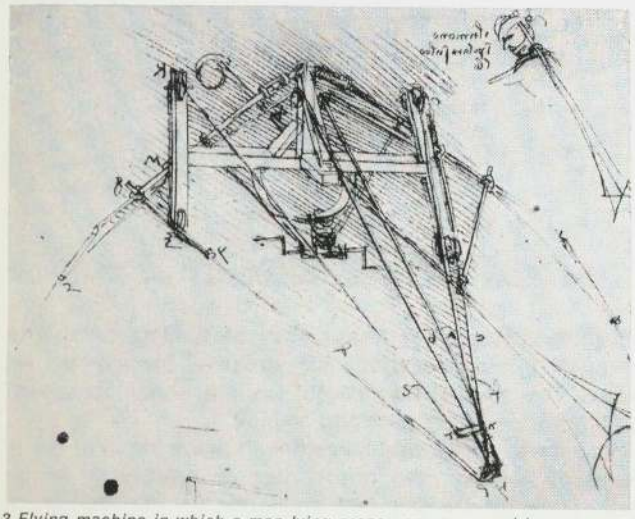


2 Wing mechanism

and the parachute. For the most part, his flying machines are far less rational than his other studies and inventions, lacking the clear insight that generally characterizes his research. Most of his aircraft were ornithopters. Although his apparatus were very heavy, he does not seem to have been concerned with their weight but attached such unessential gear as retractable undercarriage mechanisms to the already ponderous machines.

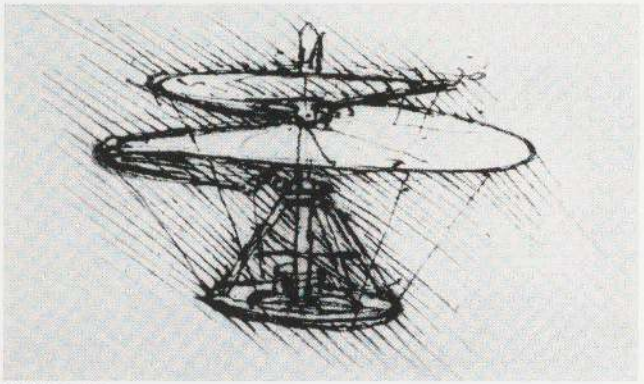
"A bird is an instrument working according to mathematical law, which . . . is within the power of man to reproduce . . . ." All Leonardo's early ornithopters were based on a misunderstanding of the up-and-down movement of birds' wings when they fly. It was not until the invention of the camera that the movement of birds in flight could be accurately studied (see page 36).

It was only rather late in life that Leonardo began to study the principles of the glider, which would seem to have provided the obvious solution to overcoming the problem of weight. His point of departure was then not observation of the flight of birds but of the movements of a falling piece of paper.



3 Flying machine in which a man lying prone uses arms and legs to flap the wings

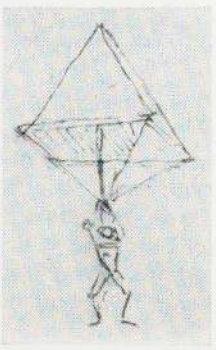
In a booklet on Leonardo's aeronautics, Charles H. Gibbs-Smith recently suggested that the reason he came so late to the construction of a glider was that "a factor beyond the passion for truth and enquiry was at work, a factor which indeed hindered and twisted his investigations; for, inextricably interwoven with his desire to impartially investigate the problems of flight, was his powerful symbolic interest in the romantic idea of flight."[1] The explanation for the relative irrationality of Leonardo's flying machines in comparison with his other technological works is probably that they have to do with the strongest emotional complex of his character. His mind had an enormously strong escape mechanism; he was obsessed with going away, with the flow of water, and he left most of his works unfinished. Thus, in his flight studies, two main streams of Leonardo's mind cross: the wish to understand the world, and the wish to find a new world. It is futile to try to decide whether, in designing his flying apparatus, he acted as scientist or as artist.



4 Helicopter

Leonardo's drawings for helicopters are an indication of his fascination with the spiral form, which he often finds and isolates in nature. He made a model for a helicopter, possibly based on a toy, known since the early fourteenth century, that could be sent spinning into the air by pulling a cord wound around its shaft.

Leonardo's studies had no direct influence on the development of aviation. His work remained unknown until his manuscripts were published late in the nineteenth century. (From some of his drawings and descriptions, Roberto A. Guatelli has constructed models for the International Business Machines Corporation.)



5 Parachute

"If a man have a tent made of linen of which the apertures have all been stopped up . . . he will be able to throw himself down from any great height without sustaining any injury."

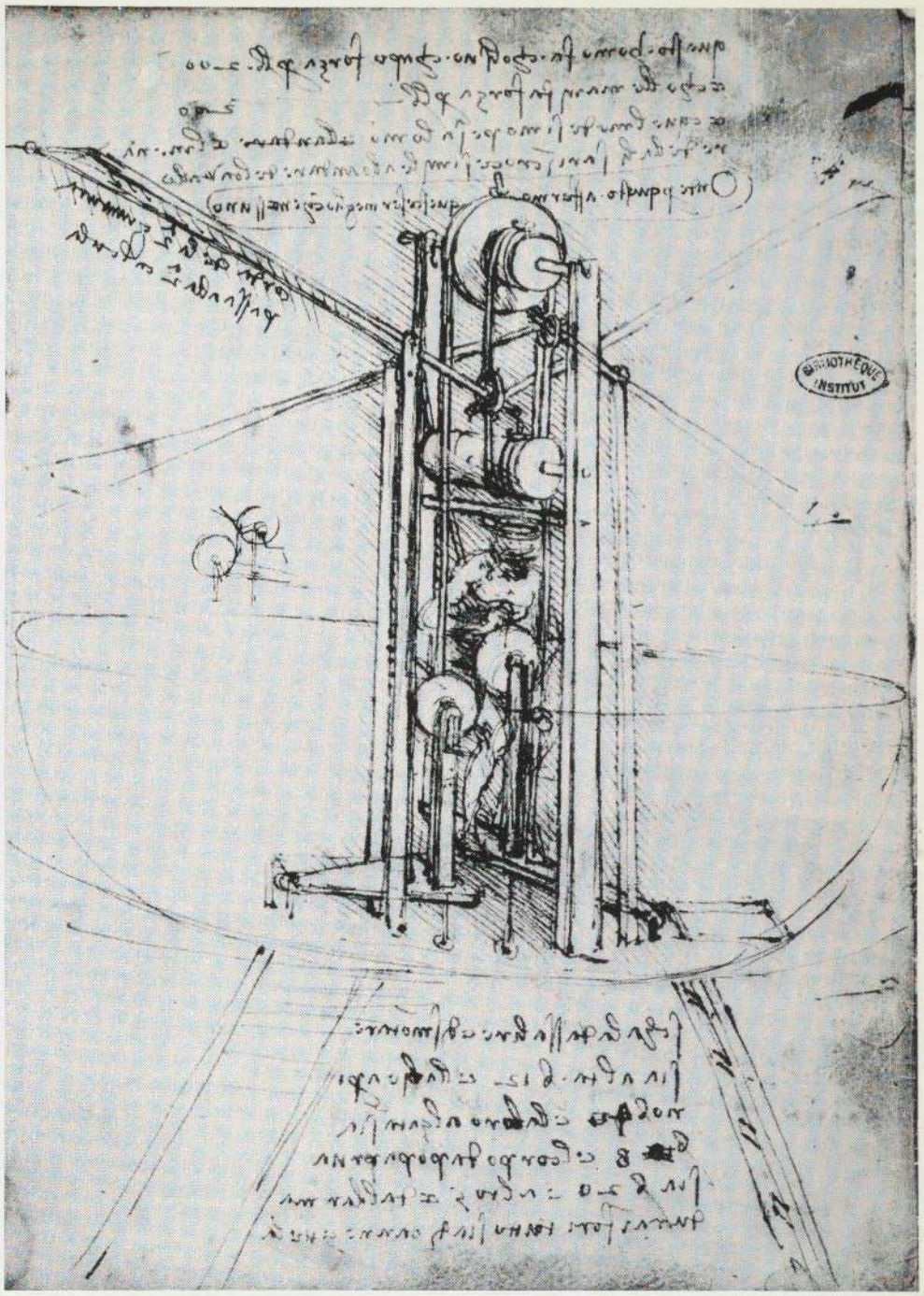
Leonardo da Vinci

Italian, 1452—1519

☼ *Drawings for flying apparatus*
c. 1485—1490

From Manuscript B, Bibliothèque de l'Institut de France, Paris:
1, folio 80 recto; 3, folio 75 recto; 4, folio 83 verso

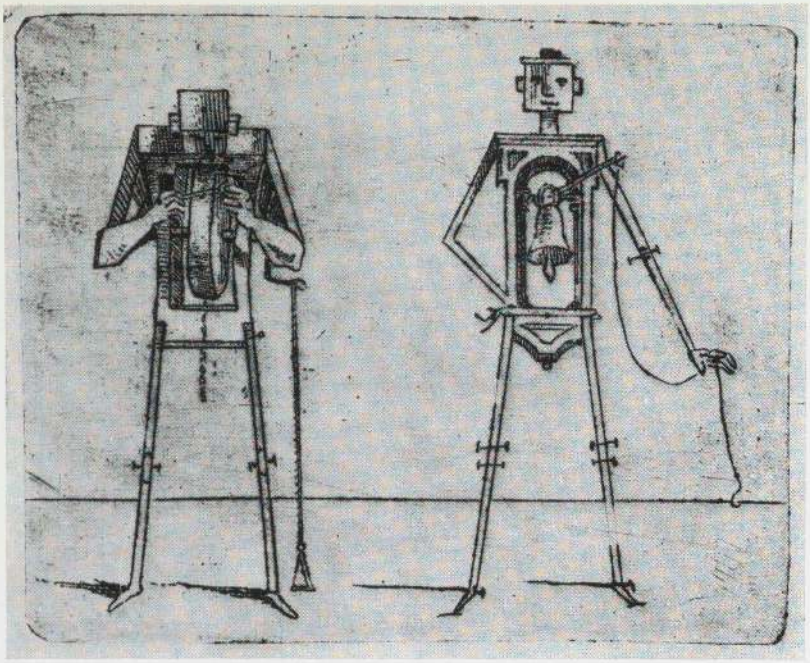
From the Codex Atlanticus, Biblioteca Ambrosiana, Milan:
2, folio 313 recto (a);
5, folio 381 verso (a)



1 Flying machine in which the operator stands upright

In Leonardo da Vinci's surviving notebooks, there are more than 35,000 words and over 500 sketches that deal with the nature of flight and with flying machines. Many aspects of his approach to reality go into these studies: his penetrating observation of nature, his love of theoretical knowledge and, above all, of mechanics, which he termed "the paradise of the mechanical sciences because by means of it one comes to the fruit of mathematics"; his sense for the empirical testing of theory through experimentation; his creative fantasy as an artist. The studies also reveal his emotional obsession with the idea of freedom and escape.

Leonardo concerned himself with many kinds of aeronautical devices: the ornithopter or craft with wings controlled by a man's feet and arms (in one design, a rudder is operated by a head harness), the helicopter,



Giovanni Battista Bracelli

Italian, active 1624—1649

Knife-Grinders (Plate 28 from *Bizzarie di varie figure . . .*). 1624. Etching, c. $3^1/_4 \times 4^1/_2''$ (composition)
Library of Congress, Washington, D.C.
(Rosenwald Collection)

The history of machine-people and machine-animals goes back to the earliest reports on mechanical devices. Automata were a principal manifestation of technology among the Arabs, who transmitted and developed the tradition from antiquity to the Middle Ages. Functioning automata were shown as great marvels at the courts and exhibited at medieval fairs throughout Europe.

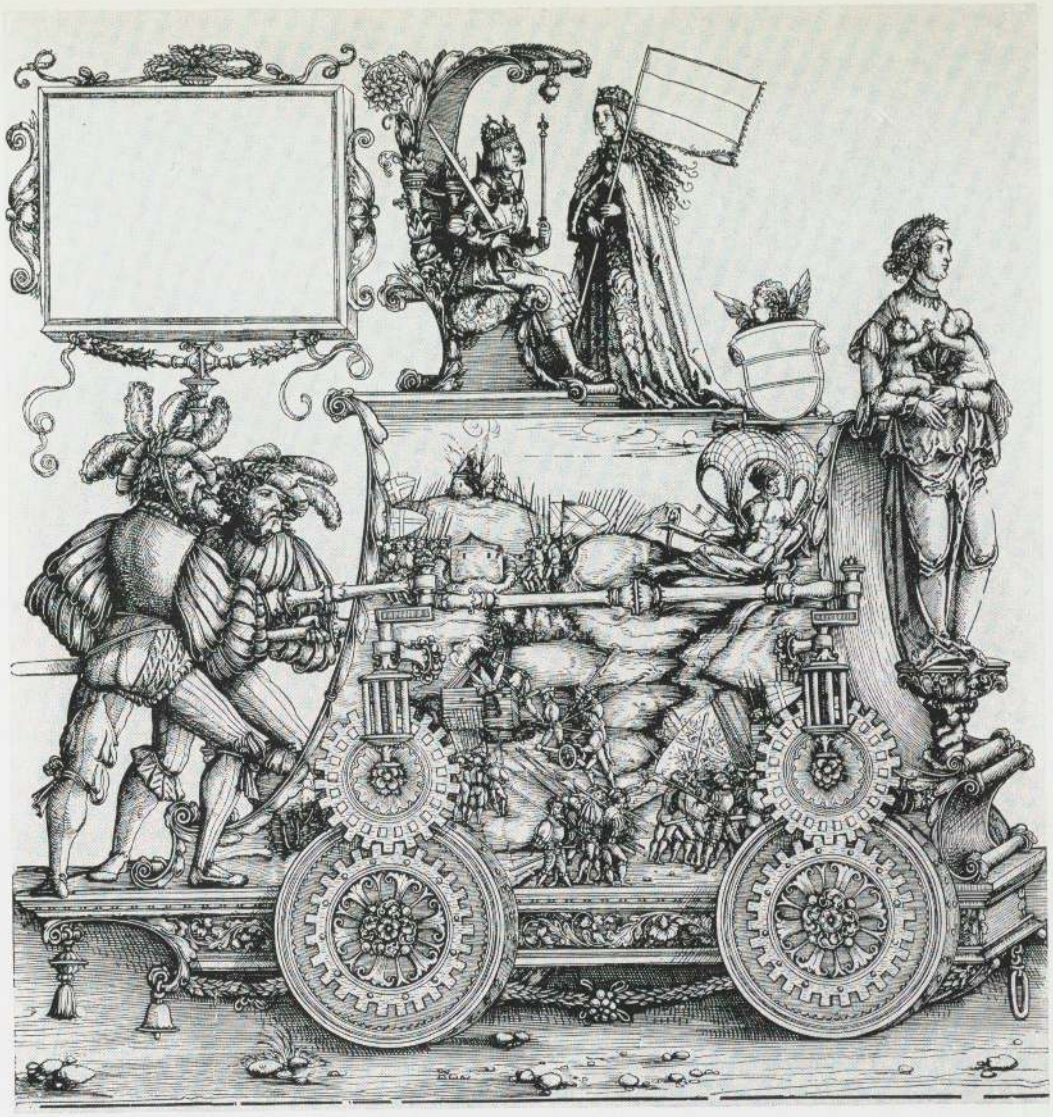
Representations of machines as people occur in the seventeenth, eighteenth, and nineteenth centuries. Like the automata themselves, they exerted a fascination not only as marvels, but because they posed the riddle: What was the distinction between man, and inanimate beings that moved and functioned like man? There was something intriguing in the sacrilegious idea that these were men created, not by God, but by man himself, and thus without souls.

The philosophical problem was set forth by Descartes, who in his *Discourse on Method* drew a distinction between non-spatial mind and space-occupying matter:

By body I understand all that can be terminated by a certain figure; that can be comprised in a certain place . . . that can be moved in different ways, not indeed of itself, but by something foreign to it by which it is touched . . . for the power of self-motion, as likewise that of perceiving and thinking, I held as by no means pertaining to the nature of body; on the contrary, I was somewhat astonished to find such faculties existing in some bodies.[2]

The paradox man-as-machine/machine-as-man, which continued to be discussed in the ensuing centuries, has in our own time been of particular interest to the Dadaists and Surrealists. It is worth noting that Tristan Tzara wrote an introductory essay for the publication, in 1963, of a facsimile of Bracelli's *Bizzarie* in the Rosenwald Collection — the only complete copy known.[3] Bracelli was a Florentine, who dedicated the original edition of forty-five etchings that composed the *Bizzarie* to Pietro Medici. In the plate reproduced here, one knife-grinder is the whetstone, the other the bell that summons customers.

Petitot, a native of Lyons, was active in Parma, where in 1771 he published a suite of ten engraved plates entitled *Mascarade à la Grecque*. They represent persons in various walks of life — a shepherd and shepherdess, a grenadier, a monk, and so forth. Their costumes, as in this drawing, are composed of objects, but although the *Two Engravers* is obviously related to the series, the subject does not appear among the printed plates.



School of Albrecht Dürer

German, first quarter of 16th century

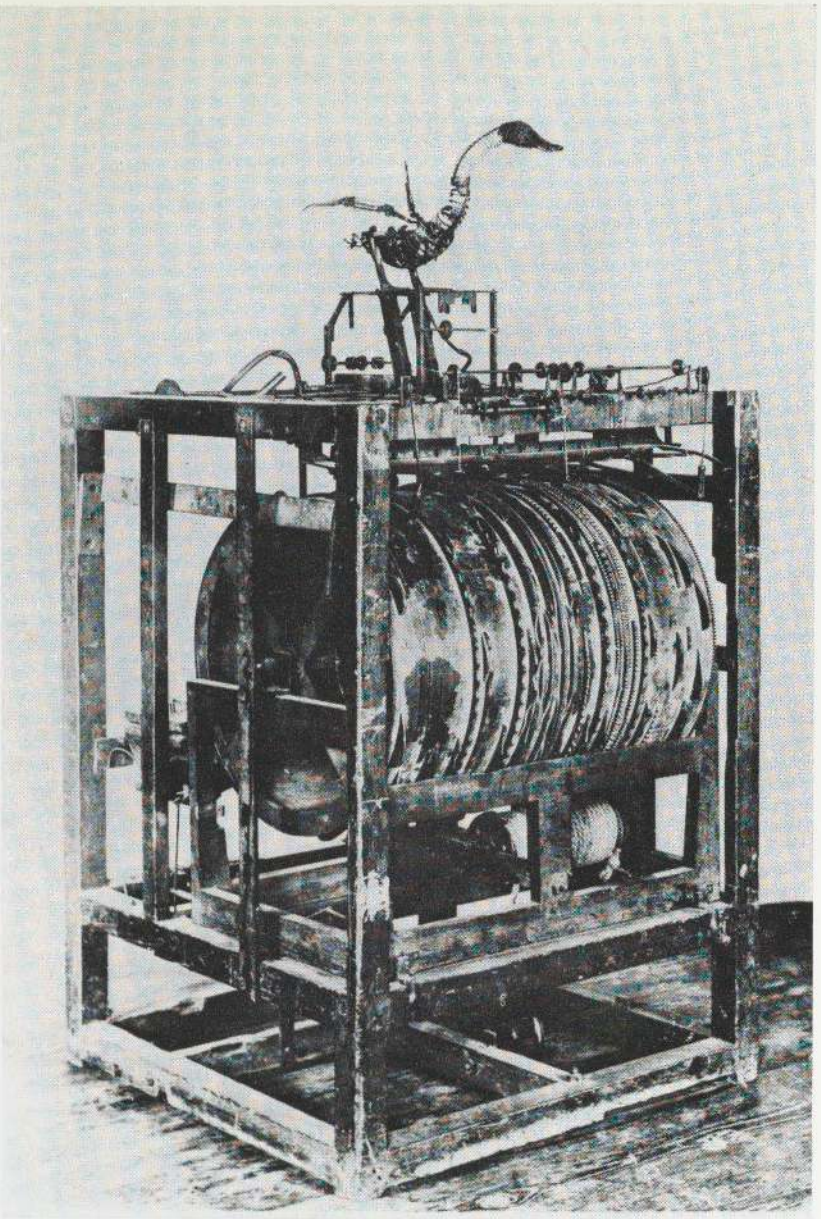
The Triumphal Procession of Maximilian I:
Plate 95, *The Austrian War*. Original blocks, before 1526; reprint, Vienna, 1883—1884. Woodcut, $18^{1}/_{4} \times 23^{3}/_{4}''$ (sheet). The Metropolitan Museum of Art, New York (Harris Brisbane Dick Fund, 1932)

This woodcut is one of several in *The Triumphal Procession* of Maximilian I that depict curious man-driven vehicles, with the Emperor's various battles represented on their sides. The cogwheel mechanism turned by cranks that foot soldiers operate is, of course, completely impractical. A chariot powered in this way could at most advance a few yards along a straight line, very slowly — but that would be its greatest feat.

The elaborate woodcuts for *The Triumphal Procession* were ordered by Maximilian I in 1512. The project engaged the efforts of a large number of the most famous artists of Nuremberg, Augsburg, and the Danube region, including Albrecht Dürer, whose share in the actual execution was minimal. (The block shown is attributed to Hans Springinklee or Hans Burckmeier.) The program, conceived by the Emperor himself, was worked out in detail by his secretary. The work, interrupted by Maximilian's death in 1519, was published seven years later by the Archduke Ferdinand.

Clockwork mechanisms were highly developed in Germany during the Middle Ages, and Dürer himself had sufficent knowledge of engineering to produce a treatise on fortifications in 1527. The machinery here, however, is meant merely to impress by displaying technological lore, as humanistic learning is paraded in the allegorical figure of Charity riding on the front of the car and the classical river god reclining in the landscape.

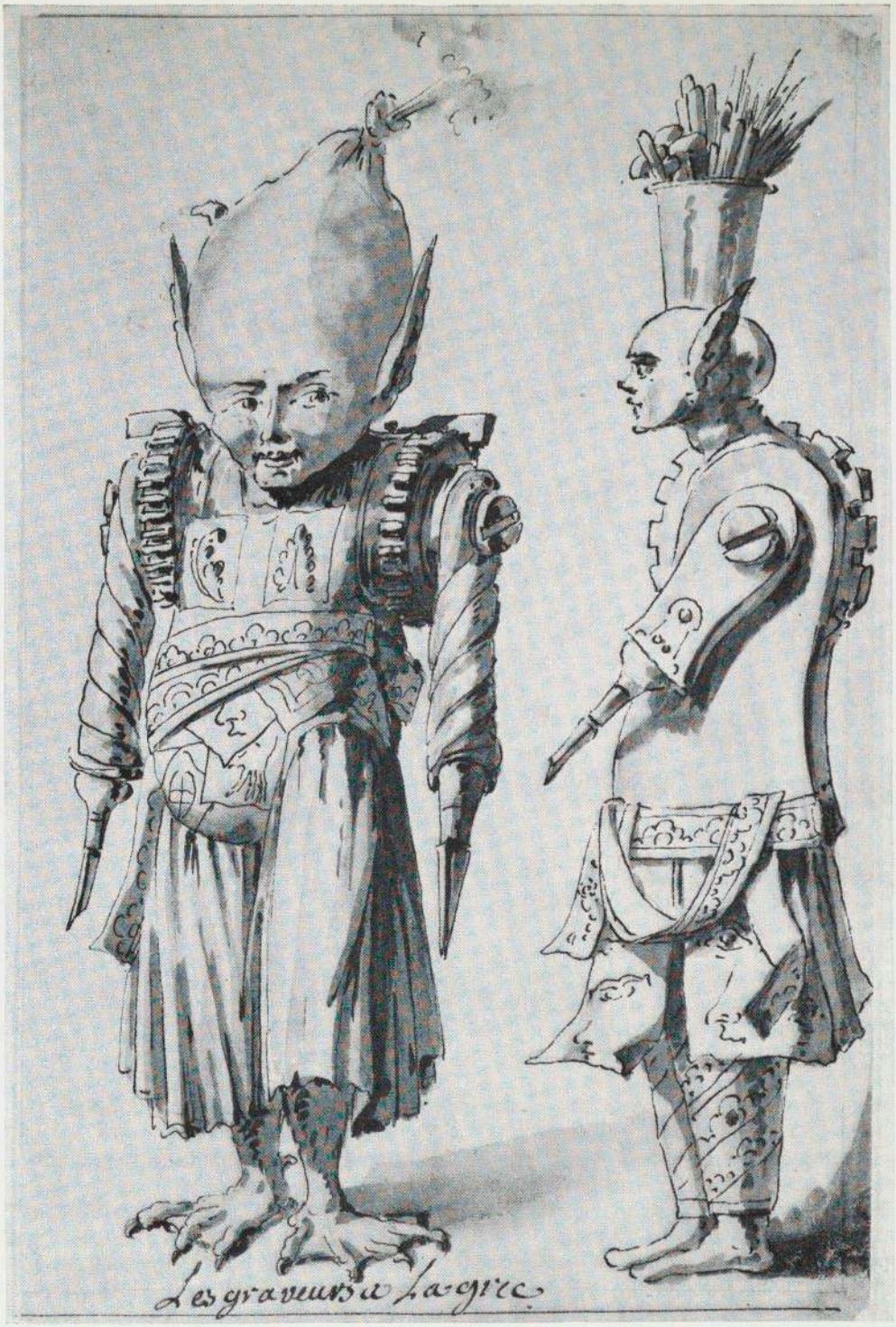
Jacques Vaucanson
French, 1709—1782
Duck, 1733—1734
Automaton (photograph
of lost original, or
imitation, in ruined state)
Musée du Conservatoire National
des Arts et Métiers, Paris



Hubert François Gravelot
French, 1699—1773
Vaucanson's Automata. 1738
(from Jacques Vaucanson,
"*Le Mécanisme du Flûteur automate . . .*)
Engraving

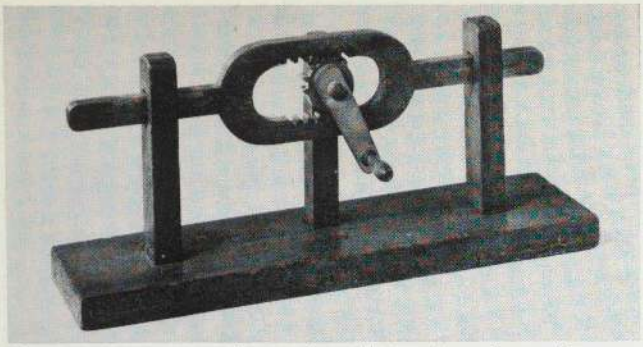
The eighteenth century saw both a great advance in the actual construction of automata and a heightened interest in philosophical discussions regarding the mechanistic nature of man. Today, we might be fascinated by the ingenuity of such perfectly functioning figures as those created by Vaucanson in France and Jacquet-Droz in Switzerland, and certainly we should be interested in the workings of the machinery that enabled artificial musicians to play, penmen to write or draw, and a duck seem to eat and digest his food. The intricate machinery, however, was always completely concealed. To contemporary spectators, the great attraction was the perfect imitation of living beings and the speculations about the nature of life to which such verisimilitude gave rise.

Vaucanson's duck is perhaps the most famous automaton that has ever existed. Already as a child, Vaucanson had built angels with wings that moved and priests that functioned automatically. Influenced by Descartes and by contemporary philosophers of the Enlightenment, Vaucanson wanted to construct moving anatomical figures (*anatomies mouvantes*), which could be used by physicians and surgeons to demonstrate bodily operations. Arriving in Paris at the age of twenty-six, he lacked money for these experiments and decided instead to produce "some machines that could excite



Ennemond Alexandre Petitot. French, 1727—1801

Masquerade Costumes: Two Engravers (Les Graveurs à la grec). c. 1771
Ink and color wash, $7^{5}/_{8} \times 5''$ (sheet). The Metropolitan Museum of Art, New York (The Elisha Whittelsey Fund, 1960)



How rotary movement can be transformed into reciprocating motion. 6¼ high×15″ long×4¾″ deep

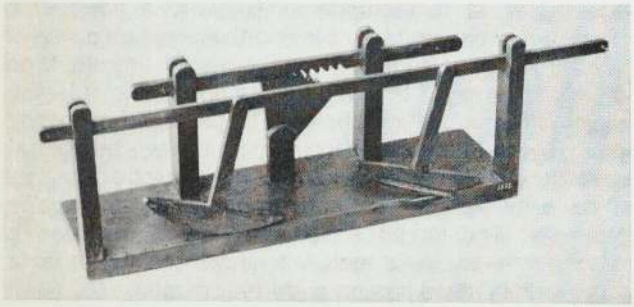
Kristofer Polhem. Swedish, 1661—1751

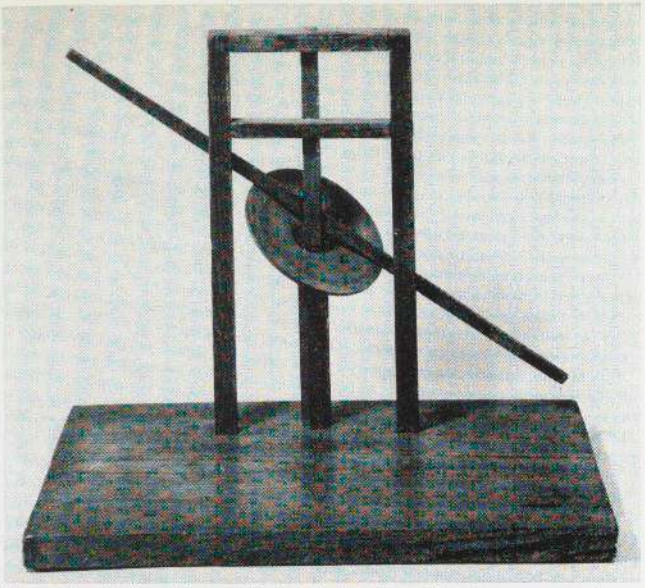
☼ *Letters from Mechanical Alphabet.* Wood, 1772—1779 (originals c. 1700)
Tekniska Museet, Stockholm

Polhem, "the Archimedes of the North," was a scholar, inventor, engineer, and industrialist. A great patriot, he wished to encourage Swedish metallurgy so that the iron, copper, silver, and other metals mined in northern Sweden would not have to be exported to be made into useful objects. Around 1700, to facilitate his teaching, he constructed a series of small wooden models that could serve as an "alphabet" of the basic mechanical functions. The alphabet included in all about eighty "letters," each demonstrating, as his pupil Cronstedt said, "the simple movement that is contained in a machine." This seems to have been the first attempt to treat mechanics in such a methodical manner and teach the basic laws of movement in the abstract, without reference to specific practical applications.

Polhem established a factory in which he introduced the principles of mass production. He is quoted as having said: "There is great need of machines and appliances which will, in one way or another, diminish the amount or intensity of manual work. This result can most adequately be achieved by the substitution of water power for handwork . . ."[6] Waterfalls provided the main source of power, which had to be transported from the river to the factory by mechanical means. The various kinds of transmission catalogued in Pohlem's alphabet were put into practice. In one famous case, power was transported across very rough country to a mine almost two miles distant from the waterfall.

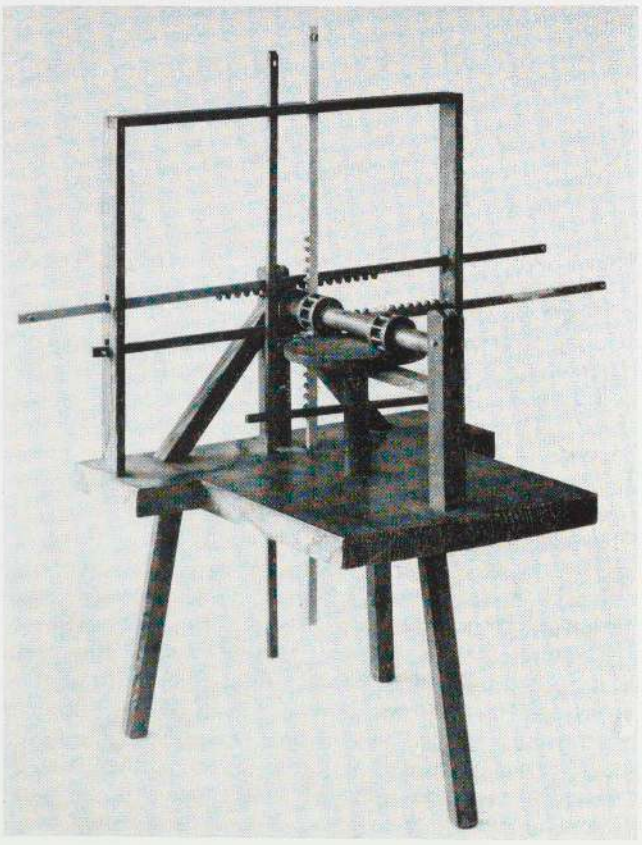
Three ways to fit and steer a rod making a straight reversible movement. 7½″ high×26″ long×5½″ deep

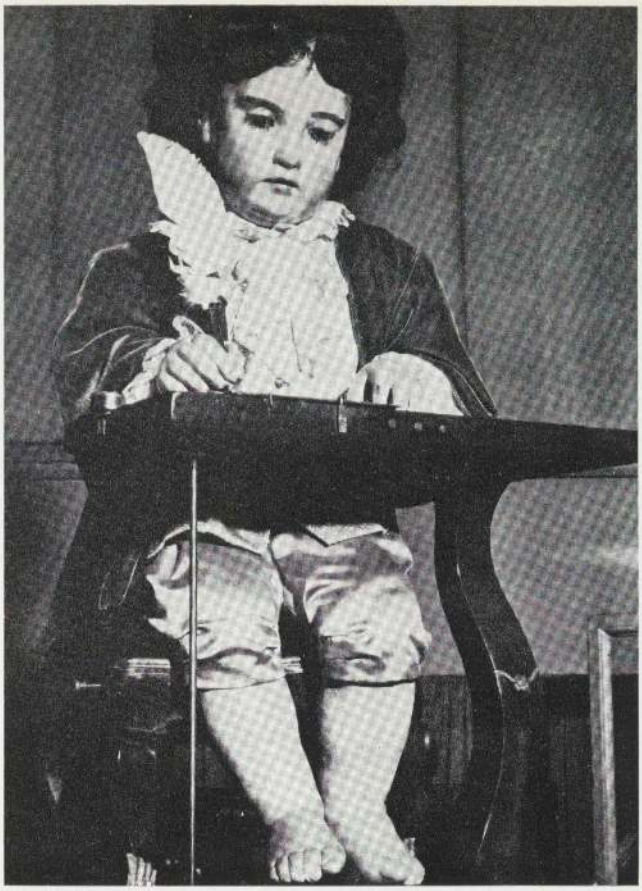


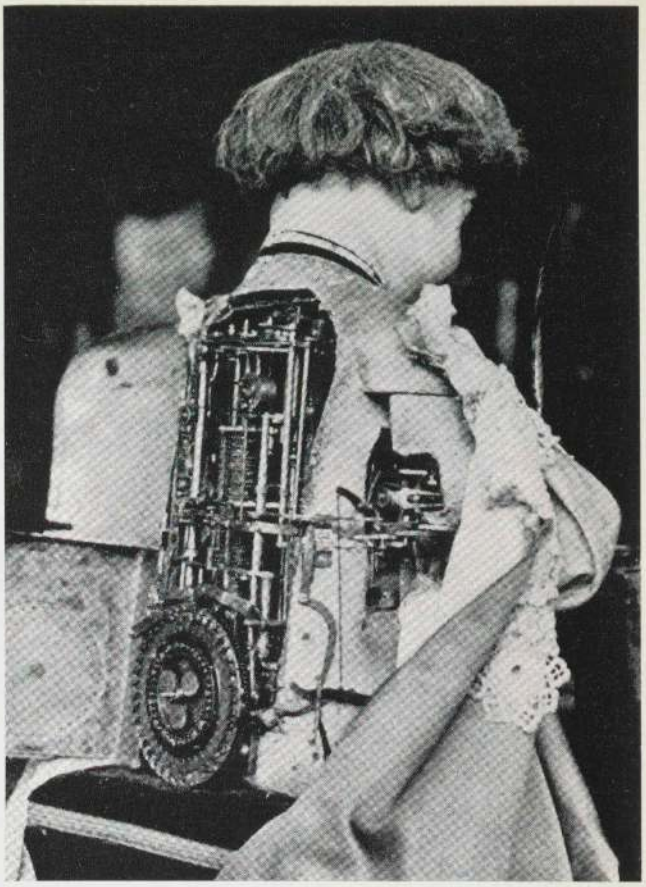


How a disc fastened to a vertical axis transforms its rotary movement to the pumping of an attached arm. 13⅜″ high×15″ long×9⅞″ deep

How rotary movement transforms the action of 4 straight rods (2 vertical, 2 horizontal) into reciprocating motion. 20¾″ high×17¾″ long×11½″ deep







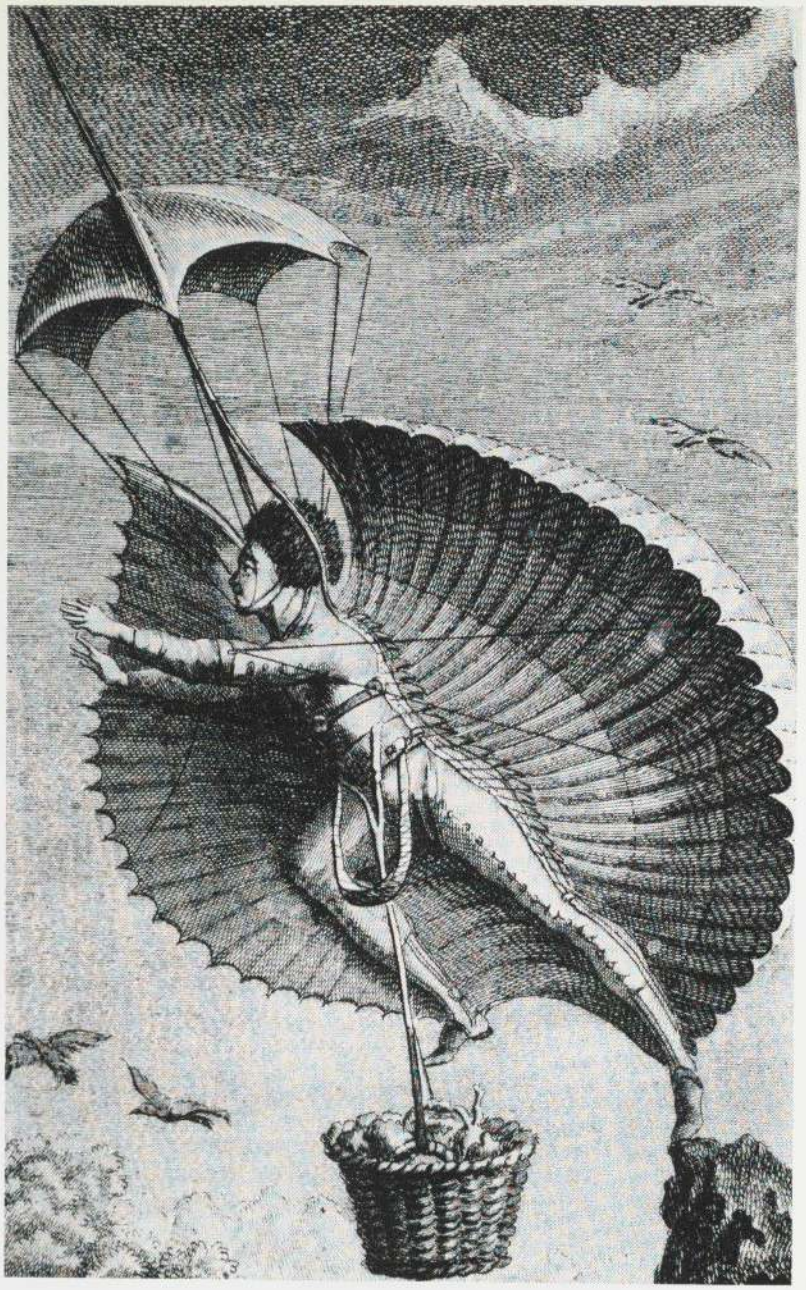
Pierre Jacquet-Droz. Swiss, 1721—1790
Young Writer. c. 1770
Automaton. Musée d'Art et d'Histoire, Neuchâtel

public curiosity." In 1738, he presented before the Académie Royale des Sciences three automata — a drummer, a flute-player, and the duck, which were described in a prospectus as: "an artificial Duck made of gilded copper which drinks, eats, quacks, splashes about on the water, and digests his food like a living Duck."[4] They met with an immediate and enormous success — not only among the public but among savants as well. Voltaire in his rhymed *Discourse on the Nature of Man* hailed Vaucanson as the "rival of Prometheus." He was cited in similar terms by Julien La Mettrie, who was born in the same year as Vaucanson and who in *L'Homme machine* wrote the first systematic statement of the mechanistic theory of man's mind.

The duck was exhibited with great acclaim throughout Europe, fell into ruins, was repaired, lost, and rediscovered, and is last recorded in the 1860s. A series of photographs, including the one reproduced here, was found some years ago in Paris. Some scholars believe they represent the ruins of Vaucanson's duck, while others believe them to be of another automaton made in imitation of it by a German clockmaker, who spent years in repairing the original duck and then constructed another of his own.[5]

The most perfectly developed writing automaton in the world is that made in 1770 by Pierre Jacquet-Droz. The Arabs were the first to construct mechanical penmen, but no automata actually capable of writing had been made before this. When the mechanism is started, the boy dips his pen in the inkwell, shakes it twice, places his hand at the top of the page, and pauses. As the lever is pressed again, he begins to write, slowly and carefully, distinguishing in his characters between light and heavy strokes.

The mechanism that produces the movement of the writer, and of two companion pieces, a young boy drawing and a young lady playing the organ, is a system of levers concealed in the backs of the figures. What Vaucanson wanted the world to admire in his automata was mysterious artificial beings. To contemporary spectators, the little mechanical writer must have seemed almost intolerably perfect. He must have inspired feelings of curiosity, admiration, and probably also paralyzing inferiority. The young scholar embodies the idea of perfection — an ideal man, who never makes an error, never gets in a bad humor, and never revolts.

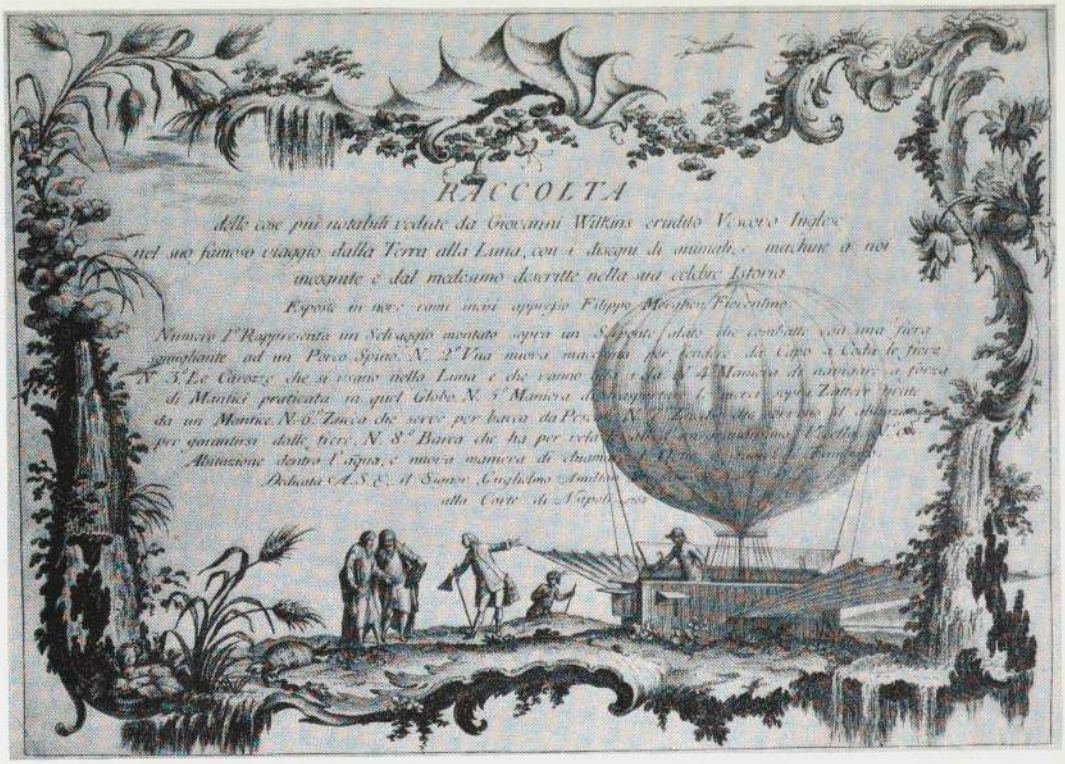


Unknown artist. 18th century
Victorin Making His Flight
(frontispiece of Restif de la Bretonne,
La Découverte australe,
par un Homme-volant,
ou le Dédale français,
Volume I.) Leipzig, 1781
Engraving, $6^1/_2 \times 3^3/_4''$
Rare Book Division,
The New York Public Library,
Astor, Lenox and Tilden Foundations

In this book, Restif de la Bretonne gives a detailed description of the "Flying Man," Victorin, and his adventures in the antipodes. Victorin's experiments in flight are motivated by his love for the beautiful Christine. He longs to take her away and place her in a nest on the "Inaccessible Mountain," far from her parents. Aided by a friend, he studies the flight of birds and decides that if he can make two enormous wings and fasten them to his body at various points, he might be able to fly. As his arms are not strong enough to propel such gigantic wings, this must be done by his thighs. When Victorin is aloft, he flies horizontally.

This account, however fanciful, is not entirely dissimilar to the idea of Leonardo's ornithopter. Like Leonardo and Tatlin (see pages 16 and 144—145), Restif de la Bretonne felt a strong urge to escape from society. In his youth, he was involved in a scandal for which he served time in prison.

Restif was apprenticed to a printer in Auxerre and later went to Paris, where he set up his own printing establishment and produced more than two hundred volumes. Most of them are licentious, filled with accurate descriptions of the underworld of his day, and draw liberally on episodes in his own life.



Filippo Morghen

Italian, born 1730, active 1757—1800

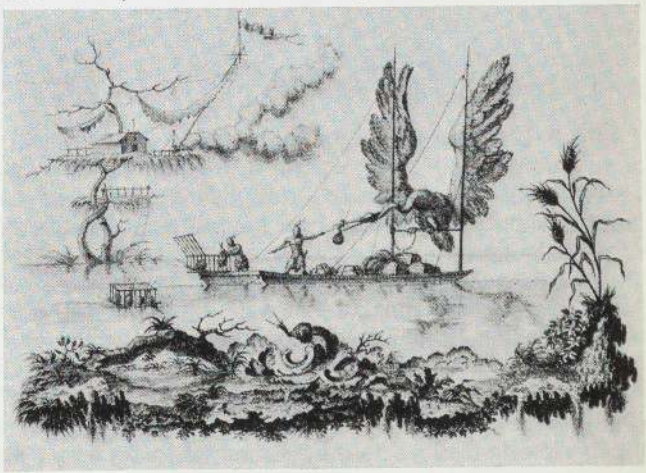
Bishop John Wilkins Taking off for the Moon on His Imaginary Voyage (title page of *Raccolta delle cose più notabili . . .*, 3rd edition). c. 1784—1785
Etching, $12^{3}/_{4} \times 19''$ (irregular; sheet). The Metropolitan Museum of Art, New York
(Harris Brisbane Dick Fund, 1932)

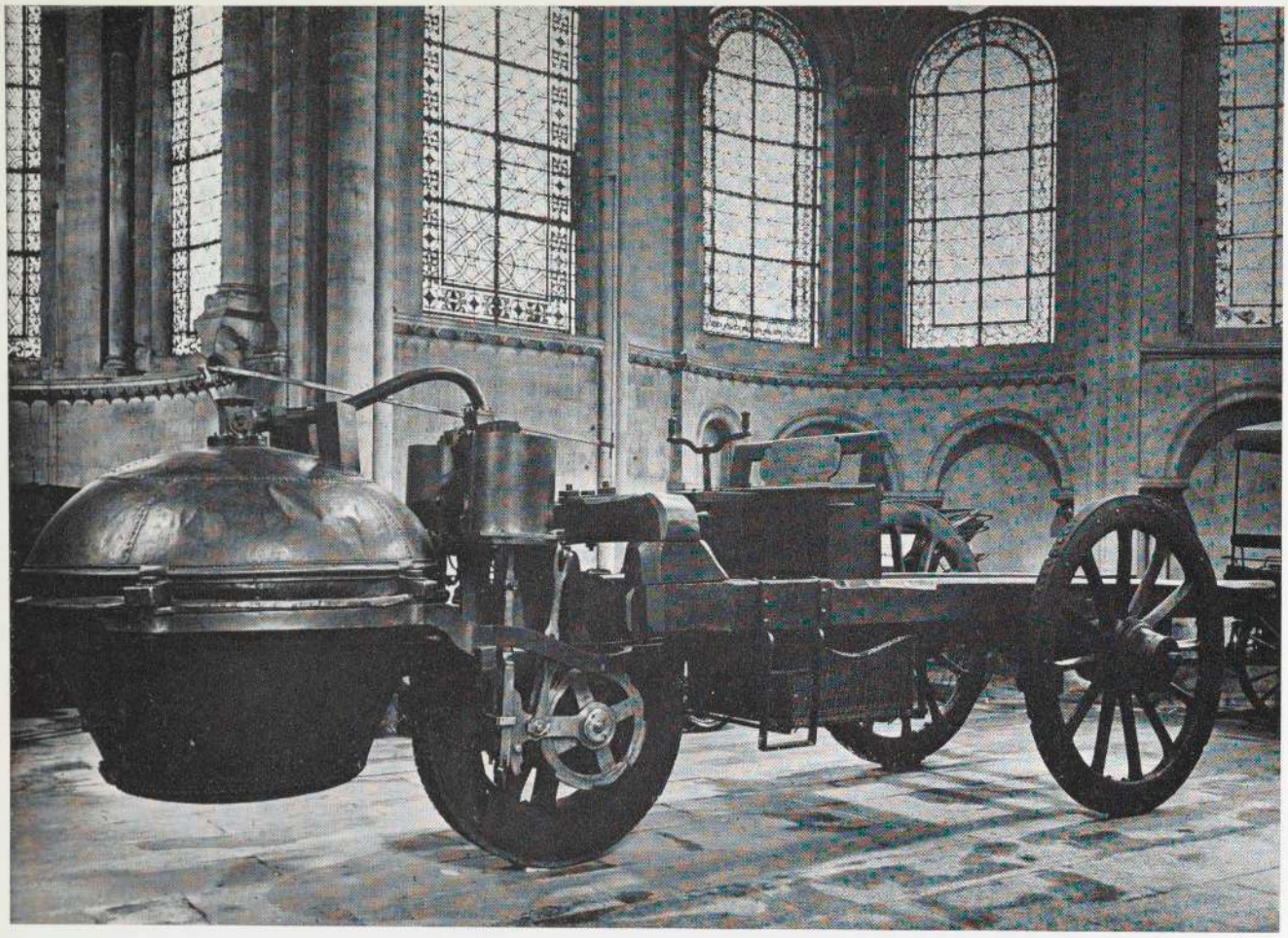
John Wilkins (1614—1672) was a prominent Puritan clergyman who tried to reconcile Copernicus' theories with Calvinist theology. He was also interested in promoting industry and navigation by the application of scientific principles and experimented with a number of technical devices, including wagons powered by sails like those on a windmill. In 1660, he was a founding member of the Royal Society.

Wilkins' *Discovery of a New World*, published in 1638, attempted to prove that there was another world of animate, rational creatures on the moon. Noting that astronomers had observed on the moon mountains and what looked like seas, he wrote: ". . . we may guess in the general that there are some inhabitants on that Plannet: for why else did Providence Furnish that place with all such Conveniences of Habitation?"[7]

The erudite Wilkins became the hero to whom were attributed a series of fantastic adventures etched by Filippo Morghen. Morghen, who is one of the earliest science-fiction artists, always kept his conceptions within the almost possible. He provided for Bishop Wilkins' transport the newest type of hydrogen balloon, invented about 1784, attaching it to the winged box and adding it over the text of the frontispiece of earlier editions.[8] In another plate, Morghen showed a "boat that has the wings of an enormous bird for sails" — a nice variant of Wilkins' invention of a sail-powered wagon.

Bird Boat (from *Raccolta delle cose più notabili . . .*, 2nd edition). 1766—1768
Etching, $10^{7}/_{8} \times 15^{1}/_{4}''$. The Metropolitan Museum of Art, New York (The Elisha Whittelsey Fund, 1949)



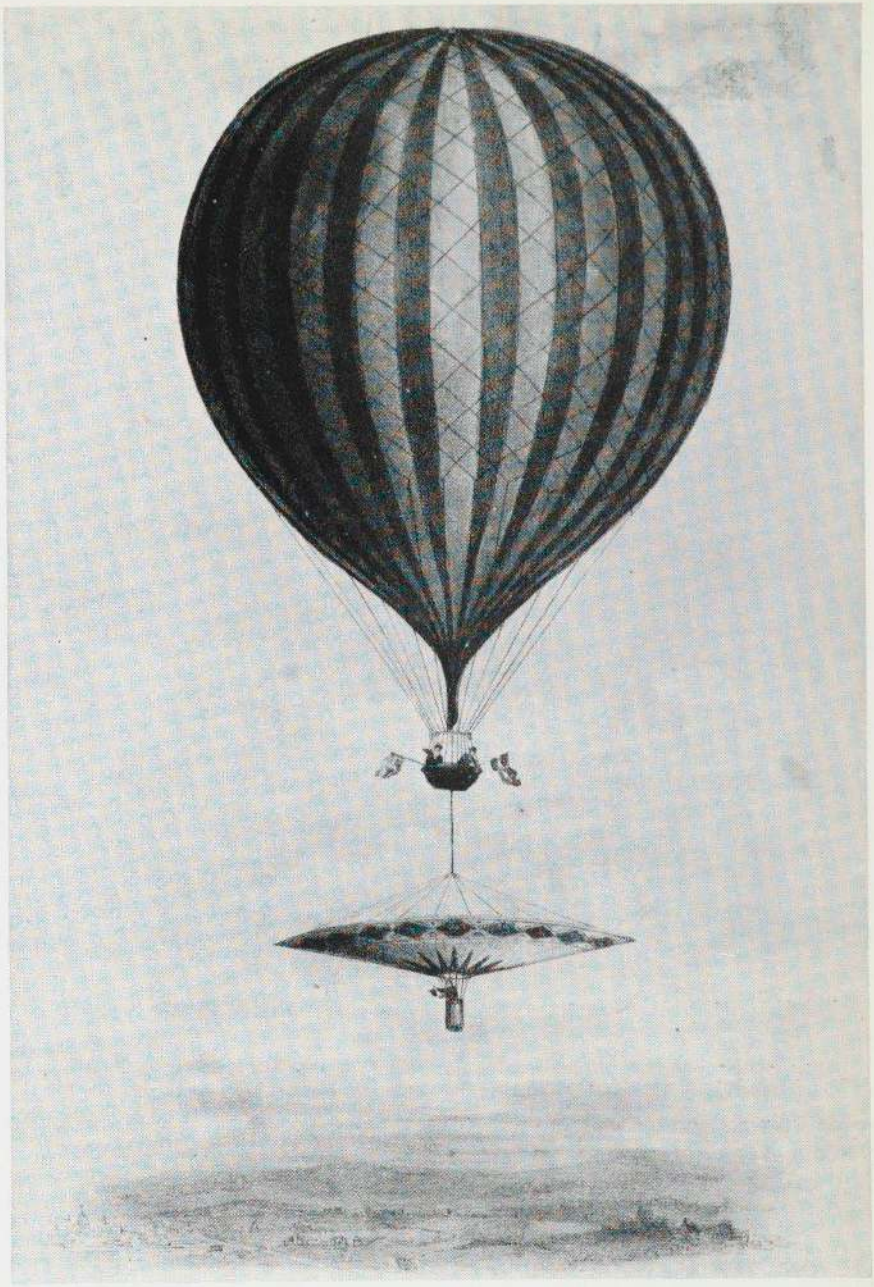


Nicolas-Joseph Cugnot. French, 1735—1804
Steam Locomotive ("the oldest self-propelled vehicle in the world"). 1770—1771
Musée du Conservatoire National des Arts et Métiers, Paris

Cugnot constructed the first locomotive cars. Little is known about his very first locomotive, except that it was meant to drag or carry artillery pieces and was built on a three-wheeled carriage, with a combustion steam-power plant operating over its single front wheel. After it was demonstrated in the presence of French army officers, in 1770 Cugnot was commissioned to construct a second, larger machine on similar principles. The car was intended to run at a speed of about a mile and a half per hour and pull four to five tons.

There seems to have been no real test run for this second locomotive, and it was never used. An astonishing lack of curiosity among the people responsible for the funds prevented it from being tried. This may have been for fear of so powerful a machine, or simply because of political events. During the Revolution, Cugnot left for Belgium but returned under Napoleon's Consulate and taught at the Arsenal. It was from there that his locomotive, ignored for thirty years, was removed in 1800 to the Conservatoire, where it still stands.

The principle of steam locomotion had nevertheless been solved, although the development of the locomotive came to a dead end in France with Cugnot's pioneering effort. The initiative passed to England, where in 1784 James Watt had taken out a patent for a steam-driven road carriage, and where in 1804 Richard Trevithick's locomotive on rails successfully completed a nine-mile run (see page 49).



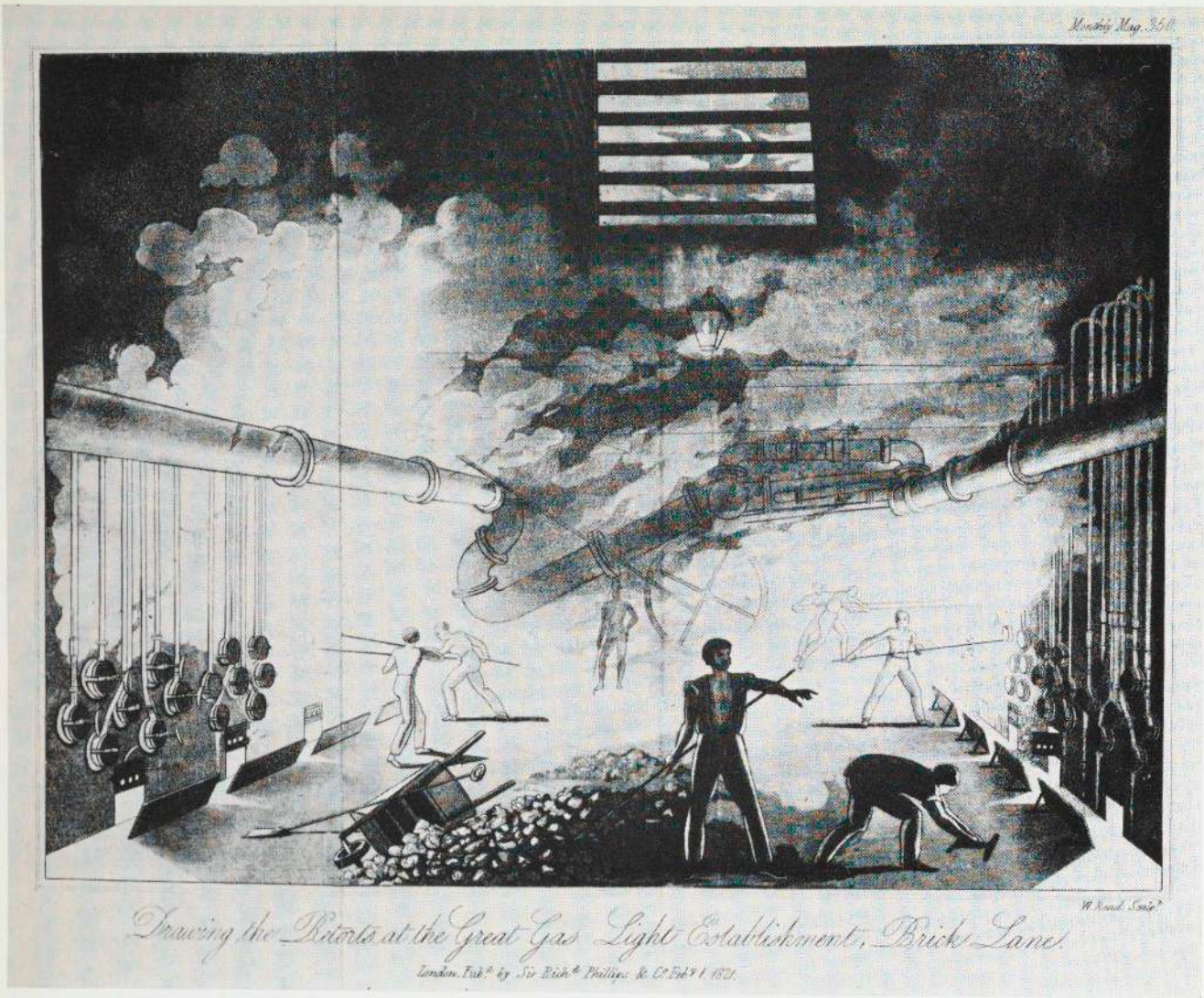
Unknown British artist
19th century
☼ *The Great Nassau Balloon with Parachute*
("The Great Nassau Balloon as it appeared from The Royal Vauxhall Gardens, Accompanied by the Parachute, in which the late unfortunate Mr. Cocking made his fatal descent, July 24th, 1837")
Hand-colored lithograph, $12^{3}/_{4} \times 7^{3}/_{4}''$
The Metropolitan Museum of Art, New York (gift of Paul Bird, Jr., 1962)

Charles Green, one of the nineteenth-century's best-known astronauts, aspired to make the first transatlantic balloon flight. His most record-breaking journey, however, was in 1836, when he covered the 480 miles from London to the Duchy of Nassau in Germany. His craft was thereafter called the "Nassau" and made a number of spectacular ascents under royal patronage.

The "Nassau" was used for one of the strangest experiments in the history of technology, recorded in this lithograph and described in the anonymous *Book of Inventions:*

Cocking had joined Green on many of his flights, and he imagined that he presented a most ingenious parachute to the world, in the form of an umbrella, turned inside out. Cocking had observed that the cloth of an umbrella always turns this way when the umbrella falls from a height. But he did not realize that this is only a consequence of air resistance, and that the convex surface of the umbrella favors the gliding of air, so that the object can more easily follow the direction of weight. Deaf to all warnings, Cocking was firmly determined to try his parachute, and Green was imprudent enough to permit this lunacy.

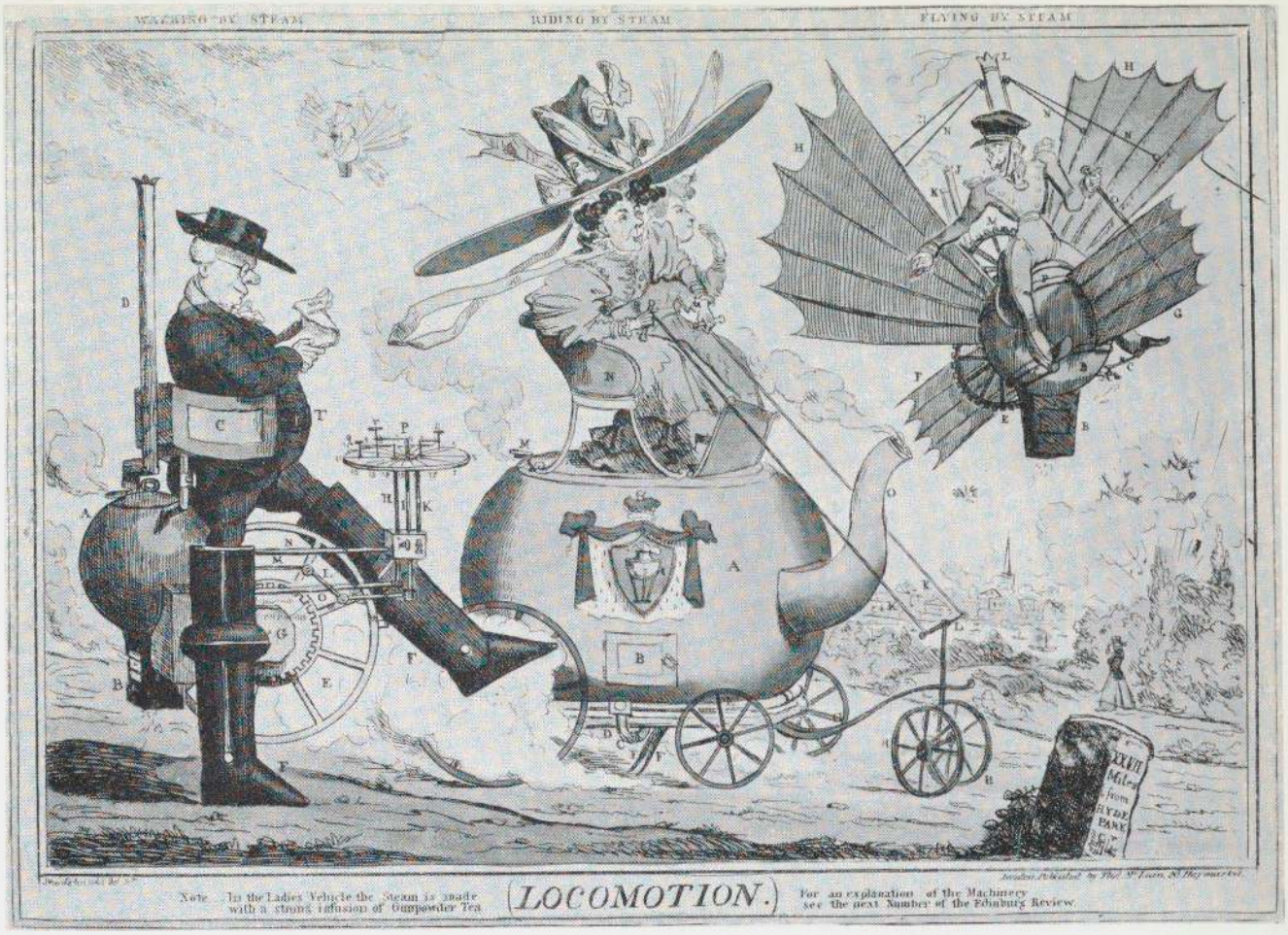
. . . the two gentlemen took off from Vauxhall in London. The luckless parachute was fastened beneath the gondola of the balloon, and Cocking took his place in a basket under it. When they had reached some 3,000 feet, Green warned him once more, but Cocking cut the rope that tied him to the balloon, and . . . plunging through the air . . . covered the whole distance, close to 3,400 feet, in a minute and a half. People rushed to the place where the parachute had fallen, and found the poor man absolutely crushed.[9]



W. Read. British, active 1821—1837
Drawing the Retorts at the Great Gas Light Establishment, Brick Lane (frontispiece from Colin Mackenzie, *One Thousand Experiments in Chemistry*. London, Sir Richard Phillips & Co.). 1821
Aquatint, $8\frac{3}{8} \times 10\frac{1}{4}$″ (sheet). Science and Technology Division, The New York Public Library, Astor, Lenox and Tilden Foundations

The curiously innocent attitude that artists of the early nineteenth century had toward the technical world is dramatically shown in this print. Conditions in the gaslight establishment must have been truly infernal, yet Read seems not to have been bothered in the least by the plight of the people working there. He has, in fact, made them look supernaturally strong and healthy, easily capable of dominating the monster machines that they serve. He seems also to have been impressed by the awesomely picturesque effects of the scene he rendered. The billowing smoke and fiery glow within the structure are like manmade parallels to the clouds and moon glimpsed through the grating.

Read's imagination did not encompass the actual human implications in the scene. He was apparently as oblivious of these as Turner was when he rushed to record in his sketchbook the spectacular burning of the Houses of Parliament in 1834.



Robert Seymour ("Shortshanks"). British, 1798—1836

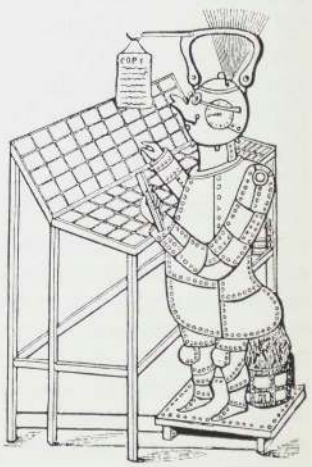
Locomotion. n.d. Hand-colored etching, $8^{1}/_{4} \times 13^{3}/_{4}''$

The Metropolitan Museum of Art, New York (gift of Paul Bird, Jr., 1962)

Most artists of the period of the Industrial Revolution were naive in their treatment of machines. The relatively few images that deal with machinery or industry are anecdotal, sentimental, or satirical. While poets or novelists were deploring the spoliation of rural England, and the slavery and degradation that mechanization was bringing to great masses of the population, artists tended to bypass these social issues.

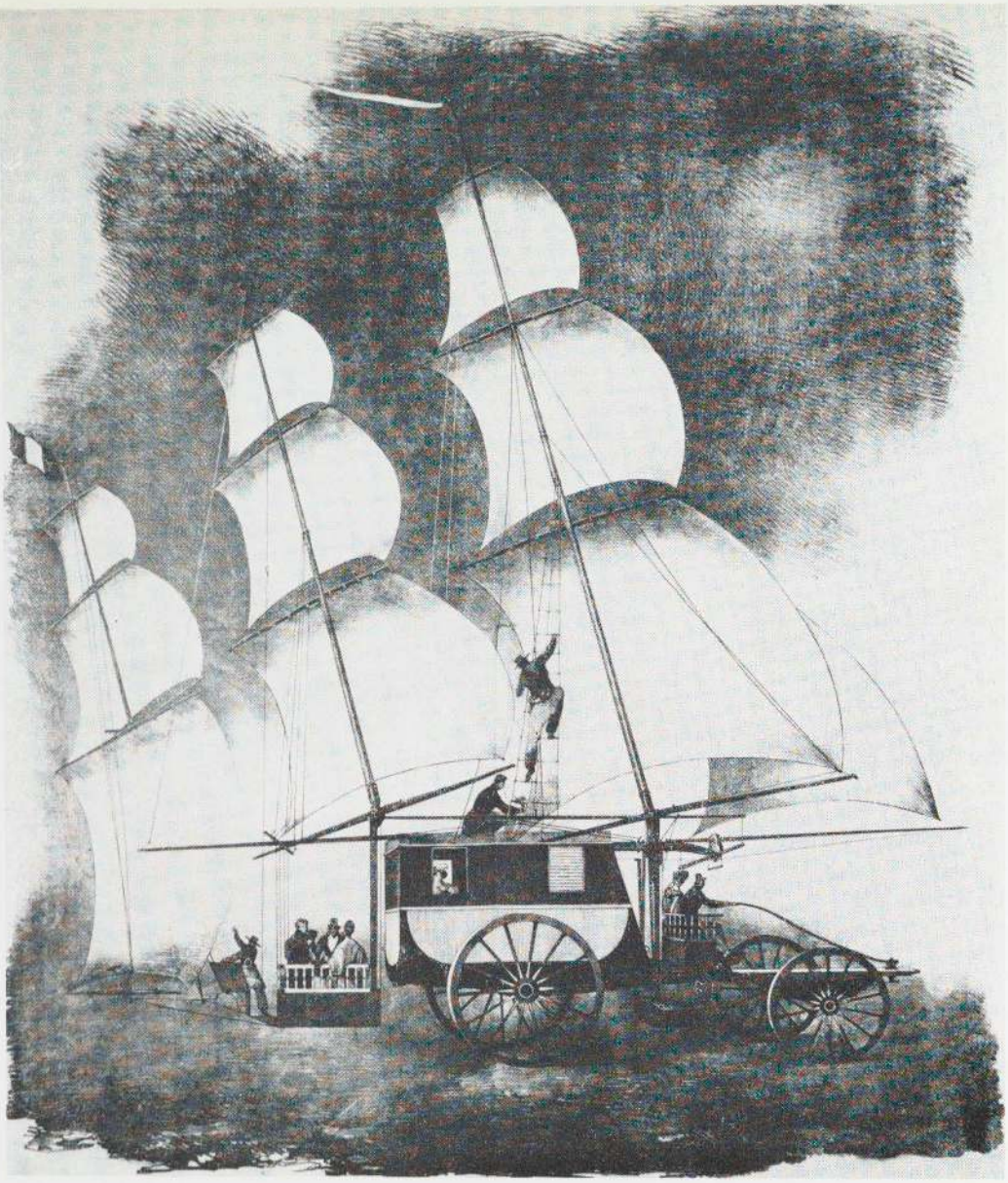
Seymour's caricature is a direct reflection of the controversies that raged in Parliament and the press from the 1820s to the 1840s over the railroad bills, which were to allow rapid expansion of railroads throughout the country. Conservative interests, tied to the earlier transport systems of inland waterways and horse-drawn coaches, feared that these new mechanical monsters would destroy their privileges.

One way of dealing with the antagonistic machine was to humanize and ridicule it. Seymour depicts steam as another refinement in the life of the rich and the idle.



Steam Typesetter (caricature from a 19th-century English printing magazine)

The Bettmann Archive

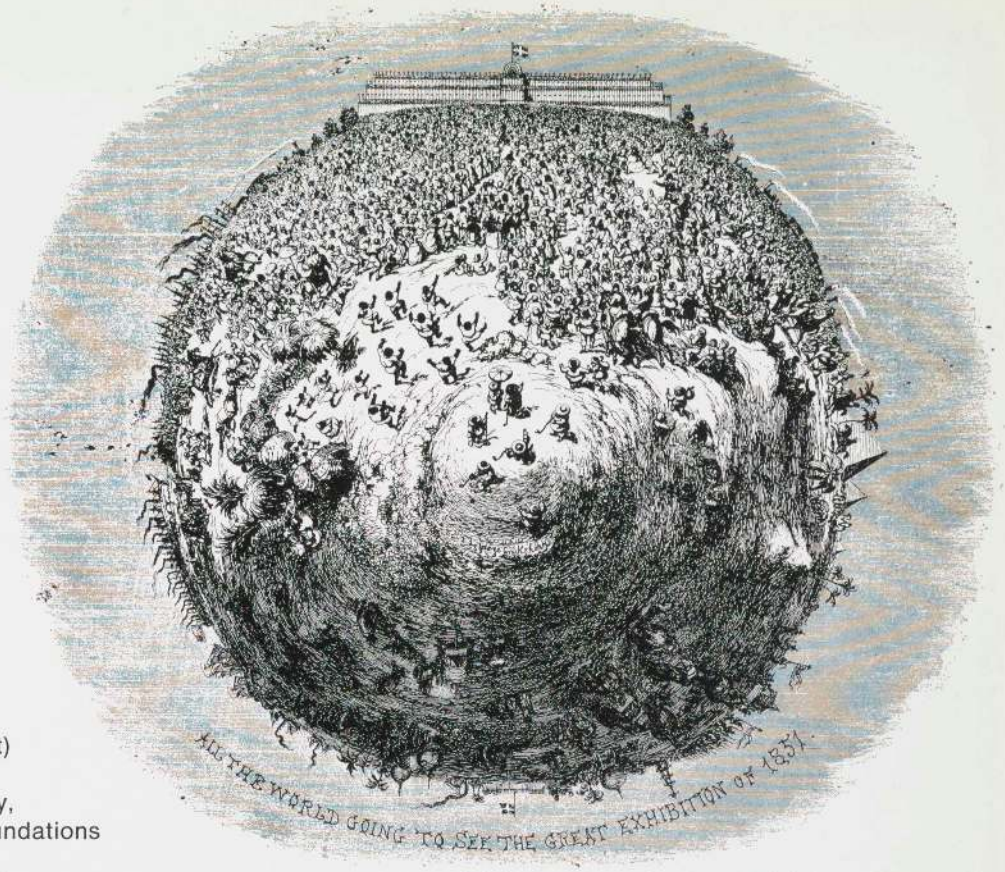


Unknown French artist
19th century
Poster for "L'Eolienne." c. 1834, destroyed
Formerly collection Charles Dollfus, Paris

By the end of the fifteenth century, sailing vessels for long-distance voyages had assumed almost the form they were to retain for another 350 years. The rapid rise of an industrial society then gave the impetus for building even swifter ships, which were rigged with as much sail as possible in order to speed up the competitive trade with China, or round Cape Horn to California after gold was discovered there. The giant clippers of about 1850, with their complicated rigging adapted to winds of many forces, represent the highest development of the sailing vessel. Ironically, they were being built just as steam was beginning to assume a dominant role.

Though the great sailing ships, with their extremely flexible and adaptable tackle, are great technological achievements, they somehow seem based on a non-mechanistic conception. They derive their power by operating in direct collaboration with the wind, whereas steamboats, by applying another source of energy, seem intent on defying and subjugating natural forces.

From about 1600 on, there were many attempts to use sails for locomotion on land. A very ambitious effort was that made by M. Hacquet of Paris, who constructed the "Eolienne" in 1834. The wagon is reported to have had two successful tryouts in September of that year.



George Cruikshank
British, 1792—1878
All the World Going To See the Great Exhibition of 1851 (illustration for *The Adventures of Mr. and Mrs. Sandboys and Family . . .* Part I)
London, 1851
Etching, $11^{6}/_{8} \times 16^{7}/_{8}$″ (sheet)
Prints Division,
The New York Public Library,
Astor, Lenox and Tilden Foundations

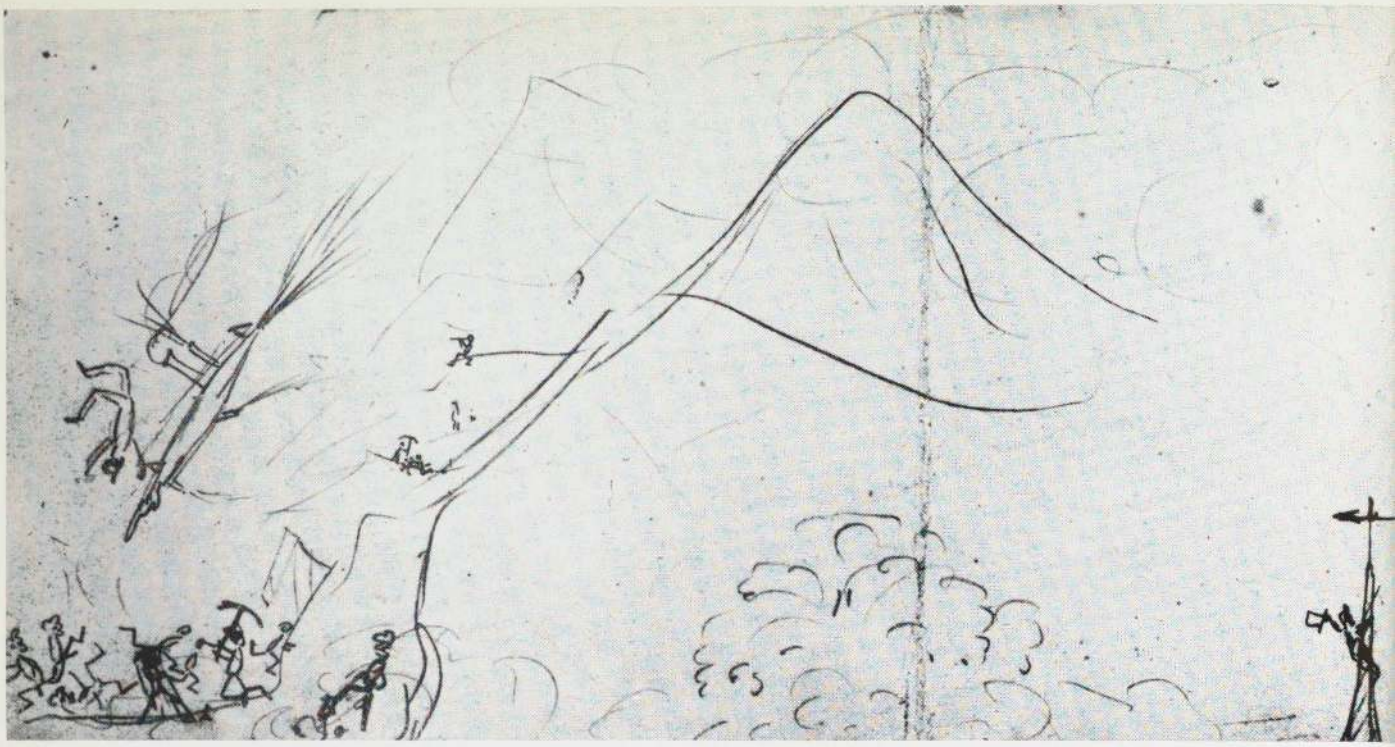
Almost all the world did. "The Great Exhibition of the Works of Industry of All Nations" was the first industrial fair of international scope, and over 6,000,000 visitors came. They saw more than 100,000 items, presented by 13,937 exhibitors and ranging from the Koh-i-Noor diamond to a "comic electric telegraph and key-board" that used facial movements to indicate letters and words. The total effect could be overwhelming. "I find I am 'used up' by the Exhibition. I don't say there is nothing in it; there's too much," sighed one visitor — Charles Dickens.[10]

This was the first time that industry, machines, and industrial materials ranked side by side with the arts. Besides divisions devoted to the fine arts and "miscellaneous," there were divisions for raw materials, machinery, textiles, and metallic, vitreous, and ceramic manufactures. The exhibition was a true manifestation of the nineteenth century's faith in progress. The Prince Consort, Chairman of the Royal Commission, declared: ". . . man is approaching a more complete fulfilment of that great and sacred mission which he has to perform in this world. His reason being created after the image of God, he has to use it to discover the laws by which the Almighty governs his creation, and . . . conquer Nature to his use . . . The Exhibition of 1851 is to give us a true test of the point of development at which the whole of mankind has arrived in this great task . . ."[11]

The exhibition was to be the model for a long series of world's fairs, perhaps the most typical expressions of the century's materialistic evolution. All the newest technical achievements were to be shown at these fairs, but their art sections were, without exception, horrifying displays — an evidence of the meretricious standards of official taste prevailing at the time.

The construction of the great iron and glass Crystal Palace that housed the exhibition was a truly astonishing feat. Joseph Paxton made his first sketch for it in June, 1850; construction began in September; and it was completed the following January. The length of its main building was 1,851 feet, to correspond with the year of its erection. The whole building was dissected by Paxton into a simple system of small, prefabricated units put together on the site. Siegfried Giedion has written of it:

The possibilities dormant in modern industrial civilization have never since, to my knowledge, been so clearly expressed . . . . In the Crystal Palace an artistic conception outdistances the technical possibilities of the era — something which is very rare in the nineteenth century. . . . The curious association of an unmistakable grandeur with a certain gentleness was never again to be achieved. From now on, development will come for decades at the hands of the engineer. He will achieve the new solutions.[12]



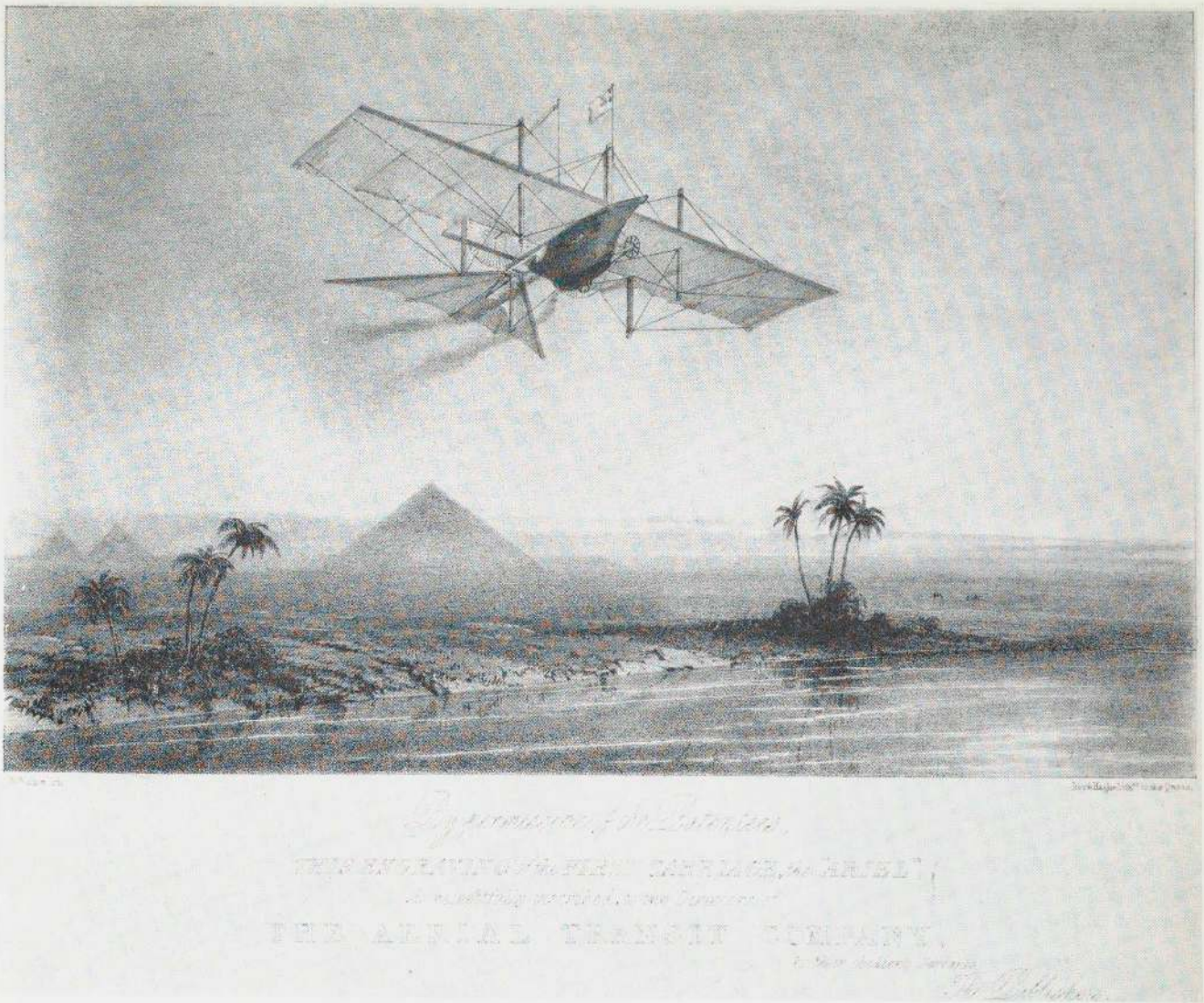
Winslow Homer. American, 1836—1910
Rocket Ship. 1849
Pencil, $3^{3}/_{4} \times 15^{1}/_{8}''$
Museum of Fine Arts, Boston (gift of Edwin A. Wyeth)

Winslow Homer drew this rocket ship at the age of thirteen. It advances through the skies at an incredible speed. Homer's imagination, which foreshadows Jules Verne's science fiction, is accurate as well as fantastic: though the machine has an animal's snout, it is clearly jet-propelled. In the left corner of the drawing, the space rider crashes. The exactitude and wealth of detail are typical of a child's conception of life and his sense of realism.

From another starting point, Mr. Golightly is borne through the air by his "new patent, high pressure, Steam Riding Rocket." The names of the patent holders are Quick and Speed. The craft seems far more plausible than the one labeled "Flying by Steam" in Seymour's almost contemporanous *Locomotion* (page 27). This steam-powered machine is functional in its construction, and even Mr. Golightly himself is streamlined.

If Homer's drawing marks a high point of childish imagination, Mr. Golightly purports to represent "The Flight of Intellect," or at least of constructive engineering thought. The results are strikingly similar.

Unknown British artist. Mid-19th century
The Flight of Intellect ("Portrait of Mr. Golightly experimenting on Mess. Quick & Speed's new patent, high pressure Steam Riding Rocket")
Lithograph, G. E. Madeley, London. n.d. $8^{1}/_{2} \times 11''$
Princeton University Library, Princeton, New Jersey (Harold Fowler McCormick Collection of Aeronautica)



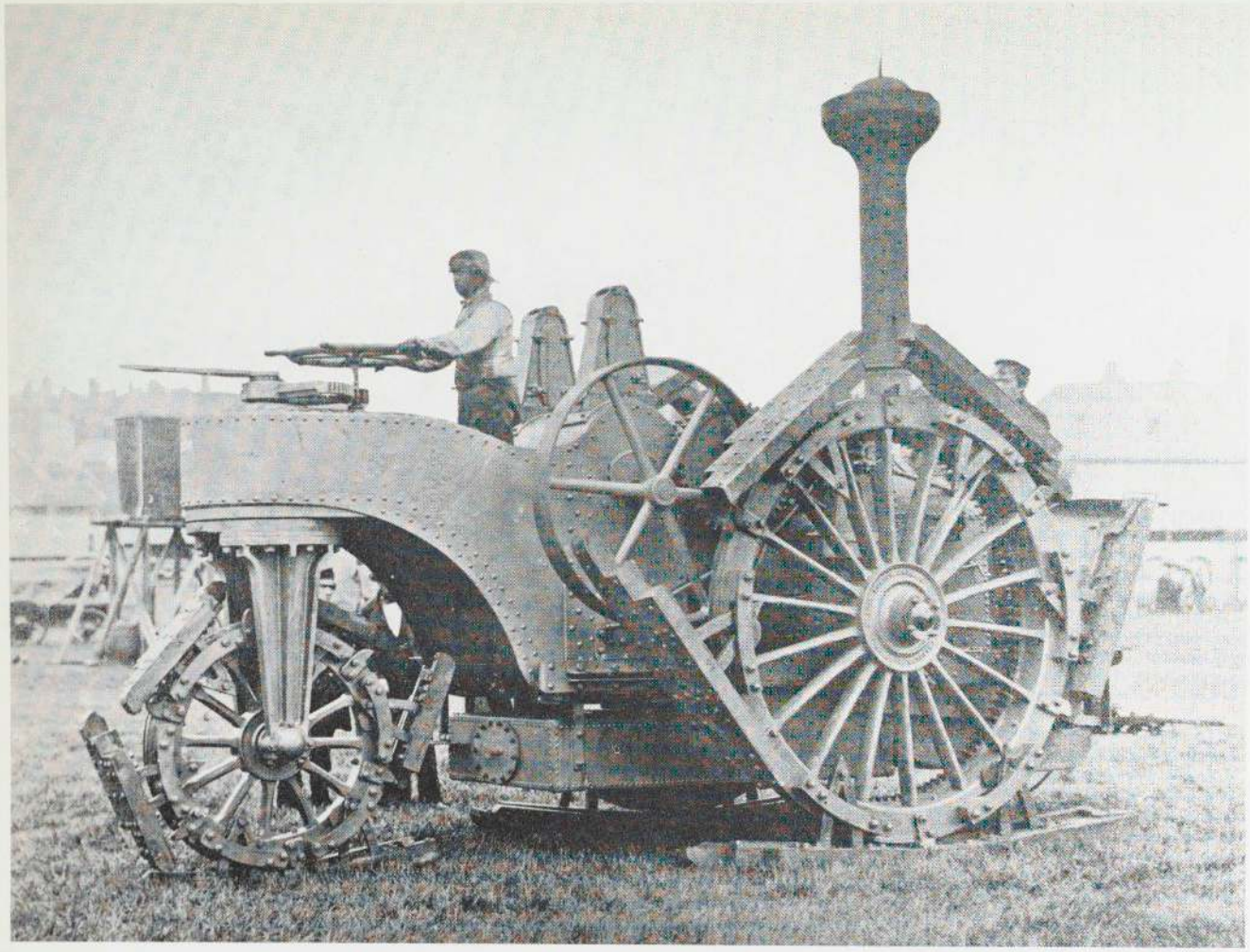
W. L. Walton. British, active 1834—1855

Aerial Steam Carriage ("First Carriage, the 'Ariel,' The Aerial Transit Company"). Published by Ackermann and Co., March 28, 1843
Colored lithograph, $8^{3}/_{4} \times 5^{5}/_{8}$″
The Metropolitan Museum of Art, New York
(gift of Paul Bird, Jr., 1962)

In 1843, posters were distributed all over London, depicting an enormous air locomotive flying over the Egyptian pyramids and the distant shores of India and China. They advertised the newly organized "Aerial Transit Company" for regularly scheduled departures to all parts of the world. The year before, William Samuel Henson had applied for a patent for a "Locomotive Apparatus . . . for Conveying Letters, Goods, and Passengers from Place to place through the Air."

To Henson, born and raised in England when the first railway was under construction and the first steam vessels crossing the Atlantic, steam was the natural solution to propulsion. His ideas on aviation were based on studies by Sir George Cayley (1773—1853), who had written on aerial navigation and built gliders.

With its slightly arched wings, screw propellers, and birdlike tail section, the "Ariel" looks surprisingly modern; and indeed, Henson was a true pioneer in the field of heavier-than-air craft, having been the first to envisage the modern propeller-type monoplane. But "Ariel" could never leave the ground, for its engine was far too heavy. After many near successes and final failures, Henson gave up in disgust. This curious large-scale advertising campaign anticipated by almost a quarter of a century the formation of the Aeronautical Society of Great Britain in 1866 and was the premature expression of a dream that was not to come true for almost a century.



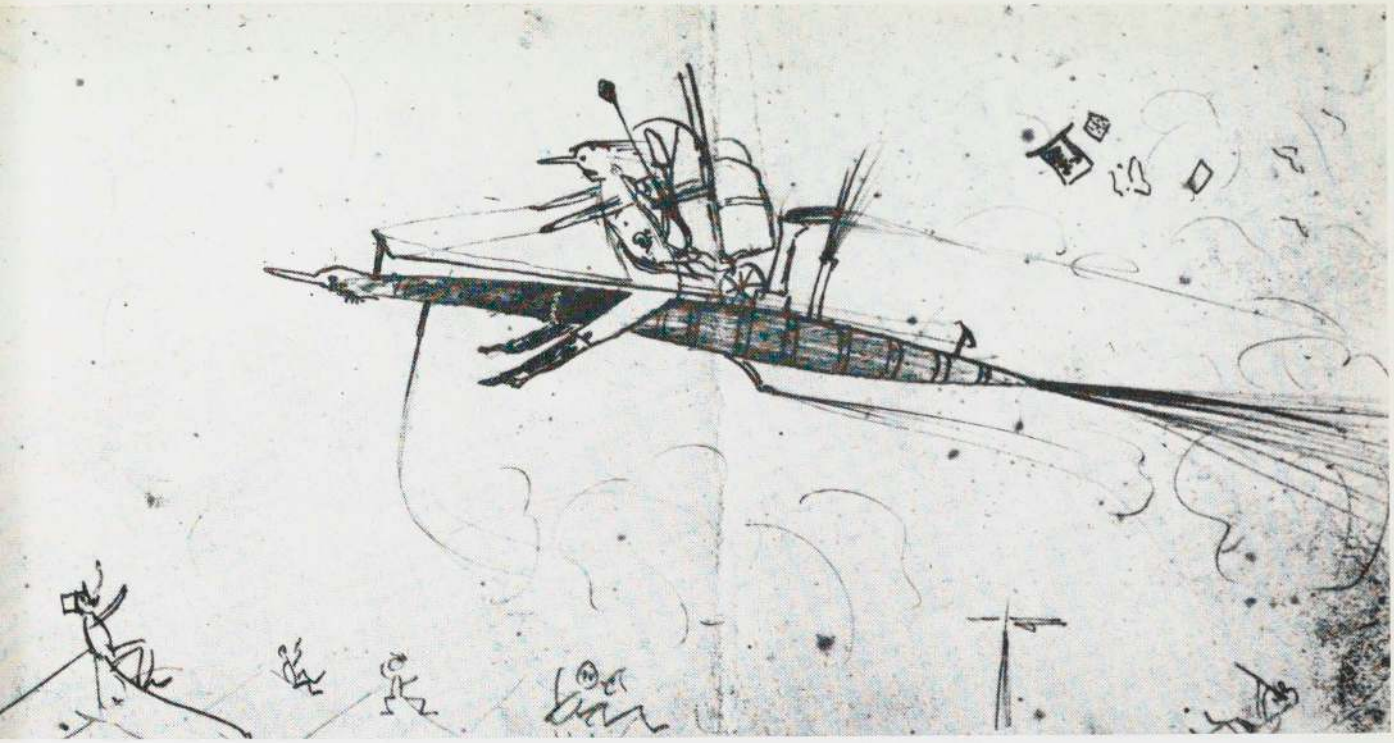
James Boydell. British, 1803—1859

Traction engine. Photograph by Spencer. 1857
Photograph, $6^1/_2 \times 8^1/_2''$
Science Museum, London

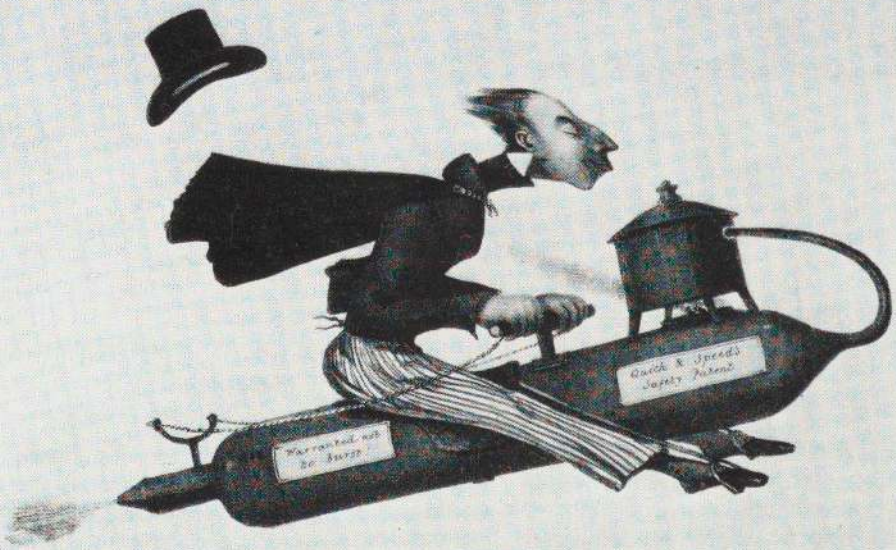
This photograph of Boydell's steam-driven tractor engine is the earliest photograph of an "automobile" — a self-powered car. Boydell had invented a system of transverse paddles to be applied to wheels covering difficult terrain; he perfected and adapted it to be used by tractors in ploughing or hauling military wagons.

Perhaps never since the Renaissance have men felt more unconditionally certain of their capacities than did the engineers of the nineteenth century. Their faith in progress and steady development was limitless.

There is something fabulous in this aspect of modern history; the men are acclaimed heroes and the machines, as they quickly become obsolete, are consecrated not only in museums but in the affections of the public. There is a characteristic expression on the faces of the men in these photographs, one of pride, determination, faith. However optimistic the invention may be, the inventor-operator shows no sign of doubt when faced by the camera: even in failure he cannot be made to feel ridiculous.[13]

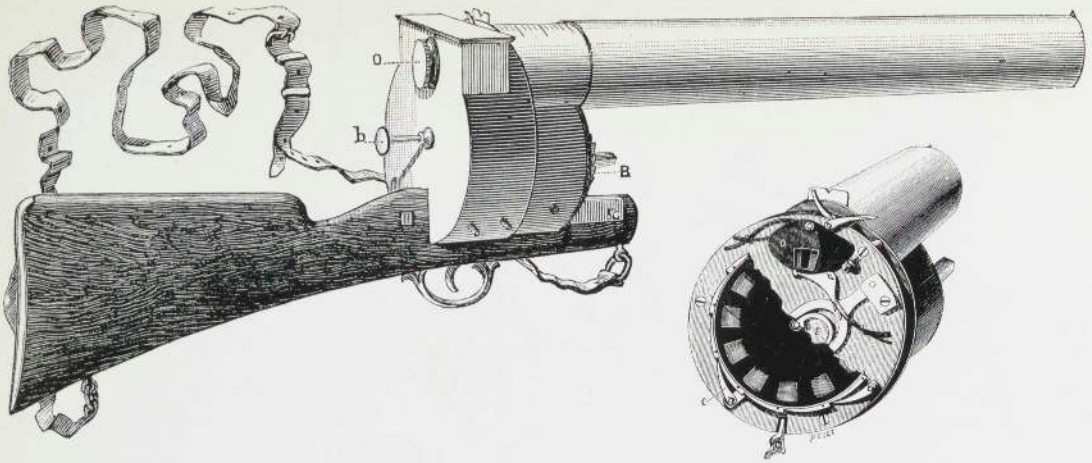


THE FLIGHT OF INTELLECT.



Portrait of Mr. GOLIGHTLY,
experimenting on Mess. Quick & Speed's new patent high pressure,
STEAM RIDING ROCKET.

Pub. by C. Tilt, Fleet St.

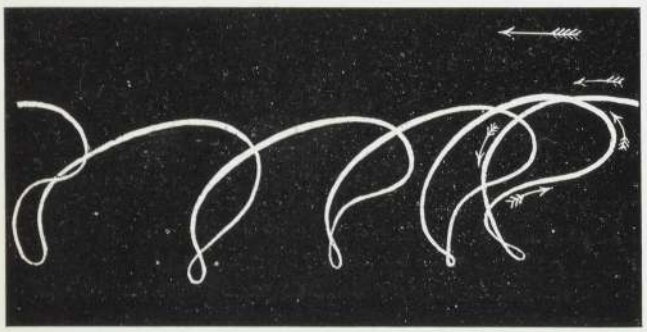


Etienne-Jules Marey. French, 1830—1904
Camera gun. Original, 1882;
reconstruction by Coutant, Paris, 1967
(*not illustrated*), 33 1/2″ long
Musée du Cinéma, Brussels

Camera gun and interior of mechanism (from E.-J. Marey, *La Méthode graphique*, 1885)

Camera gun in use (from E.-J. Marey, *Le mouvement*, 1894)

Photographic trajectory of tip of crow's wing (from E.-J. Marey, *Le vol des oiseaux*, 1890)

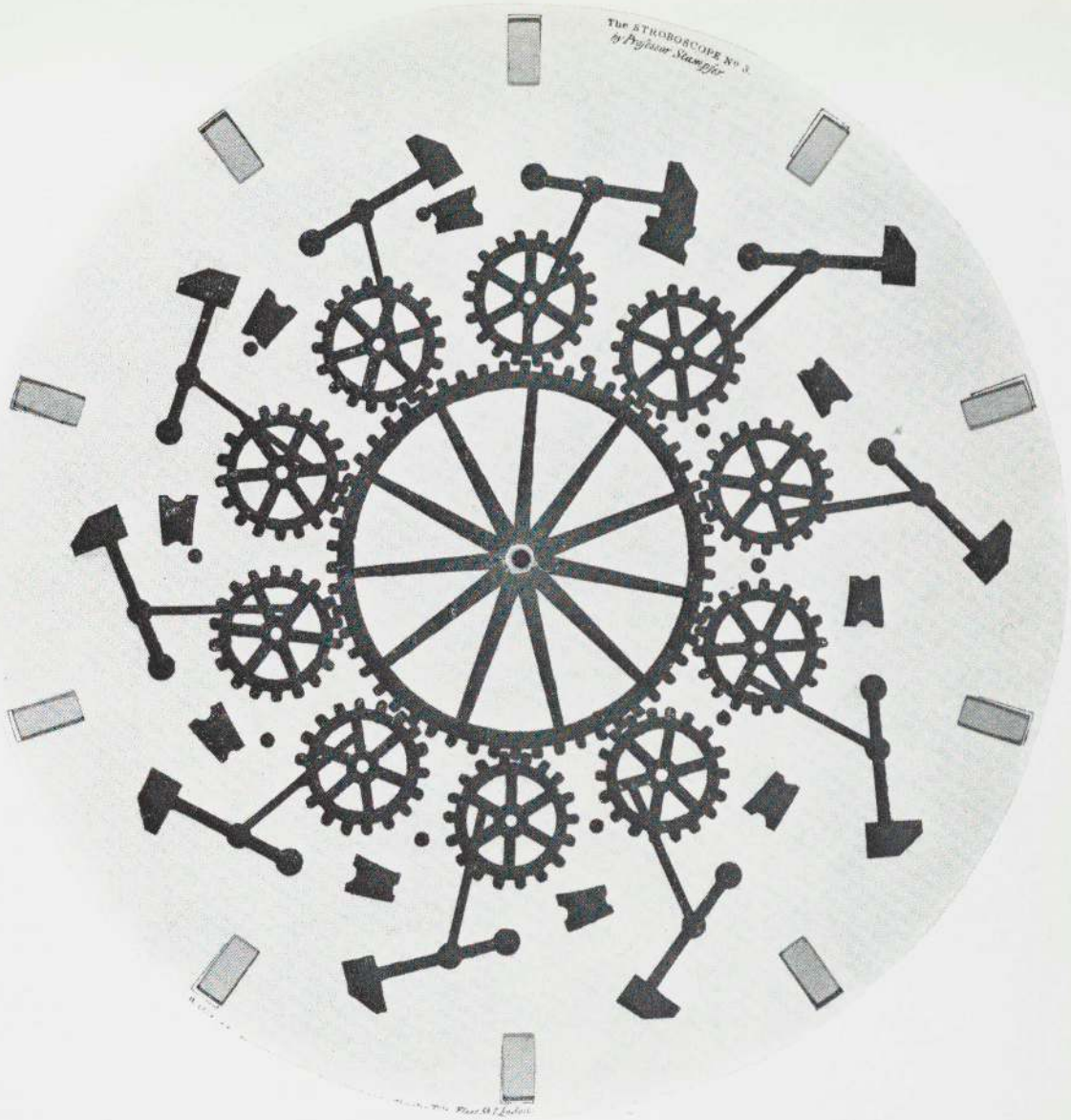


Marey, a physiologist, was the first scientist to devote himself to the study of movement, which he investigated in all its forms: in the bloodstream, the muscles, the gaits of horses, the flight of insects and birds. His fascination with the subject to which he devoted a lifetime of research led him to invent a series of apparatus for observing and recording movements that for one reason or another the eye cannot perceive. Siegfried Giedion said of Marey: "This scientist sees his objects with the sensibility of a Mallarmé."[14]

The evolution of flying machines was directly dependent on Marey's discoveries. In 1872, while studying the flight of birds, he built a working model of a monoplane with two propellers driven by a compressed air motor.

Marey constructed his photographic gun in 1882 so that he could register the successive stages of a bird's flight. The barrel houses a camera lens. The plates are carried on a revolving cylinder and changed by the action of a trigger, which permits twelve exposures a second.

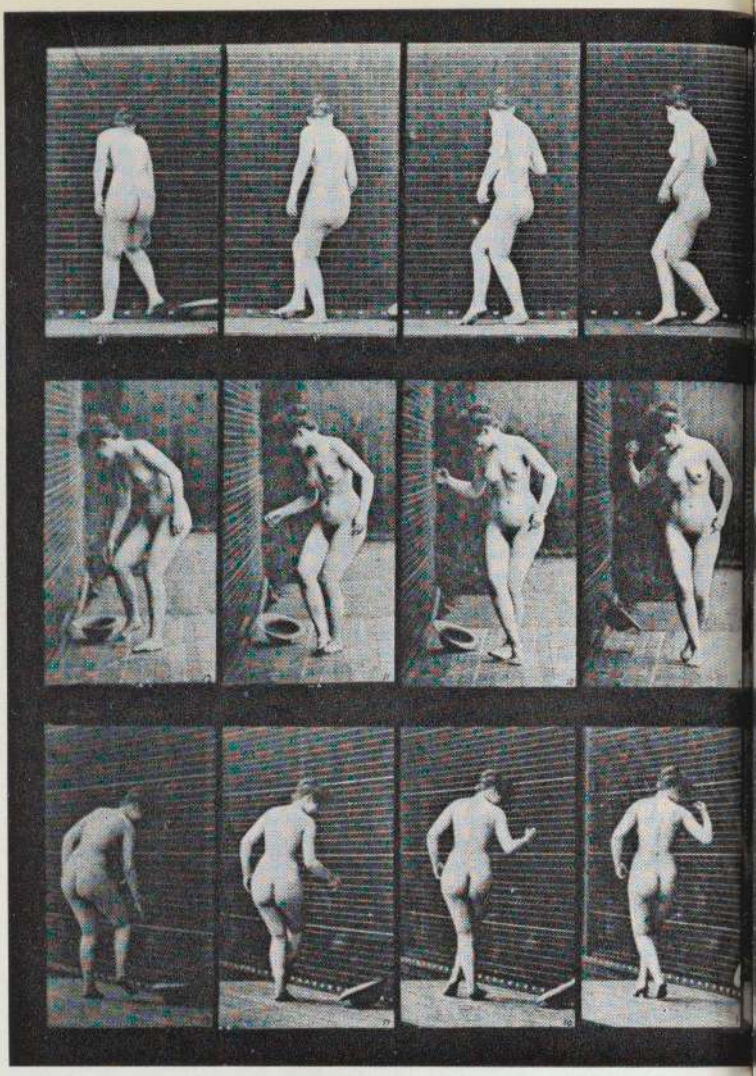
Marey's methods differ considerably from those of Muybridge (pages 38—39). Marey wanted to synthesize on a single plate successive movements as seen from a single point of view by a lens that followed the trajectory of the subject. Muybridge set up his cameras side by side, so that each one in the row caught an isolated sense of movement. These two approaches are somewhat similar to those of the Cubists and Futurists in their rendering of movement and space.



Simon Ritter von Stampfer. Austrian, 19th century
Stroboscope disc, No. 3. Published in London, c. 1832
Cardboard, 11″ diameter. Science Museum, London

During the nineteenth century, a variety of optical toys were invented. Based on the phenomenon of the persistence of vision, they can all be considered forerunners of the true moving-picture film.

One of these devices was a type of instrument invented independently in 1832 in France by Joseph Plateau, who called his apparatus the "phenakistoscope," and in Vienna by Stampfer, a professor of geometry, who named his the "stroboscope." It consists of a disc carrying on its surface a series of images, such as these hammers and wheels, in slightly different positions. When the disc is rotated rapidly, a spectator looking at it in a mirror through slots in the disc's periphery will see what appears to be continuous movement — in this case, the hammer falling on the anvil and rising again. The design of this machinery is rather unusual. Most of the preserved stroboscope discs show men riding, soldiers, couples kissing or dancing — in short, the subjects most often seen on motion-picture or television screens today.



Eadweard Muybridge. British, 1830—1904

Kicking a Hat. 1885 (published as Plate No. 367 in *Animal Locomotion*, 1887)
Collotype, $7^1/_2 \times 16^1/_4''$
The Museum of Modern Art, New York

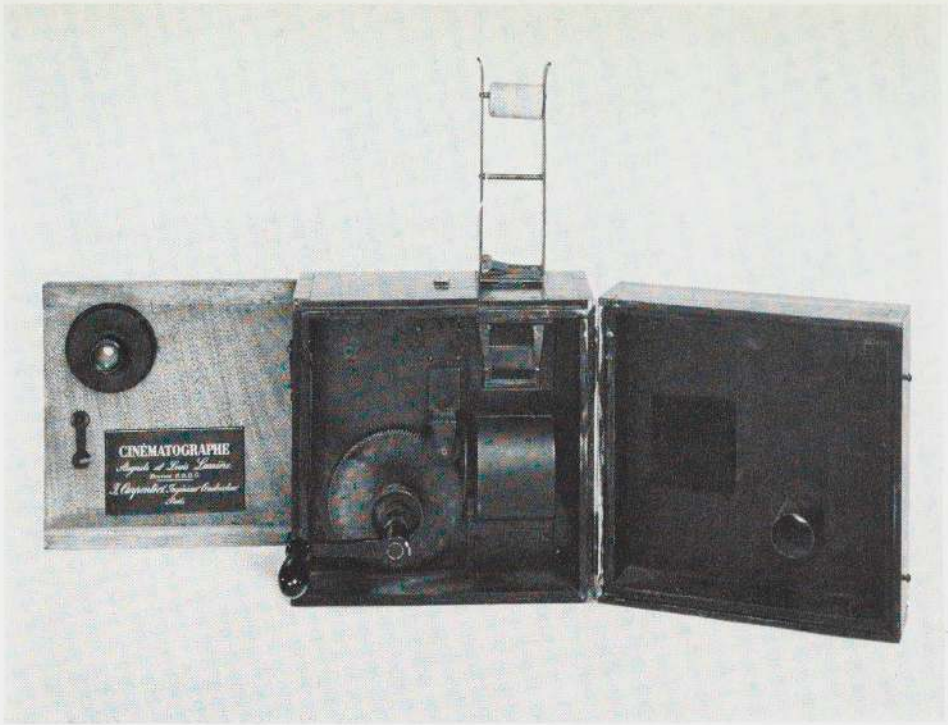
Zoopraxiscope. Original 1880; reconstruction by Robert A. Fox, 1962; with original glass disc (gift of the Kingston on Thames Public Library)
15″ high (without base)
George Eastman House, Rochester

Eadweard Muybridge's straightforward photographic studies of motion were originally motivated by an interest quite different from Marey's scientific researches. His reputation and experience as a photographer for the United States government led the ex-Governor of California, Leland Stanford, to commission him in 1872 to take photographs of a race horse of which he was especially proud. The famous story that Stanford wished to win a bet about whether a galloping horse ever has all his feet off the ground simultaneously seems unfortunately to be apocryphal; however, Muybridge's photographs did in fact establish that, at one stage of the gallop, all the horse's feet do leave the ground and are bunched below his belly. In 1878 Muybridge attained the desired results by ranging a battery of cameras alongside a race track. Their high-speed shutters were released by strings stretched across the track, which were broken as the horses rushed past.

Later, Muybridge expanded his researches to study the movement of other kinds of animals, and of men, women, and children. He also devised an apparatus that enabled him to show the consecutive frames of his photographs in motion. His "zoopraxiscope," introduced in 1880, resembled Stampfer's stroboscope in that drawings based on photographs were mounted around the periphery of a disc made of glass. A second slotted disc was mounted in front of it, and when the two discs were rotated in opposite directions in front of a magic lantern, images flashed on the screen in rapid succession appeared to be in continuous motion. This invention made Muybridge famous, and he toured Europe and England demonstrating it to learned societies.

In Paris in 1877, Emile Reynaud began experimenting with hand-painted strips of film, which he eventually succeeded in projecting onto a screen. For a time he enjoyed great public success with his "Théâtre Optique" entertainments, but around 1911 the development of the motion picture resulted in so little interest in his marvelous cartoon films that he destroyed his projector and threw his films into the Seine in despair.

The photographic studies of movement begun by Muybridge have been important to artists from his day to our own. His contemporary, Thomas Eakins, had some



Lumière Brothers

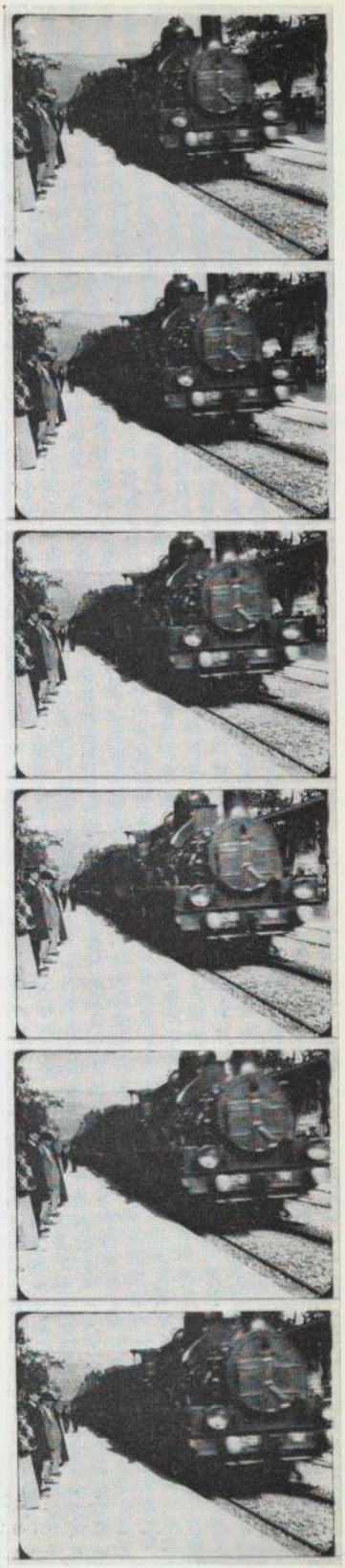
French; Auguste 1862—1954, Louis 1864—1948

Cinématographe. 1895
Combination camera, projector, and printer, 8″ high
George Eastman House, Rochester

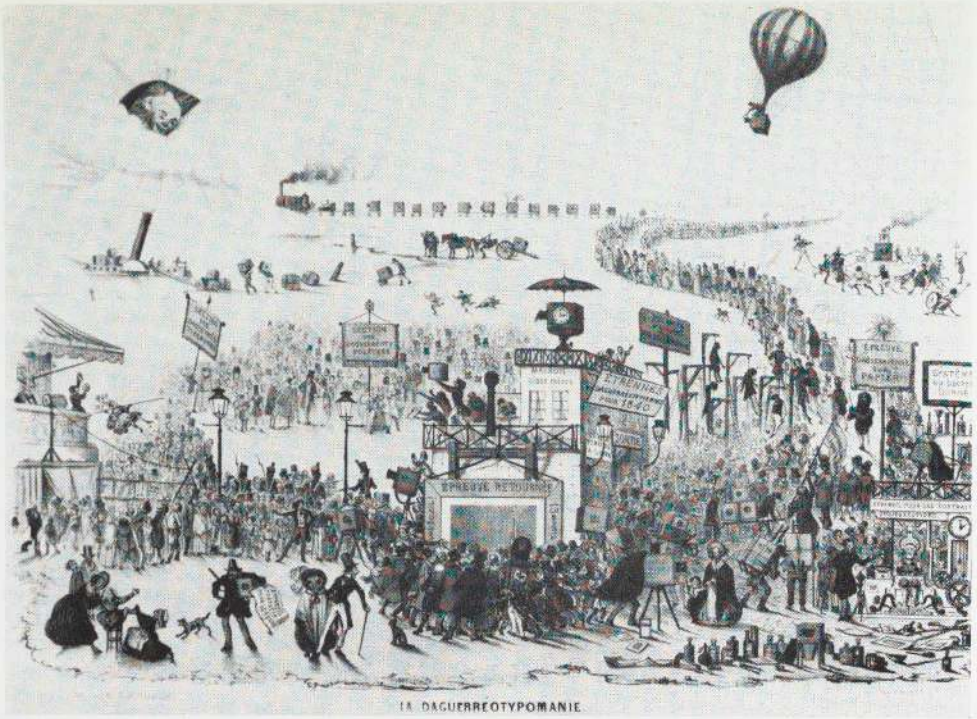
The first public presentations of Lumière's Cinématographe took place in the foyer of the Paris Opera in January, 1896; but an invited audience attended a preview on December 28, 1895. Among the guests was Georges Méliès, director of the Théâtre Robert-Houdin, who some twenty years later wrote this account of the event:

The other invited guests and I found ourselves before a little screen . . . and after a few moments a photograph of the Place Bellecoeur at Lyons was projected. Somewhat surprised, I just had time to say to my neighbor: "They've put us to all this bother for nothing but a magic-lantern show. I've been doing those for years." Scarcely were the words out of my mouth, when a horse dragging a truck began to walk toward us, followed by other wagons, then by pedestrians — in a word, the whole life of the street. At this spectacle we remained open-mouthed, stupefied, and surprised beyond words.

Then came in succession The Wall, *crumbling in a cloud of dust,* The Arrival of a Train, Baby Eating His Soup, *trees bending in the wind, then* Closing Time at the Lumière Factory, *finally the famous* Sprinkler Sprinkled. *At the end of the performance, delirium broke out, and everyone asked himself how it was possible to obtain such an effect.*[15]



Frames from "Arrival of a Train" ("Un Train arrive en gare"). 1896



Théodore Maurisset
French, active 1834—1859
The Daguerrotype Craze (La Daguerréotypomanie)
1839
Color lithograph, $9^3/_4 \times 13^1/_2''$ (composition)
George Eastman House, Rochester

This, the first caricature of photography, has been described by Beaumont Newhall, Director of George Eastman House:

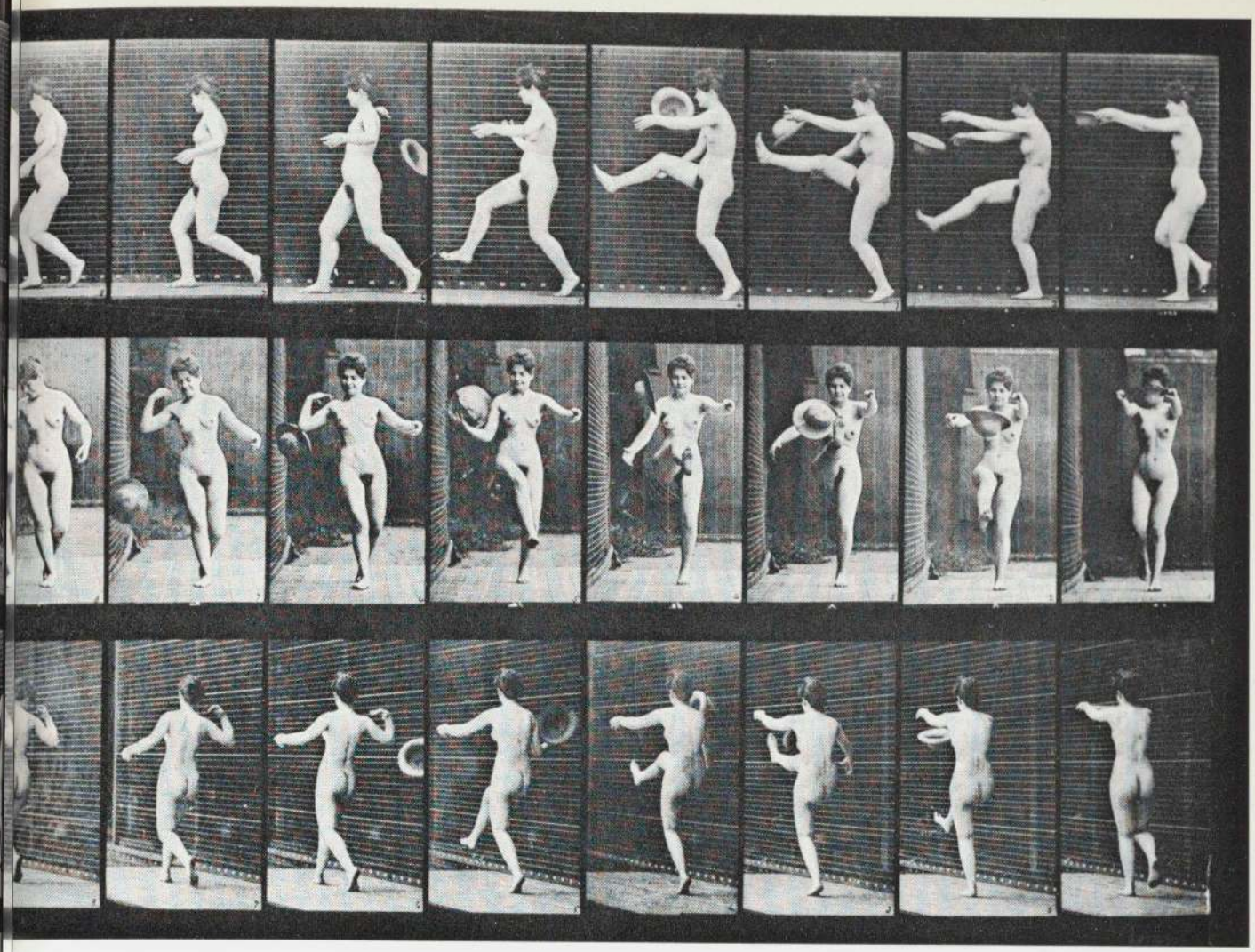
Photography was news when the French lithographer Maurisset made fun of the first camera fans in this print of 1839. In the center of the caricature a gigantic frame is marked "Without Sun! Delivered Proof 13 Minutes." From the side door of the studio marked "Exit" people surge forth beneath the signs "Windows to Rent" and "Daguerreotype New Year's Gifts for 1840." Beyond the building another sign announces "Gallows to Rent to Engravers." The first photo fans pass by in procession, carrying the banner "Down with Aquatint," a form of engraving which Dr. Donné, hidden beneath a focusing cloth, is making by photography. Underneath a victim is pilloried in a "Machine for Daguerreotype Portraits," while a clock, with madly swinging pendulum, ticks off the minutes of exposure. The procession marches past a festive group dancing around a fuming mercury developer. Everywhere there are cameras. On wheelbarrows, carts, railroad cars, steamboats. Packed on heads, shoulders, backs, under the arm ("Portable Camera for Traveling"). Set on tripods, roofs, and even swung from a balloon. Marked "300 Francs Complete." Focused on an unwilling child, on a tightrope dancer, while crowds look on bearing banners "Section of Daguerreotype Haters" and "Section of Daguerreotype Lovers." Over this animated scene King Sol, a reflector for a crown, smiles benignly.[17]

Honoré Daumier. French, 1808—1879
Nadar Elevating Photography to the Heights of Art (Nadar élevant la Photographie à la hauteur de l'Art, from *Souvenirs d'Artistes,* No. 367). 1862
Lithograph (second state), $10^1/_2 \times 8^3/_4''$
The Metropolitan Museum of Art, New York (Harris Brisbane Dick Fund, 1926)

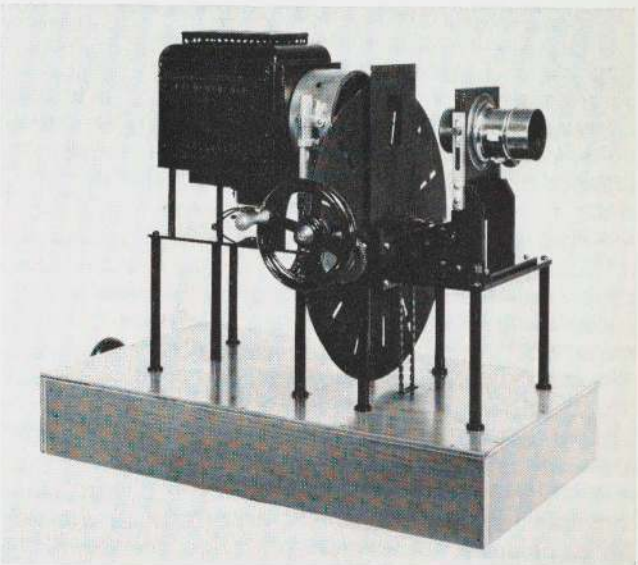
The balloonist with a camera in the upper right of Maurisset's caricature was a fantasy, but prophetic. The first man who actually ascended in a balloon to take photographs was Nadar, in 1856. Daumier's lithograph refers both to Nadar's twin interests, aeronautics and photography, and to the controversy that raged throughout the second half of the nineteenth century: Was photography suited only to recording fact and documenting events such as the Crimean War, or was it truly an art?

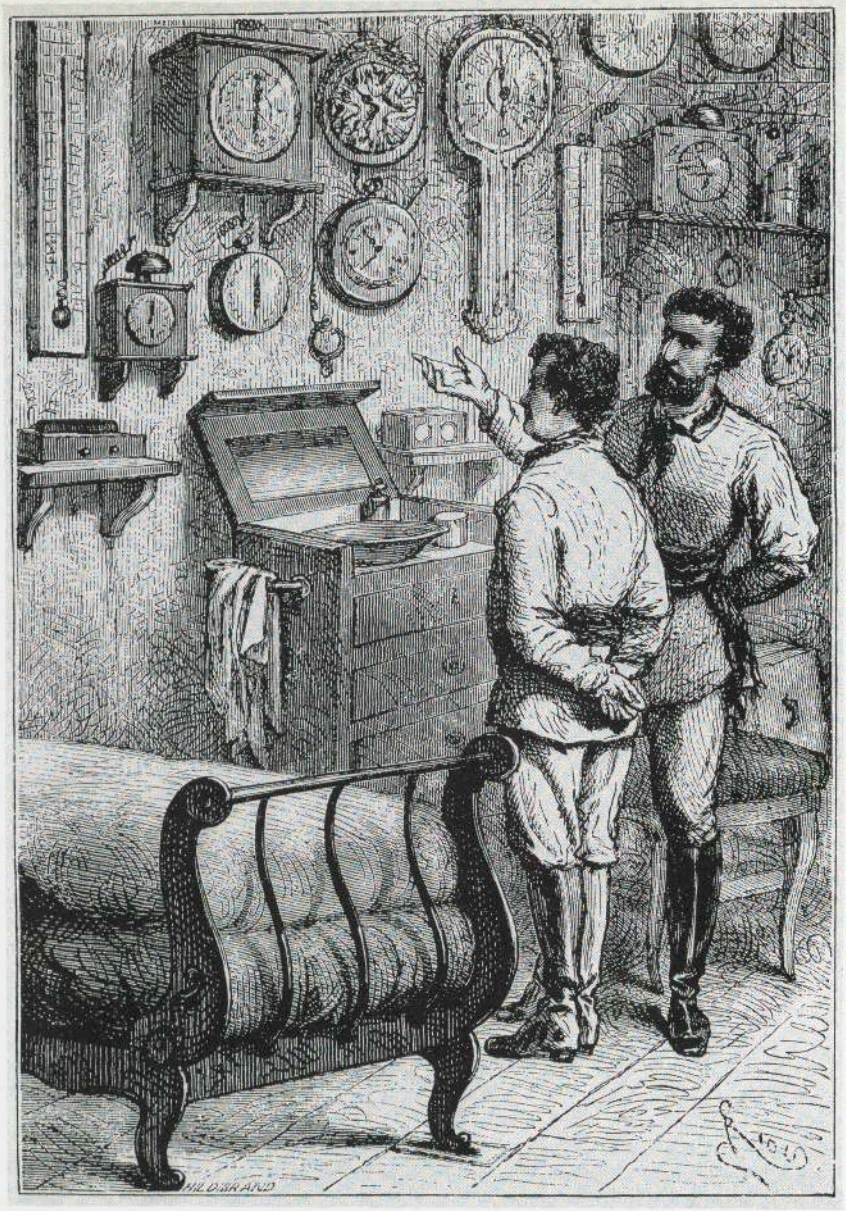
In 1853, Nadar opened a portrait studio, which soon became a meeting-place for the famous. He almost abandoned this career as his interest in aeronautics increased but resumed photography when he was unable to make a living from aeronautics. As a friend and supporter of the Impressionists, Nadar was familiar with the discussions about the status of photography and its relation to painting.

The arguments continued throughout the century. One of the most vehement disputants was Peter Henry Emerson, who in an address to the Camera Club of



of them made into lantern slides for teaching; more recently, they have greatly inspired Francis Bacon. As Leland Stanford predicted in his foreword to Muybridge's first published album, *The Horse in Motion:* "The facts demonstrated cannot fail, it would seem, to modify the opinions generally entertained by many, and as they become more generally known, to have their influence on art."[16] In a different area, studies of motion were applied in the course of research in the newly developed field of "scientific management." Around 1912, the American production engineer Frank B. Gilbreth analyzed in detail the movements of manual workers. His aim was to obtain better working conditions, but the result was that management often attempted to drive the workers harder in order to speed up production. Let us hope that we are now moving toward another result — mechanization that will relieve man of all tasks that machines can perform.



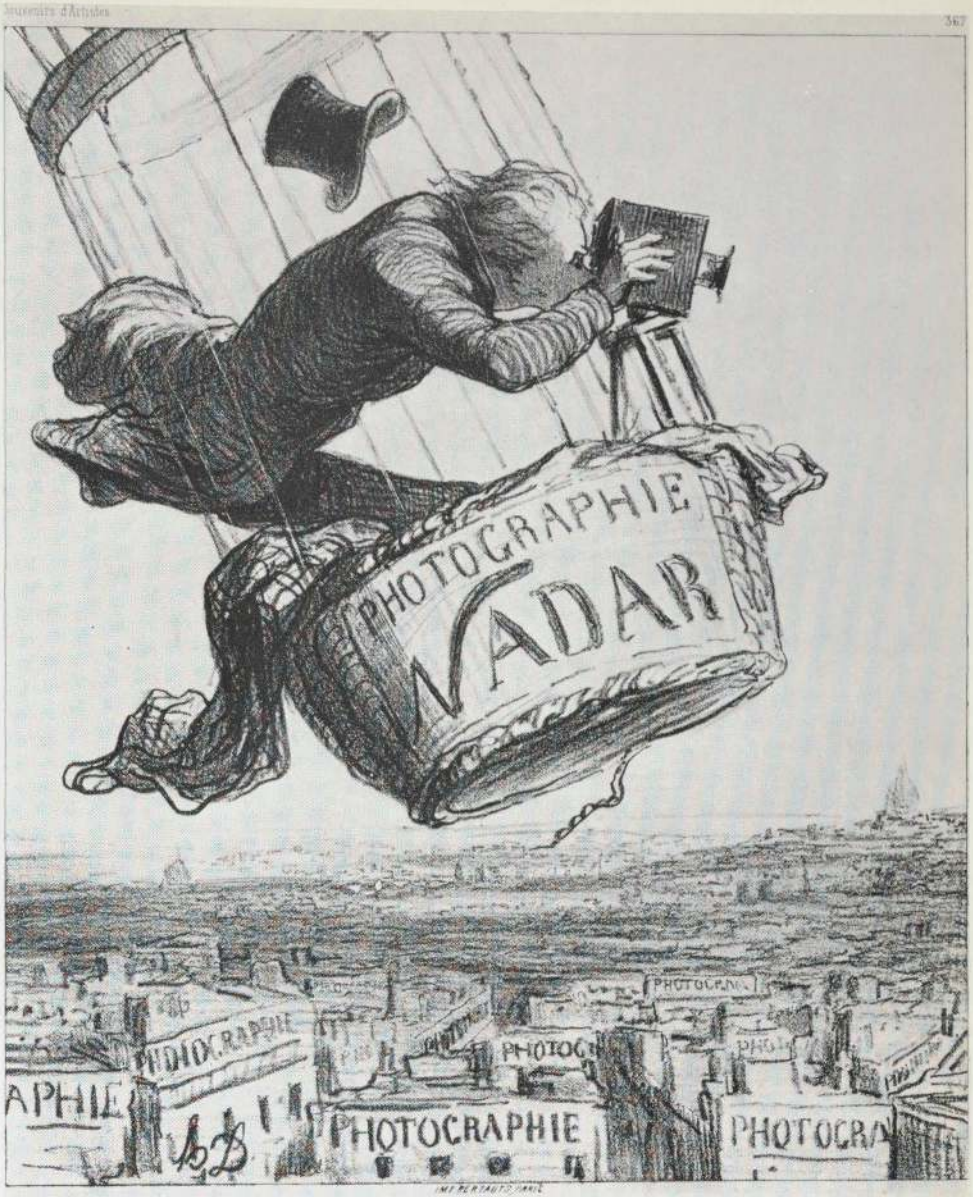


Alphonse M.A. de Neuville
French, 1835—1885
Captain Nemo's Bedchamber on the "Nautilus"
(from Jules Verne's *Voyages Extraordinaires: Vingt Mille Lieues sous les Mers)*
Paris, 1870
Woodcut, 5×3½″
Private collection, Stockholm

Jules Verne represents an optimism based on unlimited confidence in science and the scientist, during the peak of the nineteenth century's belief in progress and industry. He did not see the despair that mechanization and industrialization were bringing to a large part of Europe's population in his day; and he dismissed the Commune as "a trifle." His many books attracted an enormous public that gladly mingled fact with fiction.

Captain Nemo's "Nautilus" ran on electricity. "There is a powerful agent," he said, "which is the soul of my mechanical devices. That agent is electricity." Nemo believed in electricity with the same conviction that Lenin was later to hold; his concern, however, was not with society, but exclusively with himself and his ship. He is the incarnation of the lone technician whose genius dominates nature and enables him to force his way through the world.

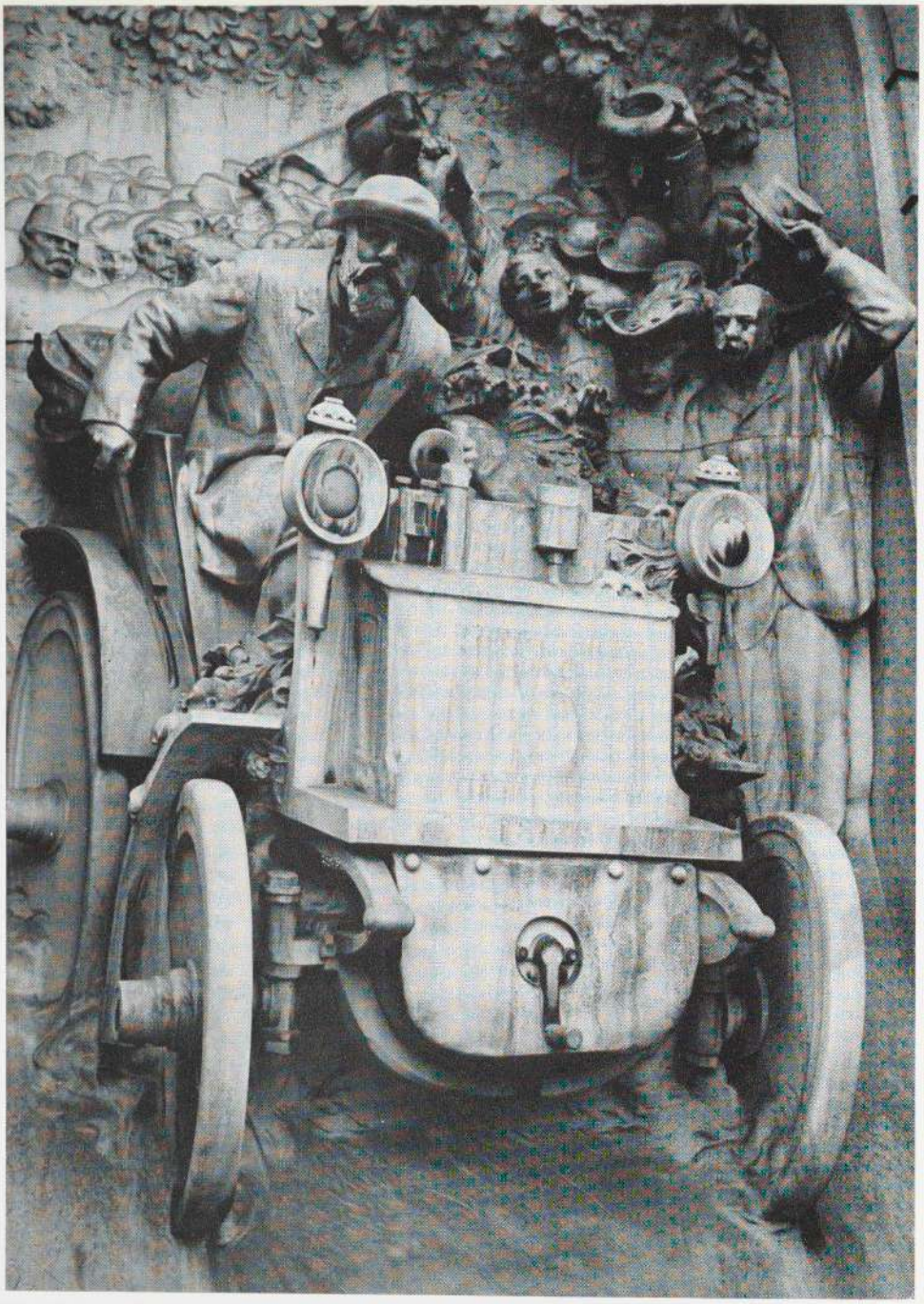
Verne's books are filled with these mastermen, the epitome of the century's engineers. His romantic science-fiction was based on a conception of science that believed the universe could be mapped out in mechanical terms, and that its structure was built upon "laws" that would last forever. His supermen heroes make use of these laws to attain mastery, just as the ruling classes in his day laid down supposedly natural laws to govern society. It never seems to have occurred to them that their laws were empirical and inevitably reflect the imperfections of the minds that formulated them. In any event, the instrument room of the "Nautilus" as depicted by Neuville does not inspire great confidence!



NADAR élevant la Photographie à la hauteur de l'Art

London in 1886 proposed a scientific basis for art, citing the most recent theories about optics and retinal perception. He came to the conclusion that photography was "superior to etching, woodcutting and charcoal drawing" in its ability to render perspective, and second to painting only because it lacked color and the ability to reproduce exact tonal relationships.[18] The result was a storm of controversy. In 1891, Emerson reversed his position, declared that he had erred in confounding art with nature, and in a black-bordered pamphlet, *The Death of Naturalistic Photography,* decided that the medium had too many limitations to rank as anything but "the lowest of all the arts . . . for the individuality of the artist is cramped, in short, it can scarcely show itself."[19]

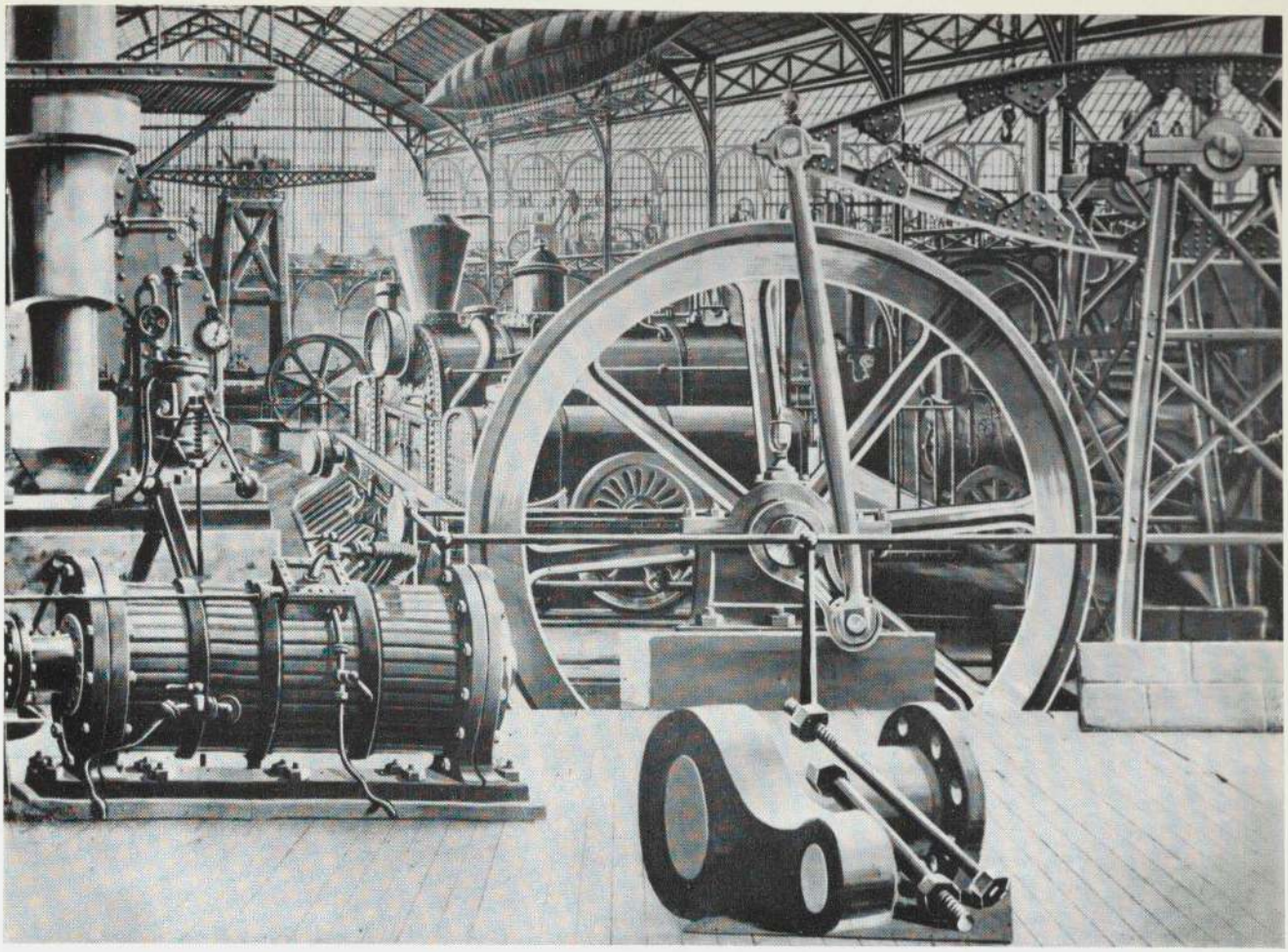
But evolution had outstripped Emerson. By opening up new ways of seeing, photography had already revolutionized art. The camera's analytical perception was essential for the Impressionists and Post-Impressionists. Photography destroyed academic preconceptions; and our present ways of seeing are probably as greatly influenced by camera work as pre-Impressionist ways of seeing were influenced by Renaissance art.



Camille Lefèbvre
French, 1853—1947
Monument to Emile Levassor. 1907
Marble relief (after Jules Dalou, 1838—1902), Porte Maillot, Paris

This monument stands at the Porte Maillot in Paris, the finishing point of the great automobile race from Paris to Bordeaux and back, June 10—12, 1895, which it commemorates. The race was won by Emile Levassor (1884—1897), engineer and car manufacturer, driving his famous two-seater Panhard-Levassor "5." By winning easily over his nearest competitor, Levassor established the superiority of cars with gasoline-combustion engines over those powered by steam or electricity.

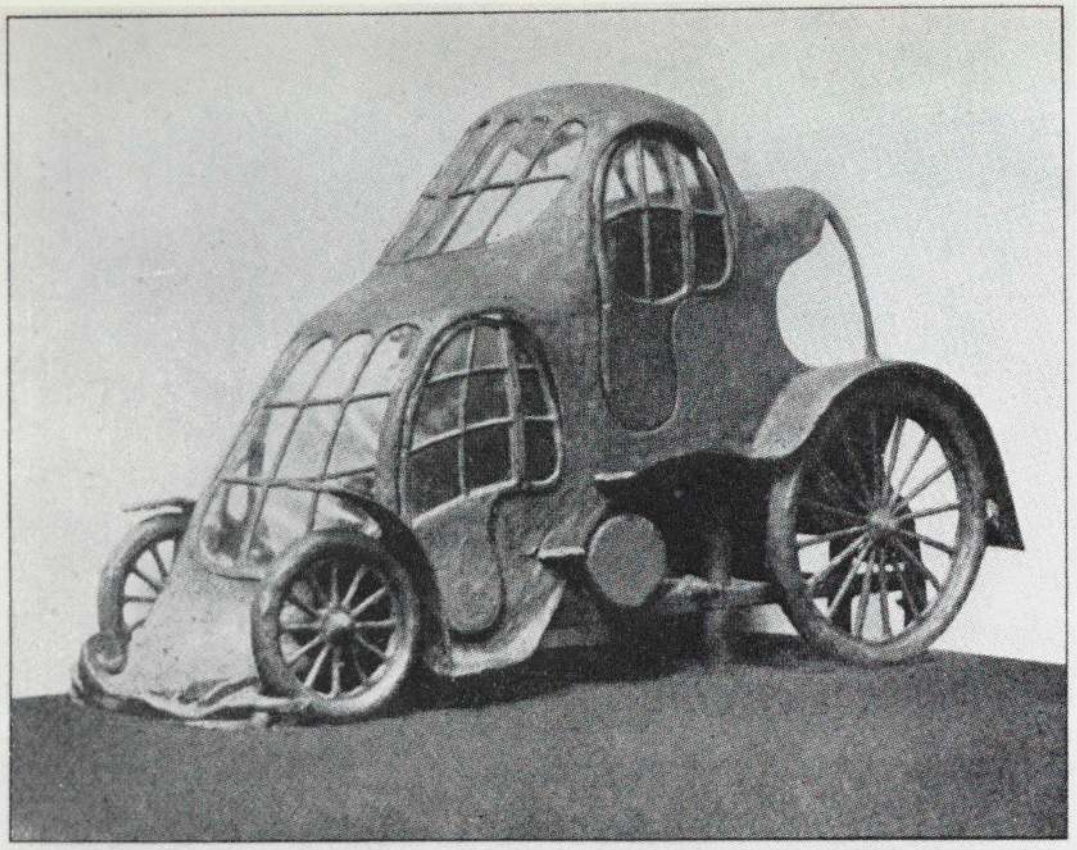
As this detail of Levassor's monument shows, the sculptor has faithfully rendered in marble the car's mechanical parts, the victorious driver, and the cheering spectators. This triumph of illusionism is also a monument to the lack of contact between art and technology at the time. The difficulty with which the car extricates itself from the surrounding people and vegetation is indicative of the misconceptions that still had to be overcome.



Georges Méliès. French, 1861—1938
Set for "Impossible Voyage" (Voyage à travers l'Impossible). 1904

George Méliès began as a magician and director of a theatre that specialized in illusionist spectacles. When he witnessed the first presentation of Lumière's motion pictures, he immediately offered a large sum to buy the apparatus but was refused. Undiscouraged, he bought and experimented with other kinds of photographic equipment and eventually became producer, author, photographer, decorator, actor, and film director. At the turn of the century, he dominated an epoch in the history of film.

Transferring his interest in trick effects to the motion picture, Méliès created a new art form, which presented a romantic-ironic image of the world of technology and machinery. The motion picture was for him, above all, a machine of enchantment. Beginning with *A Trip to the Moon* in 1902, he made a long series of films — *Impossible Voyage, The Conquest of the Pole, Under the Sea,* and so forth. In these films, Jules Verne's optimistic outlook and unlimited confidence in progress and science were subjected to a light, good-natured scepticism, and often exaggerated to the point of the ridiculous. Méliès injected a healthy doubt into people's unwavering faith in science, by making vast technological and scientific enterprises appear too easy to be believed by even the most credulous. His space ships made a trip to the moon as easy for passengers as a tram ride. By a technological feat of an artistic kind, he mocked those who placed too great confidence in technology.



Pierre Selmersheim. French, 19th century
Maquette of car for
Le Concours de Magasins du Louvre
Original c. 1895, destroyed

When, in the final years of the last century, motor cars began to atrract great popular interest, many people were upset by their "hideous forms." The lack of sincerity that prevailed in most architecture of the time was here manifested again. One would have been as reluctant to reveal the car's construction and technical parts as society hostesses of the time would have been to show their kitchens.

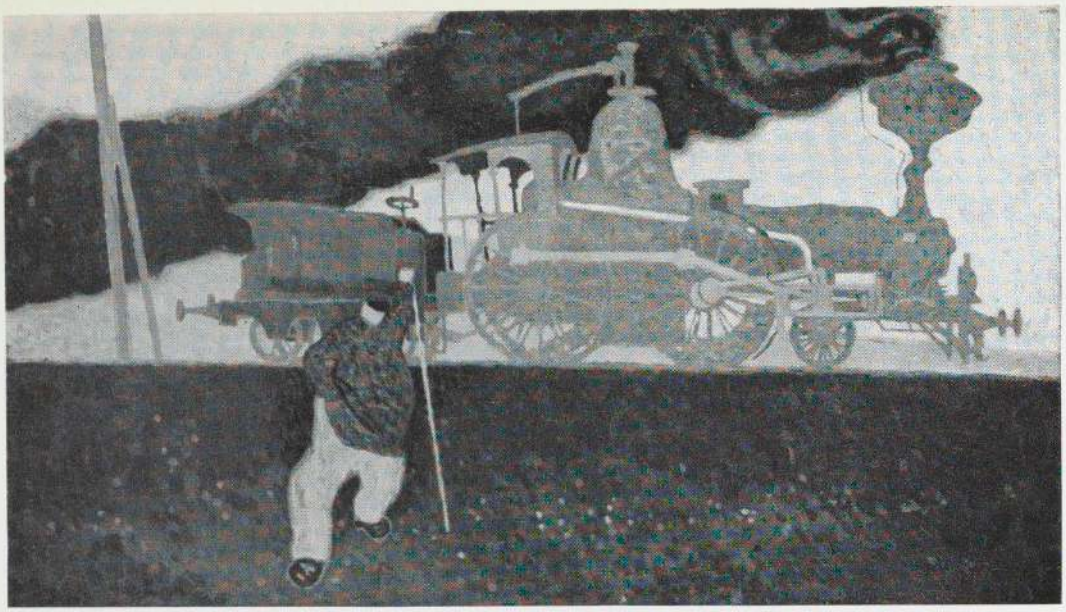
At least two competitions were held in Paris in an attempt to find more beautiful forms for automobiles. The first, organized by the newspaper *Figaro*, produced a series of designs principally inspired by eighteenth-century sedan chairs or Venetian gondolas. Their engines were carefully concealed behind rococo gilt-framed panels painted with flowers. The anachronism was perceived, however, and *Figaro* admitted that: "Unhappily, we have not been able to celebrate the hoped-for marriage between Art and Science and are barely able to feel that we have brought about their engagement.[21]

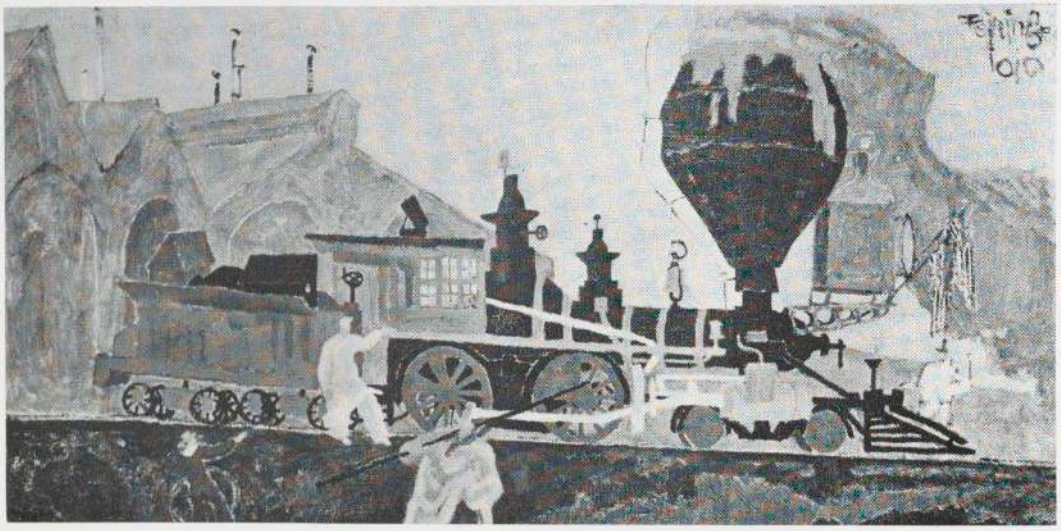
The following year, another competition was sponsored by the big department store, Magasins du Louvre. The results were not much more satisfactory, and the jury decided not to award the three medals that had been announced but only to give a money prize. This went to M. Selmersheim, who had made the model illustrated above. Considering its date, and making allowance for the collapse of the front (the maquette, now lost, was probably of wax), it is not without fascination. The jury gave the following opinion:

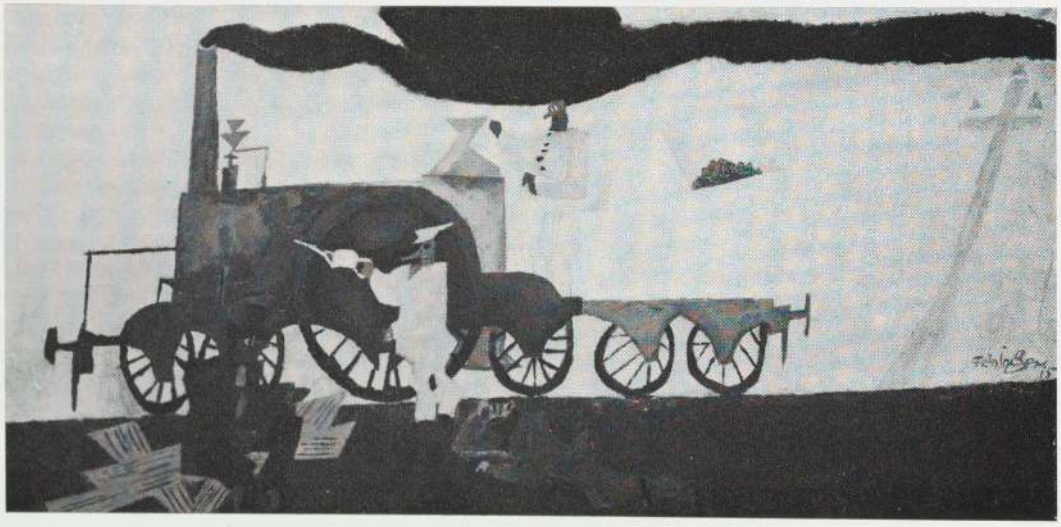
The jury was happy to offer a prize of 500 francs to model No. 22. One feels that this kind of projectile or moving catapult, fashioned to cleave the air, is quite ready and able to devour space. Placed high, like the watch officer on the bridge of his ship, the driver is not distracted by the conversation of the passengers. If the originator of this project had given his imagination free rein (!), however lacking in poetry his conception may be, there is no doubt that this truly talented artist would have been rewarded with a medal. He is the only one who has manifested a half-hearted desire to leave the beaten track to which we are confined and break old molds."[22]

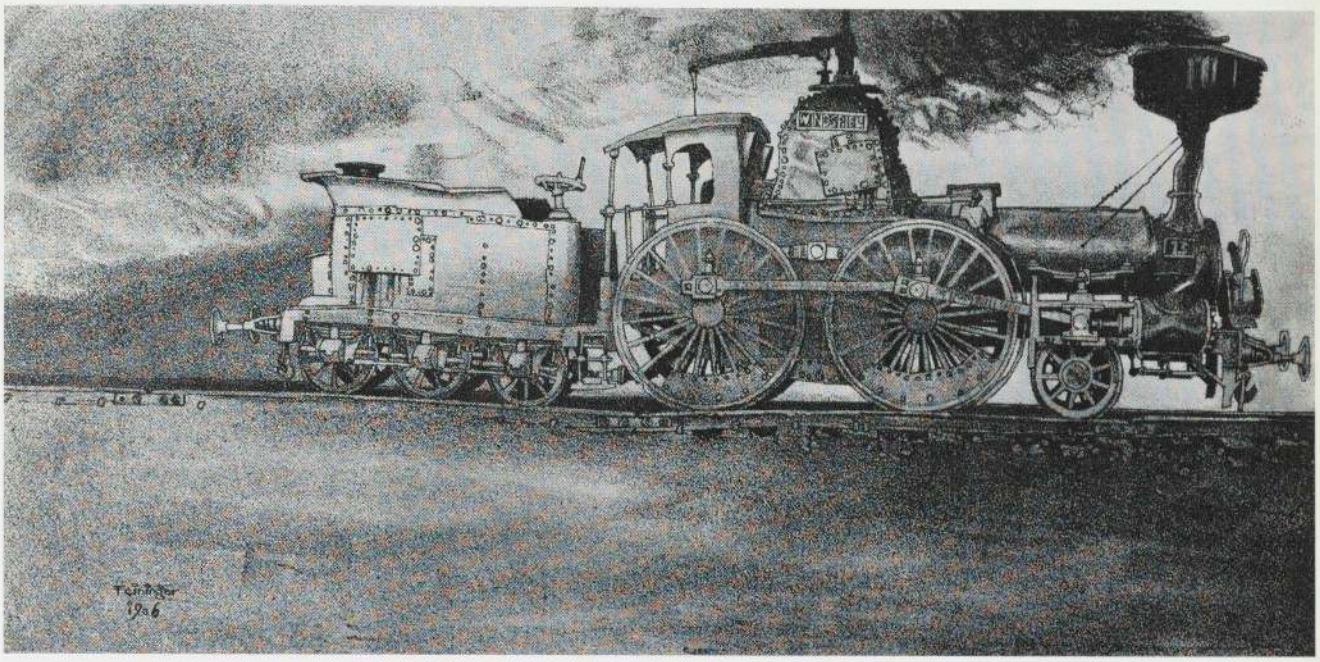
Henri de Toulouse-Lautrec. French, 1864—1901
The Motorist. 1896
Lithograph, $14^{5}/_{8} \times 10^{1}/_{2}''$ (composition)
The Art Institute of Chicago

Lautrec focuses on the driver, not the machine. His motorist is ferocious, indeed demonic — he rather than the car seems the source of the belching smoke. He is juxtaposed with the lady pedestrian as if they were Beauty and the Beast. But the satire is rather affectionate. In fact, the motorist was the artist's cousin and companion, Gabriel Tapié de Céleyran, then a medical student. Lautrec had several friends among the pioneer motorists. — David Sylvester.[20]







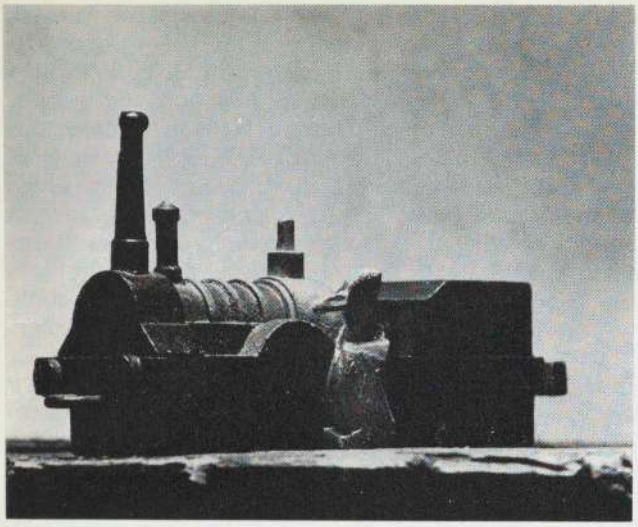


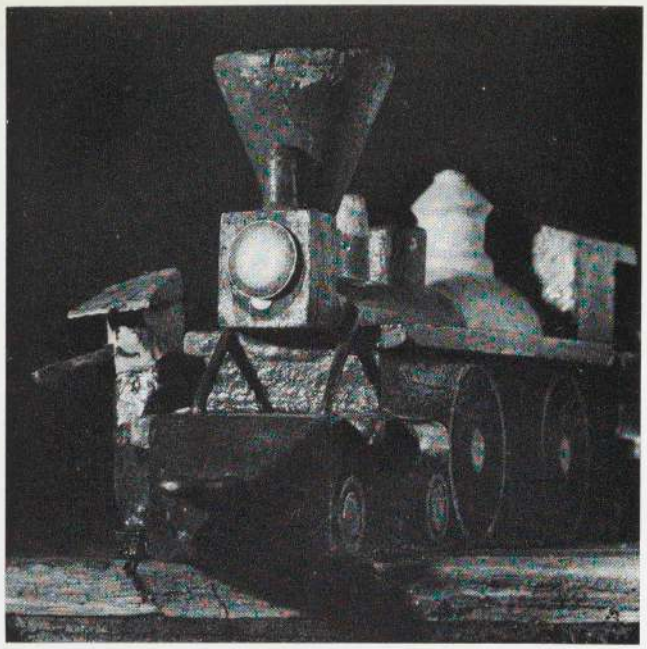
Lyonel Feininger. American, 1871—1956
The Old Locomotive ("Windspiel"). 1906
Lithograph, $6^{1}/_{4} \times 12^{5}/_{8}''$
The Museum of Modern Art, New York
(gift of Mrs. Lyonel Feininger)

The earliest impressions I had of machinery were the trains, the locomotives, half terrifying and wholly fascinating . . . I used to stand on one of the footbridges over the Fourth Avenue tracks of the New York Central . . . At the age of five years I already drew, from memory, dozens of trains . . . the black locos of the N.Y.C. with "diamond" smokestacks, and the locomotives of the N.Y., N.H. and H.R.R. with elegant straight smokestacks painted, like the driving wheels, a bright vermillion red, and oh, the brass bands about the boiler and the fancy steam domes of polished brass . . .[23]

In his early 'teens, Feininger made precise drawings of old locomotives. His childhood interest lasted all his life, forming an important, if isolated, line within his art.

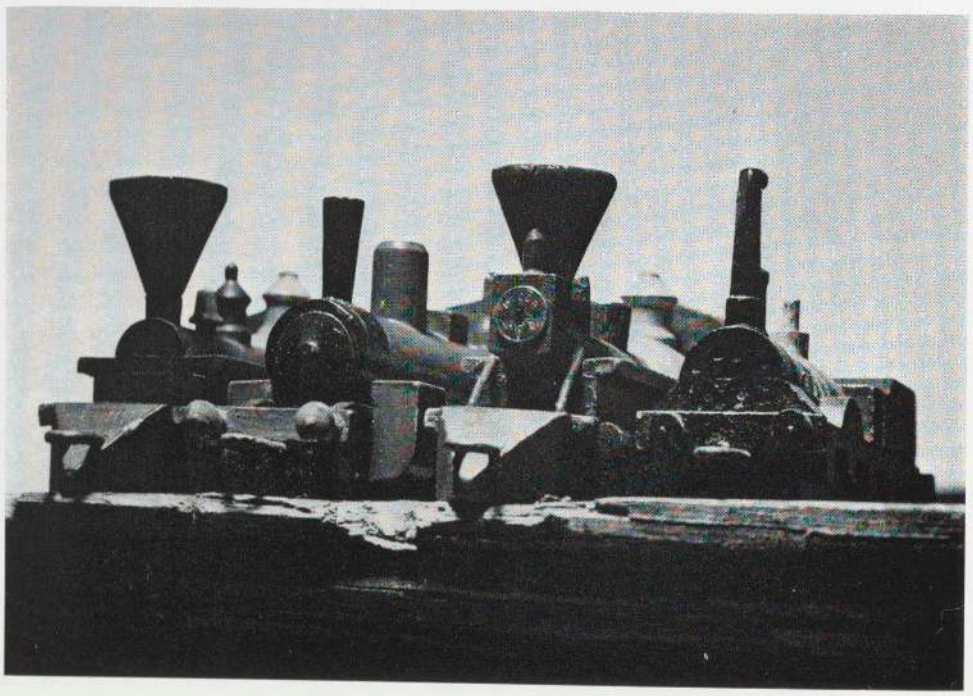
The old "Windspiel" dates from 1906, when Feininger was living in Berlin and active as cartoonist and illustrator. It is rendered as much like a human being as like a machine — a machine that has become an old man. Everything is used, battered, and very worn. Chaplin might have loved to ride West on this puffing ruin; but Feininger actually saw it somewhere along the Pomeranian shores of the Baltic.





About 1911, a friend saw and admired the toy trains that Feininger had been making for his three small sons, the eldest of whom was then about five. A plan was made to have the trains mass-produced at the wooden-toy factory in Munich owned by the friend's father. In an enthusiastic letter of April 7, 1913, Feininger wrote to his wife: "I shall design contemporary and old types. I even intend to make some ancient, ancient trains of the 1830s . . . And the trains will have proper labels . . . The oldtimers will have the year of origin, and names, like 'Rocket,' 'Lady of the Lake,' 'John Bull' etc."[25] He became so preoccupied with designing the prototype models that he neglected his painting; however, he not only enjoyed working out all the details for the trains but also looked forward to being able to support his family with the money they would bring in — something he was unable to do while pursuing "modern art." Production had actually begun in the spring of 1914, when the outbreak of war in August naturally put an end to this hopeful scheme.

The Lilliputian scale of Feininger's trains reduces none of the strength of the locomotives, which actually seems reenforced by the simplicity of forms and roughness of the material.



Lyonel Feininger
Toy Locomotives
c. 1911—1913
Painted wood: above left and far right, $7\frac{3}{4}''$ long; above right and second from right, $7\frac{1}{2}''$ long; third from right, $4\frac{1}{2}''$ long
Private collection, New York

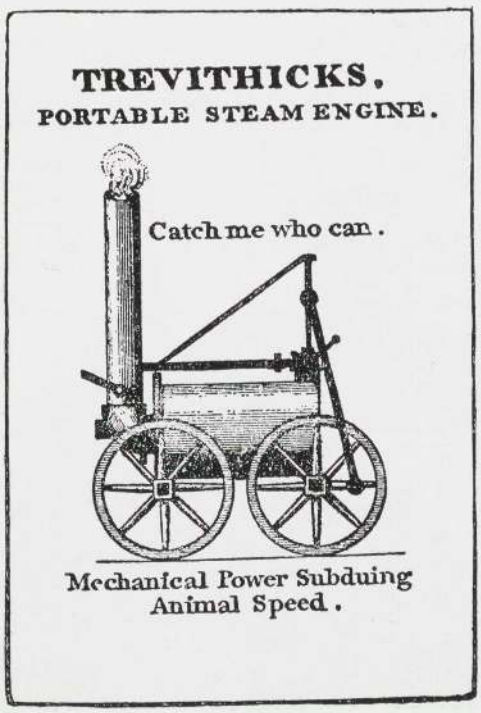
Lyonel Feininger
Locomotive. 1908
Oil on canvas, 17 5/8 × 32″. Private collection, New York

Old American Locomotive. 1910
Oil on canvas, 19 3/4 × 39 1/2″
Collection Mrs. Julia Feininger, New York

Locomotive with the Big Wheel. 1915
Oil on canvas, 22 × 47 1/2″
Collection Mrs. Julia Feininger, New York

Feininger's machines are often more human and sympathetic than the people he portrayed. He remained a caricaturist when painting his locomotives, but he revealed warm feelings toward them, and even love, which he often denied to his human subjects. The trains probably reflect a nostalgia for his American childhood, at a time when Feininger was living in Germany before and during the early years of the First World War.

These locomotives are at rest, being serviced and taking on water. There seems to be a harmonious rapport between them and the men who are serving them. Feininger evidently had faith in the engines; big trains and ships represented for him evolution and progress. Yet the unrestrained optimism of the nineteenth century is no longer in evidence, and its image of progress has become somewhat tarnished. The future world, it is obvious, was to be under the domination of machines, but the old optimism would be gone. Feininger is among the first artists of our century who seems to have perceived the complexity of man's relation to the machine.

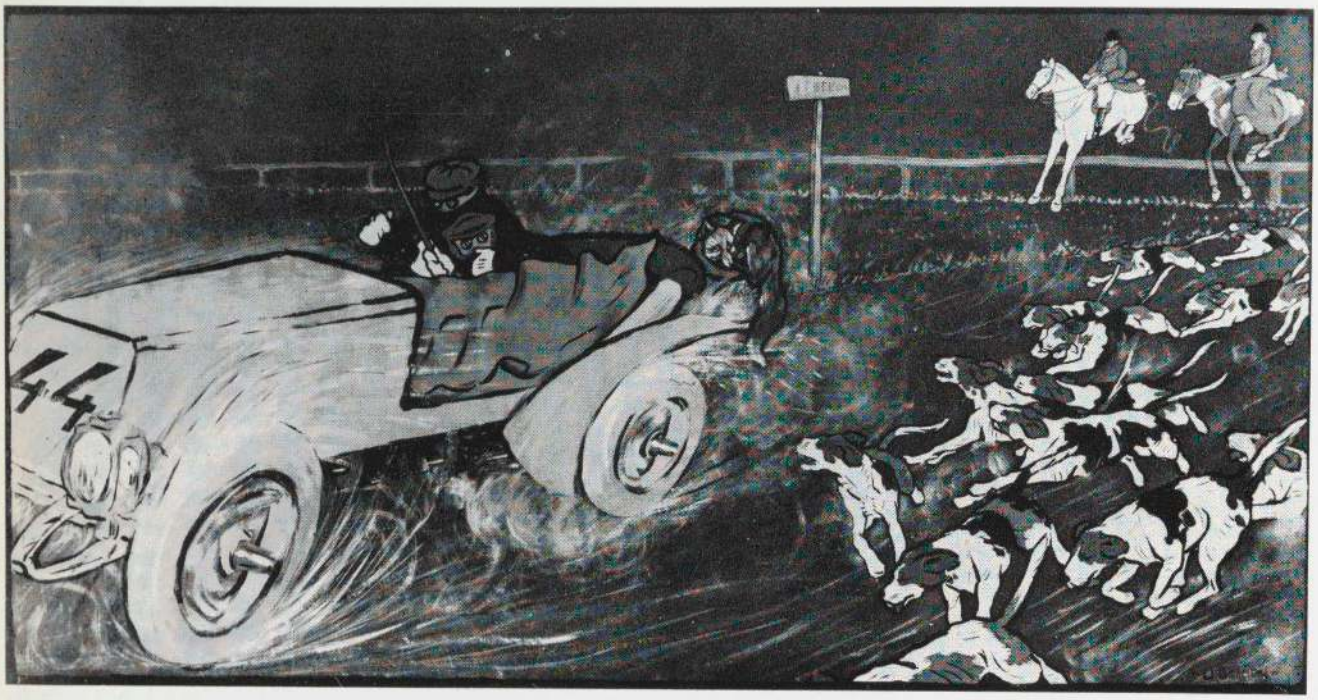


In February, 1804, the very first locomotive running on rails was put into operation at the Pen-y-Daren Iron Works, in southern Wales. Powered with a high-pressure steam engine, it hauled ten tons of iron and seventy men for over nine miles. This locomotive was nameless, but Trevithick's next one was called "Catch-me-who-can." George Stephenson continued the evolution of the railway, with "Mylord" and "Locomotion." The earliest use of locomotives was for mines and iron works: it was not until 1825 that Stephenson inaugurated the first railway line for cargo and passengers. Horses still continued to provide man's fastest means of transportation.

Engine names are a commentary on railway history. If you look at the Great Western locomotive lists from 1837 onwards you can watch the machine age getting under way. At first the namers of engines could not escape the conception of a relationship between gods and machines. The classical dictionary was ransacked. But in their new guise the gods lost their omnipotence. Gooch, the G.W.R. locomotive superintendent, while allowing that Aeolus, Apollo *and* Neptune *were good runners, had little to say in favour of the rest.* Vulcan, *he reported, developed serious wear and tear,* Bacchus *showed severe strain on his valve gearing,* Venus *was "the worst engine delivered."* Perseus *burst his boiler and killed three men, while* Mars, *after only three years' service as a goods engine, had his driving-wheels removed for the purpose of "transporting the equestrian statue of the Duke of Wellington from the sculptor's studio in Harrow Road to Hyde Park." A final snook was cocked at the classics when the workshops misread "Laocoön" on a blueprint and turned out a new engine called* Lagoon.

Meanwhile two of the more legitimate gods of the new age, Robert Stephenson and Isambard Brunel, were restoring order by designing a new batch of locomotives for the Great Western. Of the first of these Brunel wrote: "it would be a beautifull ornament in the most elegant drawing room." This was the famous North Star, *bearing Stephenson's favourite engine name. "Another Star," said Brunel to Stephenson, "would make us comparatively easy, particularly the Directors, who consider the Stars double Stars. Can you by extra exertions deliver us one in March?" So came* Morning Star, Dog Star, Red Star, Shooting Star *and many more, adding a new poetry as well as a new efficiency to railway practice.*

As the century advanced the romantic period claimed its engines. Ivanhoe, Robin Hood, Rob Roy, Waverley, Red Gauntlet, *to mention but a few, sped westward at the head of broad-gauge expresses. Most famous of these was* Lord of the Isles, *the stories of whose speed records are still told in the railway world. And it cannot be without significance that* Lord of the Isles, *after drawing international attention to himself at the Great Exhibition, crashed in 1852 at Aynho, derailing himself, breaking his buffer beam and smashing the station platform. The romantic period was at an end.*[24]

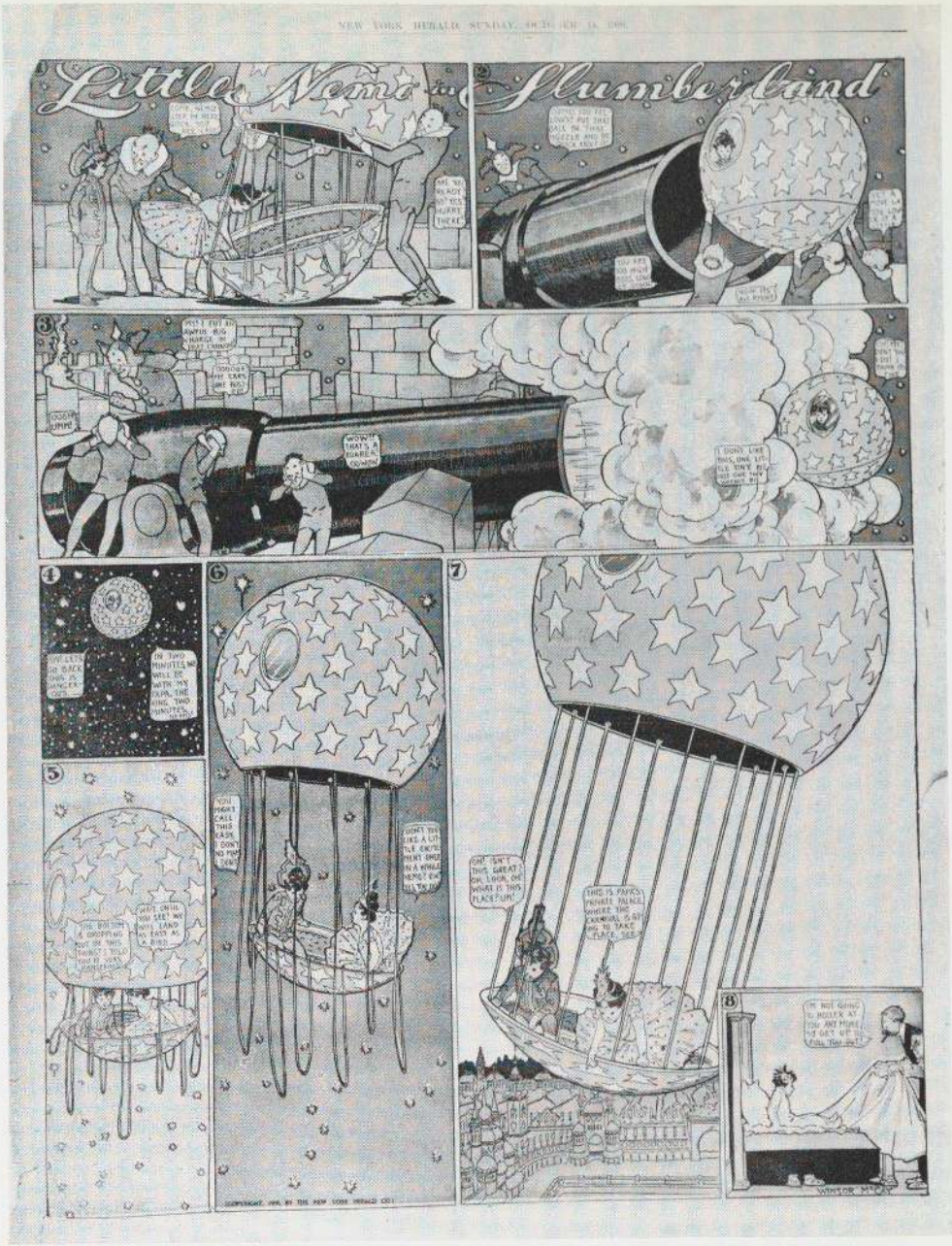


Umberto Boccioni. Italian, 1882—1916
Untitled (Speeding Automobile). 1901
Tempera, $29^{1}/_{8} \times 50^{3}/_{8}''$
Collection Automobile Club d'Italia, Rome

At the turn of the century, the car became the ultimate symbol of progress and the bearer of hopeful expectations, especially for young people. Automobiles were just beginning to free themselves from slavish imitation of carriages and take on a shape of their own. In Florence, young Ettore Bugatti abandoned brushes and palette to devote himself, as he said, "to a new kind of art, the mechanical" (see page 142). In 1901, before he was quite twenty, he constructed his first car. It had four motors — one for each wheel — but its exterior was not unlike the vehicle in this picture, painted in the same year by Umberto Boccioni, then nineteen.

The words one might provide for the missing balloon-captions of this picture are: The fox, closely pursued by hounds and the elegant pair of hunters, has jumped onto the luggage rack and is clinging to a cane protruding from the bags. Unaware of what has happened, the driver and his companion think themselves in the predicament of the legendary Russian travelers chased over the snow by wolves. The whip is being wielded to ward off not the fox but the dogs. It is the speeding machine rather than the humans which is saving nature from civilization.

It is a very optimistic story!



Winsor McCay. American, 1869—1934

Little Nemo in Slumberland. 1906
Newspaper sheet, printed in color, from the *New York Herald*, Sunday, October 14, 1906, $21^{3}/_{4} \times 16^{3}/_{8}''$
Collection Woodrow Gelman, New York

Original drawing (*not illustrated*), pen, brush and ink, pencil, $16^{1}/_{2} \times 22^{1}/_{8}''$. Collection Mr. and Mrs. Ray W. Moniz, Highland Falls, New York

Winsor McCay started to draw his series *Little Nemo in Slumberland* in 1905 (the year in which Feininger began *The Kin-der-Kids)*. McCay soon became the undisputed master of the early comics, as much because of the elegance, simplicity, and poetic quality of his drawing as because of his enormous productivity. *Little Nemo* appeared full page in color seven days a week.

Little Nemo often uses flying machines for his travels. Mostly, they are balloons of different kinds — none of them highly technical, as is natural, since they always appear in Slumberland. McCay's interest in actual technology manifested itself in 1909, when he transported Little Nemo into animated films — the first made in the United States, and among the first in the world.

Giacomo Balla. Italian, 1871—1958

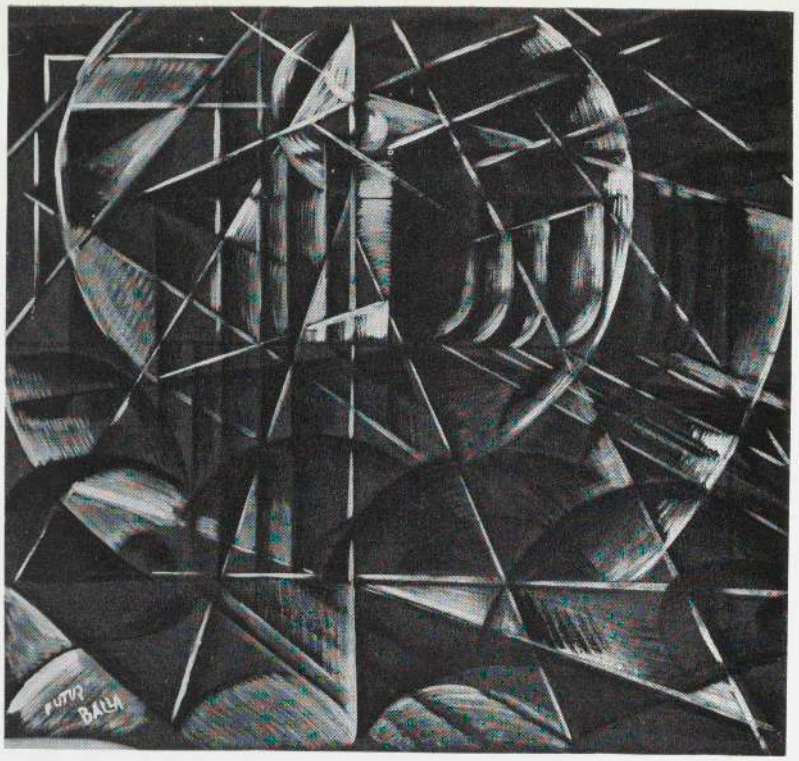
Speed of an Automobile Series
1912—1913

Filippo Tommaso Marinetti's Foundation and Manifesto of Futurism, first published in Paris on the front page of *Le Figaro* for February 20, 1909, was reprinted shortly thereafter in Italy in broadsides and in the literary magazine *Poesia* which he edited. It summoned Italian intellectuals to make a violent rupture with the past, embrace the mechanized present, "break in the mysterious portals of the Impossible," and open the way to the future.

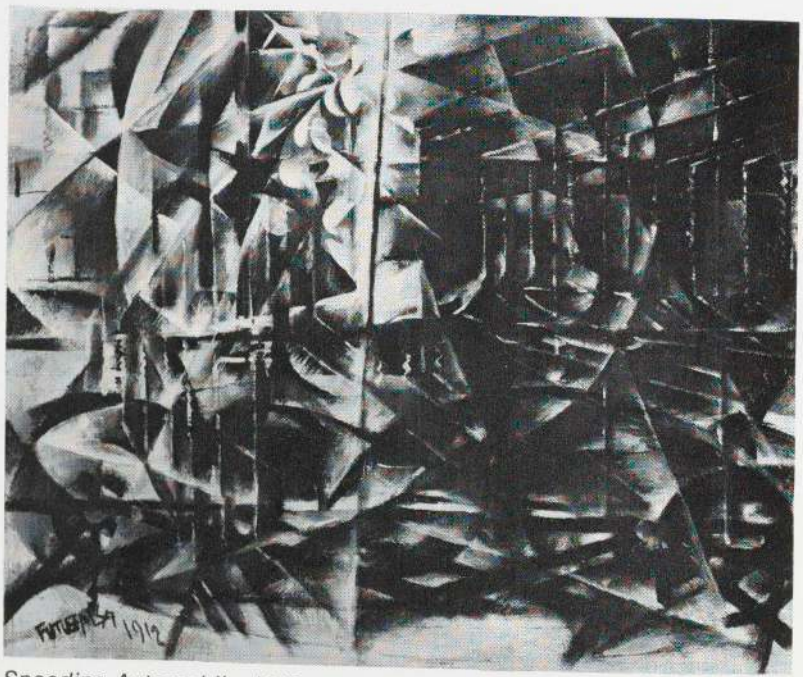
Within a month, several of the younger artists rallied to the Futurist cause; and when the Technical Manifesto of Futurist Painting appeared on April 11, 1910, it bore the signature of five Italian painters: Umberto Boccioni, Carlo Carrà, Luigi Russolo, Giacomo Balla, and Gino Severini. They became the first group of artists to make their commitment to technology a central feature of their work.

As if inspired by Marinetti's declaration that "a roaring motor-car . . . is more beautiful than the *Victory of Samothrace*," Balla between 1912 and 1914 made a series of paintings of different sizes, whose subjects and titles were variations on the theme of the speeding automobile. Previously he had applied the principles of Post-Impressionist divisionism to the analysis of light, as in *The Street Light,* 1909, and of movement, as in the famous *Dynamism of a Dog on Leash,* 1912. The little dog with multiple legs and eight or nine tails is still rendered in an impressionistic way based on the close analytical observation of nature. With the car paintings, however, Balla moved rapidly toward a more abstract language, in which observed impressions are condensed into far less representational forms. In some of these pictures, one can still divine the back and head of the driver, and behind the spirals such mechanical elements as the wheels and the repeated shapes of the fenders and windshields of that period.

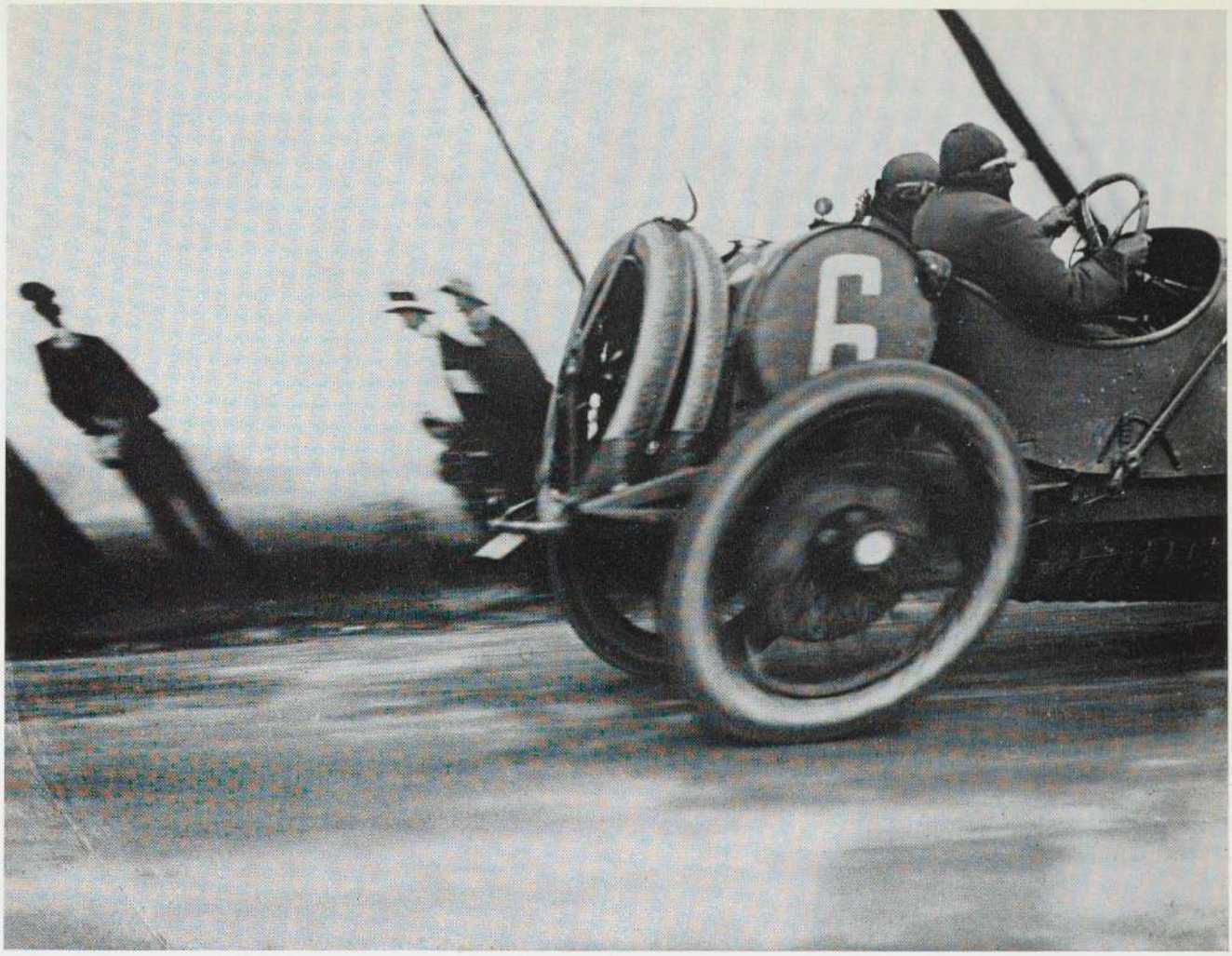
Balla's increasing tendency toward abstraction probably came about through his having seen paintings of the Analytical Cubist style, but his basic aim of rendering the essence of speed was characteristically Futurist. It was, of course, no accident that Balla should have chosen the car as the motif for this series of paintings, in which he first developed his advanced formal ideas.



Speed of an Automobile. c. 1912
Gouache on red paper, 25½ (irregular) × 27½″
Collection Mr. and Mrs. Joseph Slifka, New York



Speeding Automobile. 1912
Oil on wood, 21⅞ × 27⅛″. The Museum of Modern Art, New York



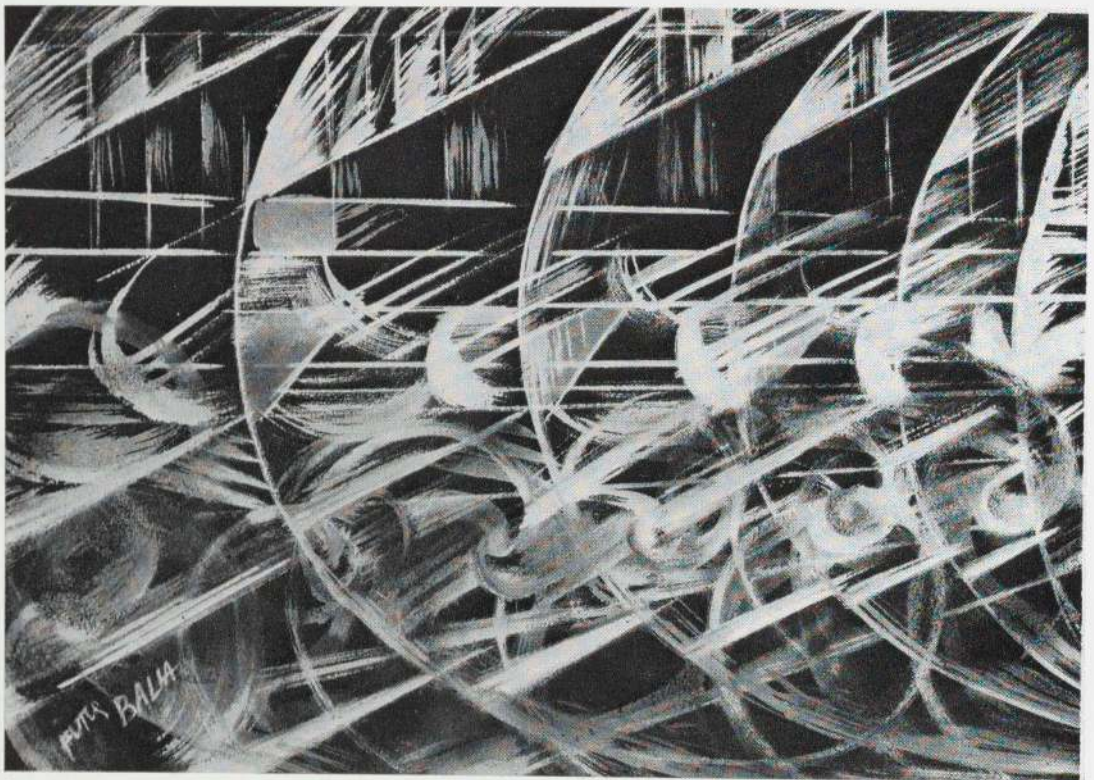
Jacques Henri Lartigue. French, 1896
Grand Prix of the Automobile Club of France, 1912
Photograph, $11^{5}/_{8} \times 15^{5}/_{8}''$
The Museum of Modern Art, New York
(gift of the photographer)

The photographs that Jacques Henri Lartigue made as a child are a remarkable example of what a machine — the camera — can produce in the hands of someone without preconceived ideas of how it should be used. As John Szarkowski has remarked: "Perhaps only a greatly talented child, left to his own devices, could have made these pictures half a century ago. Such a child needs neither tradition nor training, but he does need great motivation and great talent."[26]

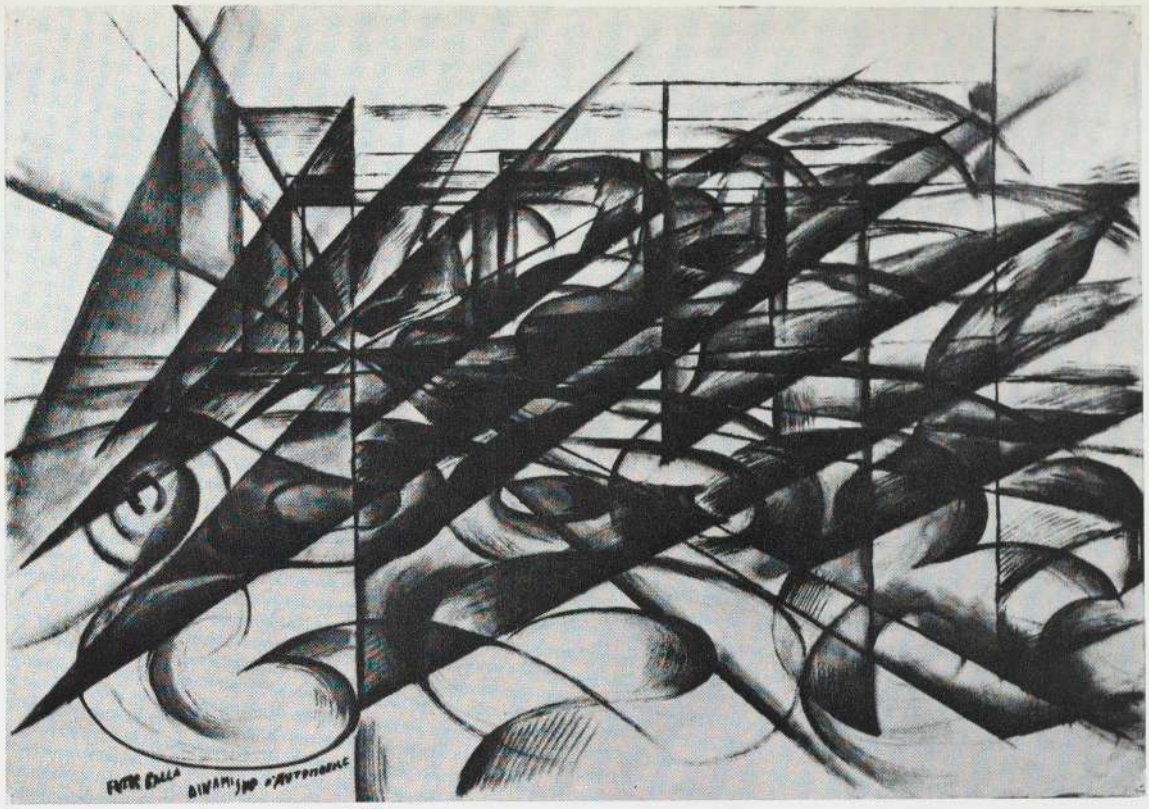
Lartigue loved the world around him, and he was fascinated by the transient scene. Left to himself to discover the possibilities of the camera, by the time he was ten he had already created extremely straightforward and telling images of his time. Human beings have seldom been seen with such objective curiosity.

In taking this picture, Lartigue moved his camera from left to right, following the car. The interesting distortion of the image, which greatly adds to the impression of speed, is due to the fact that his camera had a focal-plane shutter that operated from bottom to top. Images made with similar apparatus established the oldest photographic convention for what a speeding automobile should look like. As Reyner Banham has pointed out, the result had such striking impact that it survived into the late 1930s and influenced the overhanging front of many American automobiles.[27]

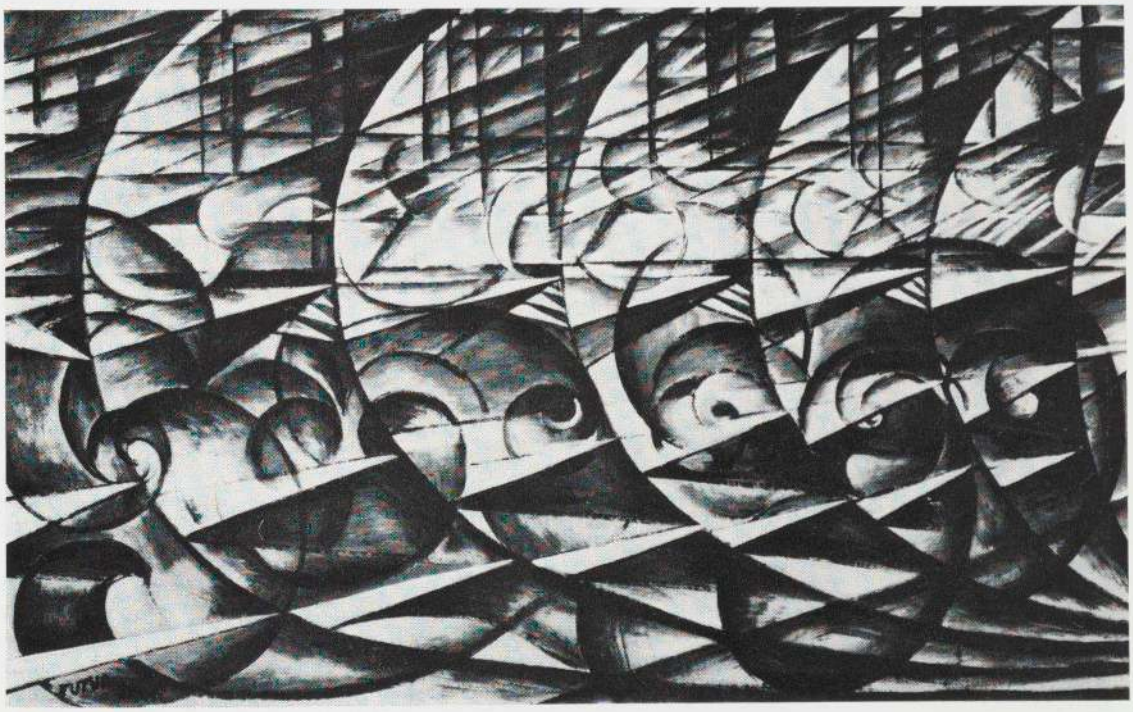
Speed of an Automobile. 1913
Tempera, watercolor, and Chinese ink on canvas, $27^{5}/_{8} \times 39^{3}/_{8}''$. Stedelijk Museum, Amsterdam



Study for Materiality of Lights + Speed. 1913. Tempera on canvas, $11^{3}/_{4} \times 17''$
Mrs. Barnett Malbin, Birmingham, Michigan (The Lydia and Harry Lewis Winston Collection)



Dynamism of an Automobile. 1913
Ink and varnish on paper, $21^{1}/_{8} \times 30''$. Collection Claudio Cavazza, Rome



Dynamic Expansion + Speed. 1913
Varnish on paper, $25^{5}/_{8} \times 42^{1}/_{2}''$. Collection Signorina Luce Balla, Rome

Speed of an Automobile + Lights + Noise. 1913. Oil on canvas, 34¼ × 51¼″. Kunsthaus, Zurich

Then the silence deepened again. Yet, as we listened to the ancient canal muttering its feeble prayers, and the creaking bones of the dying, ivy-bearded palaces, we suddenly heard beneath the window the hungry roar of automobiles.

Let's go, I said, let's go, fellers, let's get away. Mythology and Mystic Idealism are licked at last. We're in at the birth of centaurs, we shall see the first angels fly. We must rattle the doors of life, test the hinges and bolts. Let's go. There on the earth is the first dawn of history, and there's nothing to match the red sword of the sun, slashing for the first time through the shadows of a thousand years.

We came up to the three snorting beasts, to lay amorous hands on their scorching breasts. I stretched myself on my machine like a corpse on its bier, but revived at once under the steering wheel, a guillotine threatening my stomach.

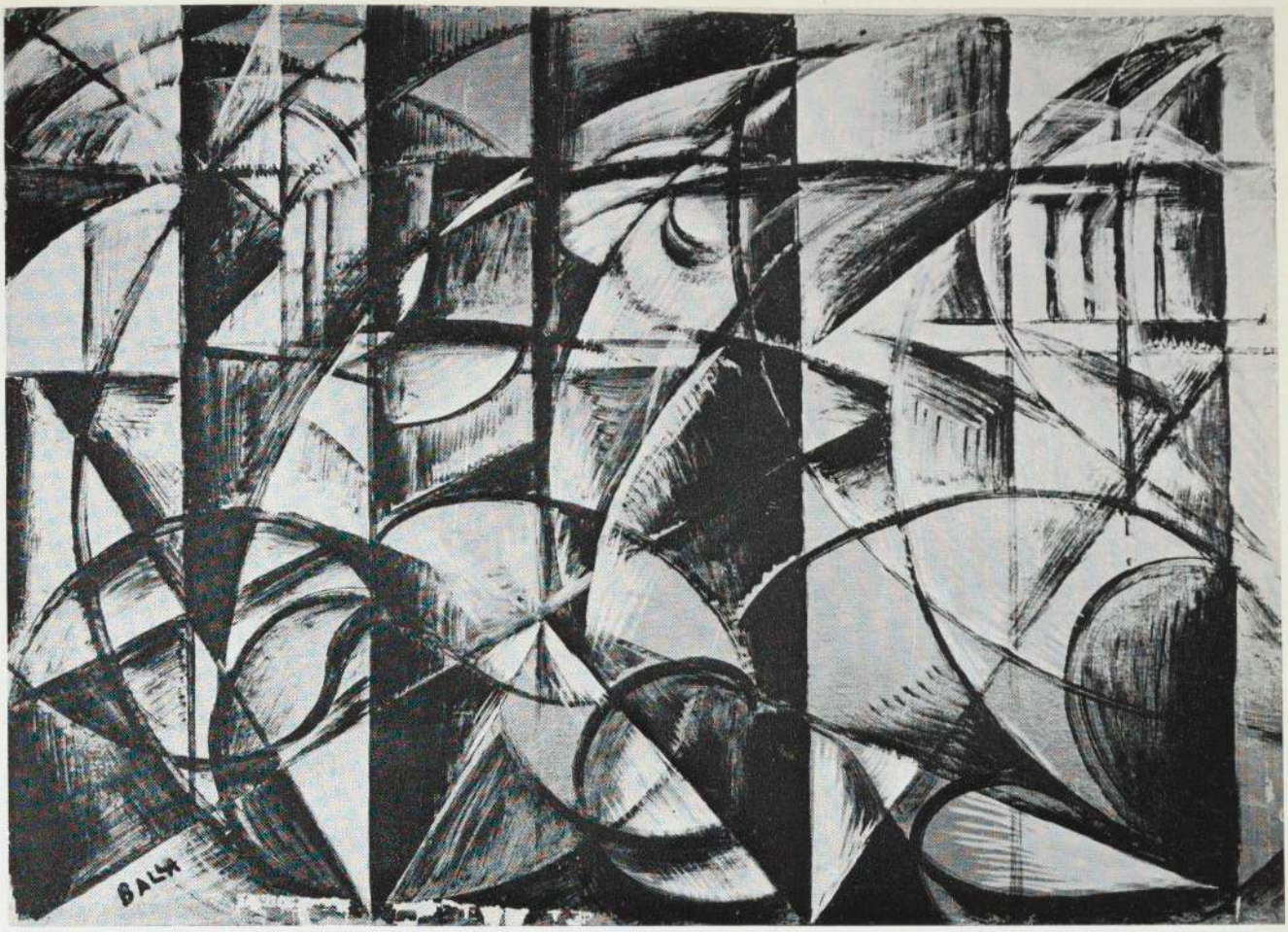
The wild sweep of madness whipped us out of ourselves and chased us through streets as rugged and deep as torrent-beds. Here and there a sick light in a window taught us to mistrust the fallible mathematics of our used-up eyes.

I cried, The scent, the scent alone is enough to guide these beasts.

And we, like young lions, pursued Death with its black belt dotted with pallid crosses, running on under the vast violet sky, alive and pulsating.

But ours was no ideal love lifting her sublime face to the clouds, nor a cruel queen to whom we offered our bodies twisted like Byzantine rings. Nothing, this wish to die, but the desire to be freed at last from the load of our courage.

And we sped on, flattening watch-dogs on doorsteps, curling them up under our flying tyres like collars under the flat-iron. Domesticated Death came up with me at every corner, stretching out an ingratiating paw, or flattening on the ground with a chatter of teeth, making velvet, caressing eyes at me from every puddle. Let's break out of the stuffy husk of wisdom and throw ourselves like pride-ripened fruit into the big sharp mouth of the wind .... Let's just give ourselves up to



Speed of an Automobile + Lights. 1913
Oil on cardboard, 19×26 3/4". Collection Mr. and Mrs. Morton G. Neumann, Chicago

The car was not only the symbol of the new, but it also permitted him to convert the Futurists' love of speed into a pictorial expression of universal motion.

To understand fully the symbolic power that the car held for the Futurists, one must reconstruct in imagination the situation at that date. The automobile represented the ultimate liberty of the individual who, at the wheel of his monster-car, could be a kind of superman terrorizing the countryside. He was an heroic figure: a modern centaur, he was one with his machine, enjoying sensations that no mortal had ever experienced before.

At the same time, when the machine failed him, it could involve extreme frustration — as well as the threat of a danger both feared and desired. Although the new god could not be portrayed at the moment of its failure, the drama is clearly hinted at in Marinetti's introduction to the first Futurist Manifesto:[28]

We had been astir all night, my friends and I, under eastern lamps of copper filigree, star-dusted like our souls, for they, too, blazed with the sealed lightning of electric hearts. We had trampled out our ancestral sloth at length on rich oriental carpets, disputing to the uttermost limits of logic and blackening quires of paper with our frenzied scribblings.

A great pride swelled in our chests, for we felt ourselves alone in that hour, alone, awake and afoot, like proud beacons or forward guardposts against the hostile armies of the stars, spying out their celestial encampments. Alone with the stokers bustling about the satanic furnaces of great ships, alone with the black phantoms that fossick in the red-hot bellies of locomotives launched on their mad journeys, alone with the gesturing drunks flapping uncertainly along the walls of the city.

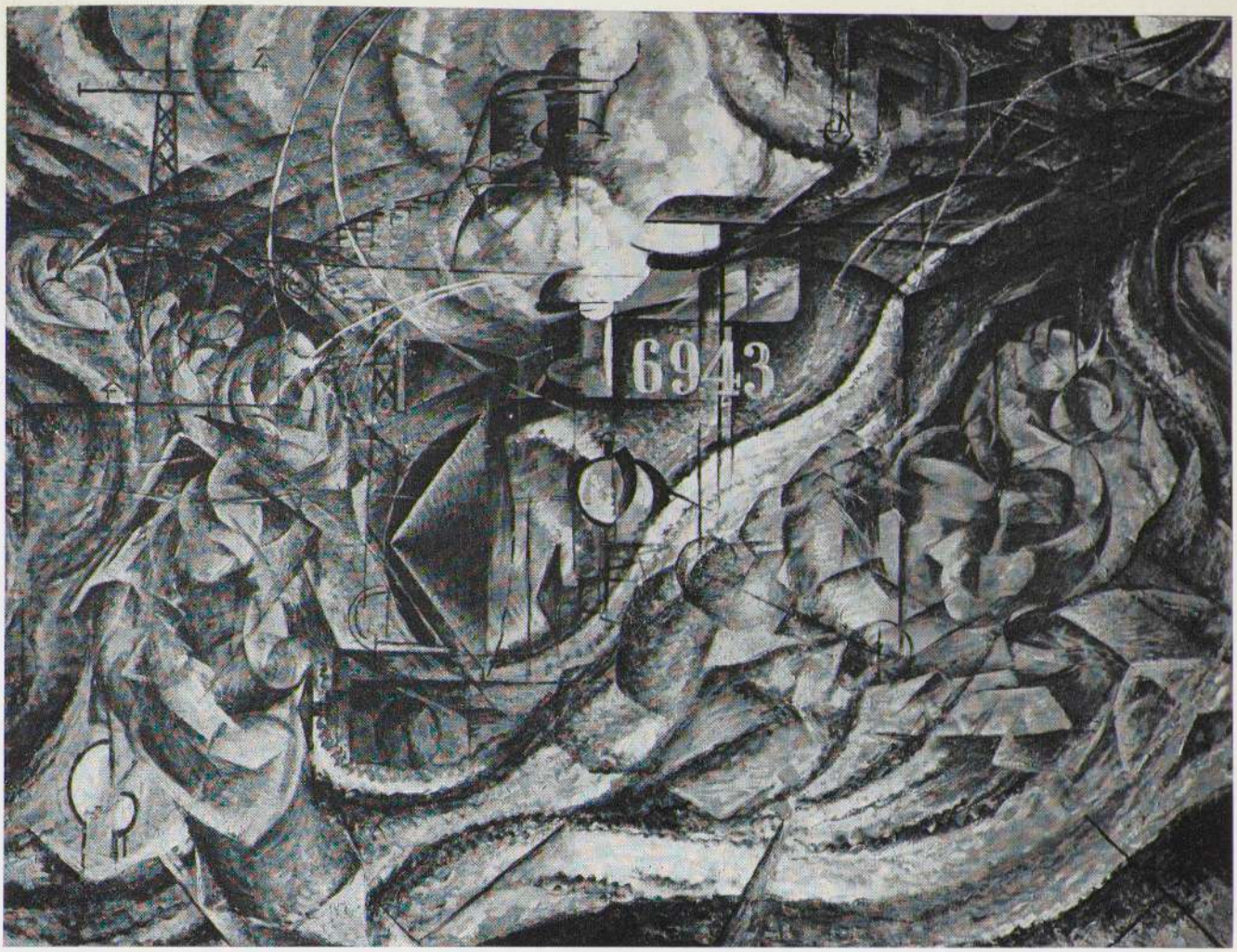
But suddenly we all jumped at the mighty rumble of a double-deck tram, rocking past in a blaze of coloured lights, like a village festival that the flooded Po tears without warning from its banks and sweeps through rapids and gorges, down to the sea.

Umberto Boccioni. Italian, 1882—1916
States of Mind: Those Who Stay. 1911
Tempera and oil on canvas, $27^{7}/_{8} \times 37^{3}/_{4}$"
Collection Nelson A. Rockefeller, New York

Whereas Balla portrayed the visual impression that speeding automobiles made upon the spectator, Boccioni was the first to set artists the programmatic goal of depicting the new emotions born of the meeting between man and the mechanized world. Boccioni was probably the most contemplative as well as the most gifted of the Futurists. Realizing how complex would be the interference of machines in people's emotional lives, he could not content himself with the over-enthusiasm displayed by some of his colleagues for the mechanical world.

In a lecture delivered at the Circolo Internazionale Artistico in Rome in May, 1911, Boccioni developed the idea of "the painting of states of mind." Before going to Paris with Carlo Carrà in the autumn of 1911 to see the most recent trends in art and prepare for the Futurist exhibition that was to take place the following winter, he had already exemplified his aims in a first version of *States of Mind*. He described these paintings to Guillaume Apollinaire: "one expressing departure, the other arrival . . . . To mark the difference in feeling I have not used in my painting of arrival a single line from the painting of departure."[29]

Boccioni's early sketches and first canvases of *States of Mind* were still somewhat under the influence of Edvard Munch. Highly charged with symbolism, they were filled with expressive lines that tellingly convey a sense of nostalgia and anxiety. After his encounter with the Cubists in Paris, he reorganized the composition of the three paintings, *Those Who Stay, The Fare-*



Umberto Boccioni
States of Mind: The Farewells. 1911
Oil on canvas, $27^{3}/_{4} \times 37^{7}/_{8}''$
Collection Nelson A. Rockefeller, New York

wells, and *Those Who Go,* to give them a more precise spatial clarity. Included in the first Futurist exhibition in Paris (held at Bernheim-Jeune, February 5—12, 1912), the triptych was described in the catalogue preface, "The Exhibitors to the Public":

In the pictorial description of the various states of mind of a leave-taking, perpendicular lines, undulating and as it were worn out, clinging here and there to silhouettes of empty bodies, may well express languidness and discouragement.

Confused and trepidating lines, either straight or curved, mingled with the outlined hurried gestures of people calling one another, will express a sensation of chaotic excitement.

On the other hand, horizontal lines, fleeting, rapid and jerky, brutally cutting into half lost profiles of faces or crumbling and rebounding fragments of landscape, will give the tumultuous feeling of persons going away.[30]

Boccioni makes us realize that goodbyes in a railway station are not the same as those said at a stage-coach. In a station, the departures are more final — not because trains go faster and farther than stage-coaches, but because those who enter into a train become part of a system, while those who stay behind are outside that system. Those who leave become a group, although a minute earlier they may have been unknown to one another. In *The Farewells,* Boccioni shows how drastically the locomotive has split people into two groups.

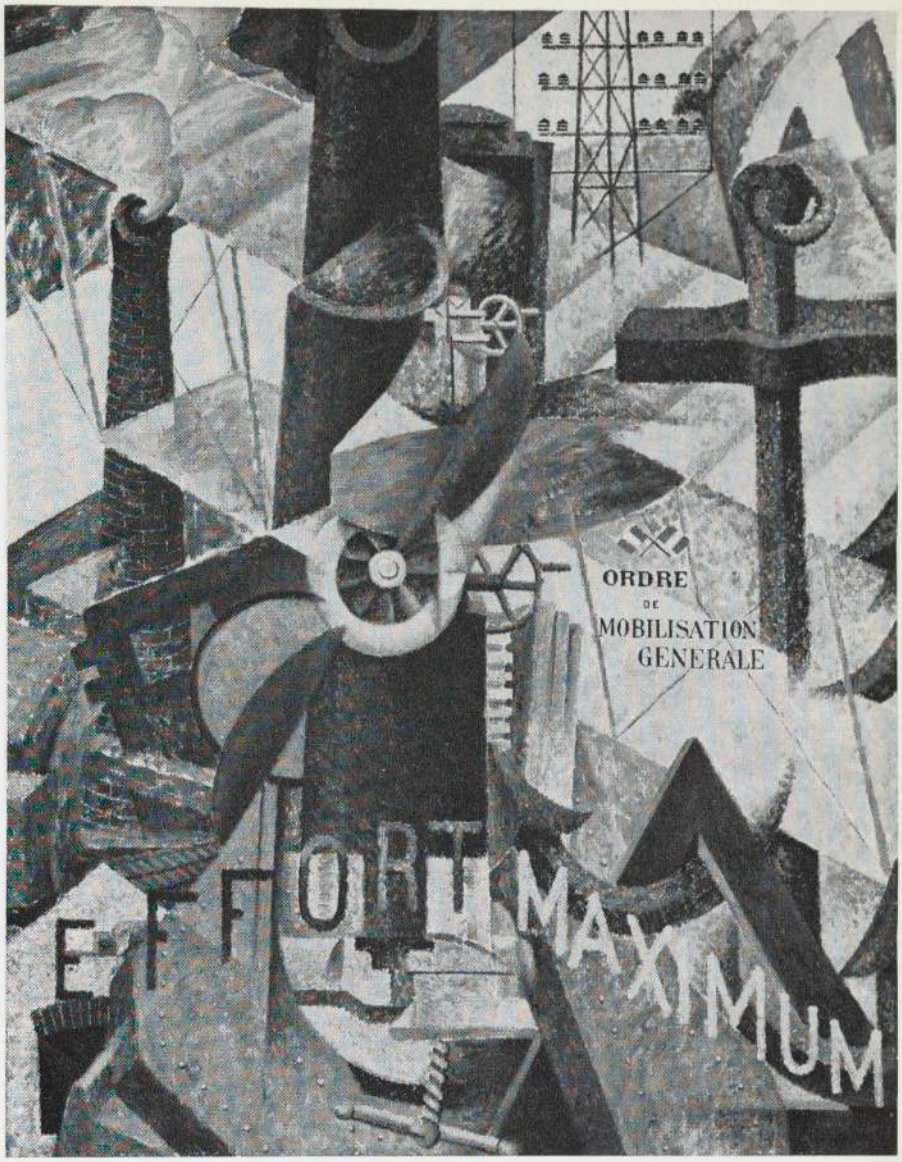
Umberto Boccioni
States of Mind: Those Who Go. 1911
Oil on canvas, $27^{7}/_{8} \times 37^{3}/_{4}''$
Collection Nelson A. Rockefeller, New York

His representation of the locomotive itself is the strongest and most beautiful of all such images of the period. The numbers "6943" that rise out of its side become a clear and simple mathematical symbol of the machine's own strength and individuality. Severini, however, criticized the three paintings as "literary and unclear."

Boccioni's admiration for the train was probably tempered by his emotions concerning his first journey to Paris. On the one hand, he was leaving behind in Milan his mother, to whom he was extremely attached. On the other hand, he knew that he was about to be confronted with the Cubists and their works and realized that this would drastically change his own style of painting, and perhaps also his outlook on life. But though his formal vocabulary was indeed modified, his basic aim of expressing emotions remained unchanged. In the Paris exhibition catalogue, for whose preface he was chiefly responsible, he wrote:

One may remark, also, in our pictures spots, lines, zones of colour which do not correspond to any reality, but which, in accordance with a law of our interior mathematics, musically prepare and enhance the emotion of the spectator.

We thus create a sort of emotive ambience, seeking by intuition the sympathies and the links which exist between the exterior (concrete) scene and the interior (abstract) emotion. Those lines, those spots, those zones of colour, apparently illogical and meaningless, are the mysterious keys to our pictures.[31]



Gino Severini
Italian, 1883—1966
War. 1914
Oil on canvas,
$36^{1}/_{4} \times 28^{3}/_{4}''$
Collection
Mr. and Mrs. Joseph Slifka,
New York

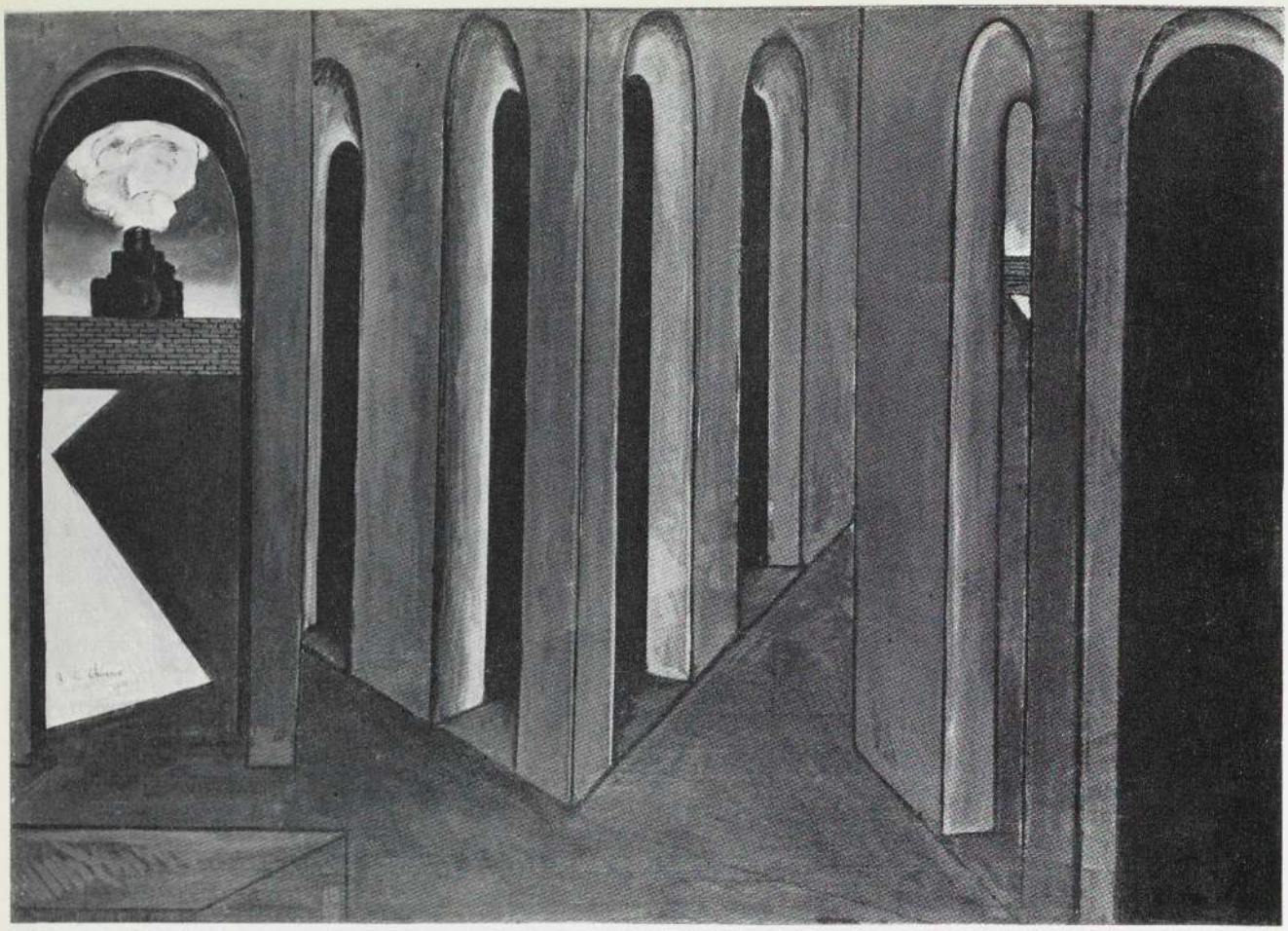
"We wish to glorify war — the only health giver of the world," Marinetti proclaimed in his Manifesto of 1909. In line with their enthusiasm as political activists, immediately on the outbreak of the First World War in August, 1914, the Futurists began intensive propaganda and demonstrations calling for Italian participation.

War was one of several related paintings of 1914—1915 that Gino Severini included in his one-man show, "First Futurist Exhibition of Plastic Art of the War," held at the Galerie Boutet de Monvel in Paris, January 15—February 1, 1916. In a concurrent article, Severini described his pictorial intentions:

I believe . . . that a modern work of plastic art should not only express the idea of an object and its extension (continuité) *but also a kind of plastic* ideograph *or synthesis of general ideas . . . . For example I have tried to express the idea:* War, *by a plastic composition made up of these realities, Cannon, factory, flag, mobilization order, airplane, anchor.*

According to our concept of ideational realism, no more or less naturalistic description of a battle field or carnage could give us the synthesis of the idea: War, *better than these objects which are its living symbol.*[32]

The symbols alluding to the army, the navy, and the air force, and the inscription EFFORT MAXIMUM in large capitals, parade the outward signs of heroism still to come. In some other paintings of 1915 included in his exhibition, such as *The Armored Train*, Severini portrayed a more concrete and aggressive glorification of war and the beauties he found in military equipment.



Giorgio de Chirico. Italian, born 1888
The Anxious Journey. 1913
Oil on canvas, 29¼×42″. The Museum of Modern Art, New York (acquired through The Lillie P. Bliss Bequest)

In his veneration for the past, Giorgio de Chirico was the antithesis of his contemporaries and compatriots, the Futurists. A recurring motif in his paintings of the years 1913—1914 is the seeming lack of connection between the large open spaces of city squares with their surrounding buildings, and the mechanical world of the railroad. In many of these works, a locomotive hides threateningly behind a wall in the background, with steam rising from its smokestack. The smoking machine seems a threat to the peaceful calm of the silent city.

De Chirico spent his childhood in Greece, where his father was an engineer constructing railroad lines. One of his autobiographical essays is entitled "The Son of the Engineer." His attitude toward trains seems to have been ambivalent. An early drawing, showing a toy train, bears the title *Joy;* and in a short prose piece, "The Song of a Station," he refers to the "little station" as "a divine toy. . . . Little station, little station what happiness I owe you."[33] On the other hand, according to his autobiography, actual train travel upset de Chirico nervously to the point of extreme illness. During his sojourn in Paris, he was often desperately homesick for Italy, so that longing and dread were probably intermingled in his thoughts of a contemplated trip.

These contrasting feelings are apparent in *The Anxious Journey.* The menace of the locomotive, seen head on, is unusually strong. At the same time, the engine's fury is somewhat lacking in real power; encaged, ferocious, it is blocked by the brick wall. In his monograph *Giorgio de Chirico*, James Thrall Soby has described it:

. . . an oneiric, menacing phantom, recognized suddenly, as when one is aware of a motionless snake in one's path . . . . The nightmarish reality of the locomotive is sharpened by its emergence at the edge of a veritable labyrinth of arches, winding in and out, leading nowhere. The painting is clearly a dream image, expressing the terror of being lost in a railroad station before an important journey, of trying desperately to locate a train, only to discover it finally at the far end of an inaccessible corridor.[34]

Jacob Epstein. British, born U.S.A., 1880—1959
The Rock Drill. 1913—1914; cast 1962
Bronze, 28″ high
The Museum of Modern Art, New York
(Mrs. Simon Guggenheim Fund)

It was in the experimental pre-war days of 1913 that I was fired to do the rock drill, and my ardour for machinery (short-lived) expended itself upon the purchase of an actual drill, second-hand, and upon this I made and mounted a machine-like robot, visored, menacing, and carrying within itself its progeny, protectively ensconced. Here is the armed, sinister figure of to-day and to-morrow. No humanity, only the terrible Frankenstein's monster we have made ourselves into . . .

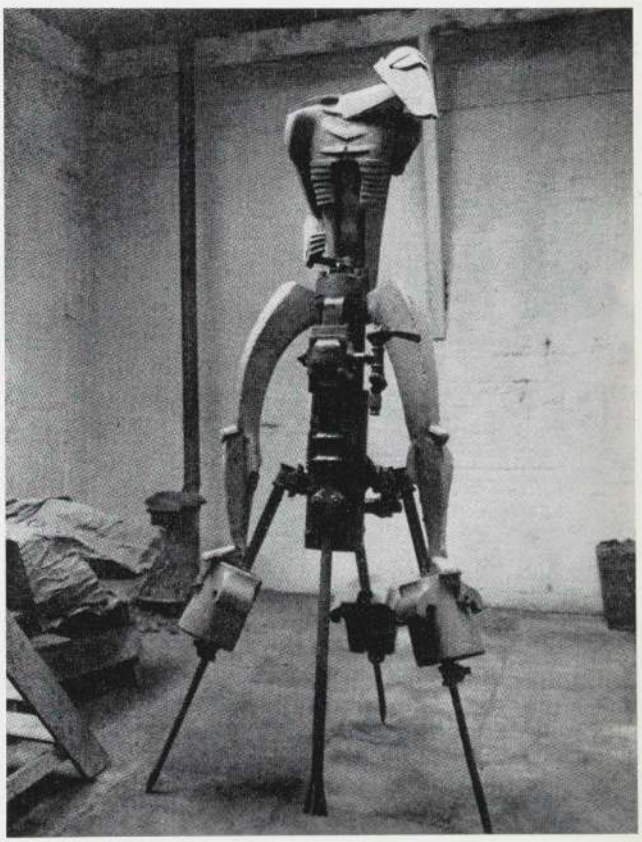
Later I lost my interest in machinery and discarded the drill. I cast in metal only the upper part of the figure.[35]

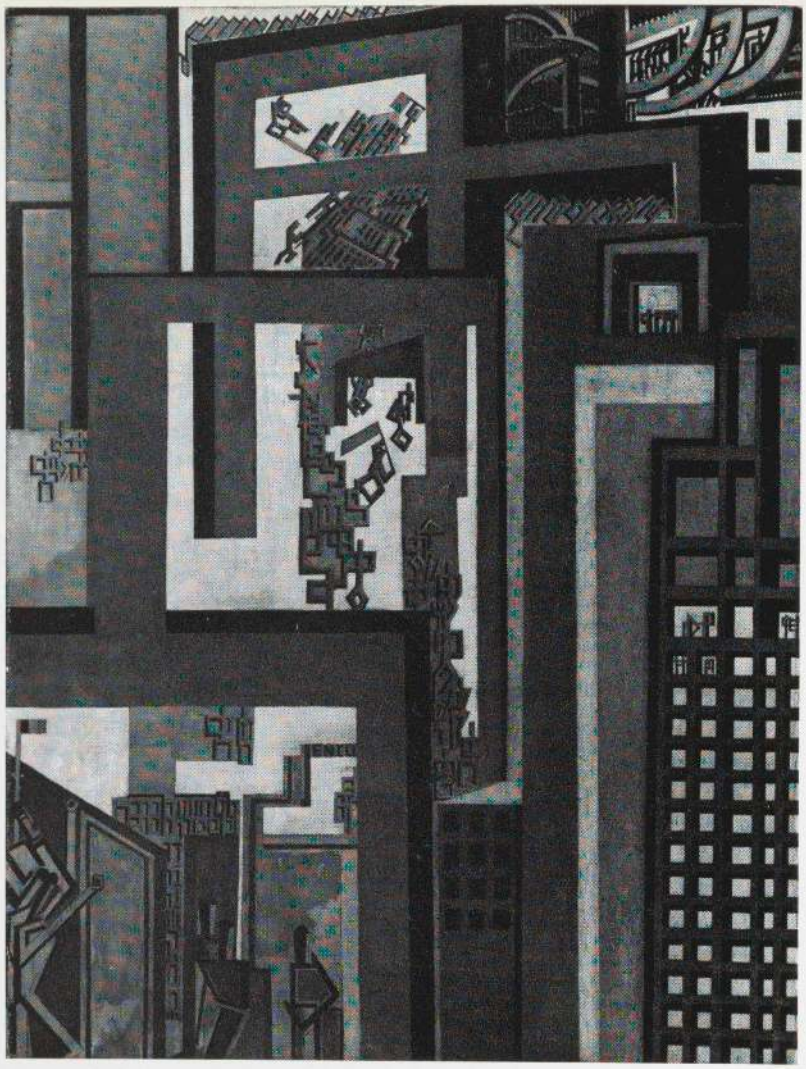
After thus describing *The Rock Drill* in his *Autobiography* some forty years later, Epstein goes on to add that: "I had thought of attaching pneumatic power to my rock drill, and setting it in motion, thus completing every potentiality of form and movement in one single work," but he abandoned this idea, deciding that it would provide "a kind of excitement . . . far removed from the nature of the aesthetic experience and satisfaction that sculpture should give."

The confusion in Epstein's thinking about *The Rock Drill* is typical of the ambivalent attitude toward machinery held then and later by many people who, for lack of a clear commitment, have been unable to define their opinions or positions toward it. As Richard Buckle has pointed out, Epstein's concept of a masked man drilling rock "held for him the fascination of a heroic, demonic, even sexual image";[36] its phallic character is especially evident in some of the preparatory drawings. At the same time, as the passage from his *Autobiography* makes clear, Epstein also felt a kind of abhorrence and fear of the figure, which he termed "menacing," "sinister," "terrible," and devoid of all humanity.

When the plaster model was exhibited in London in March, 1915, it was mounted on an actual rock drill that formed a tripod-like base. It seems almost too symbolic that Epstein ultimately took this away, thereby depriving the sculpture of most of its original meaning. His fear of the machine turned out to be too strong. Unable to resolve this undefined emotional crisis, his art and ideas thereafter lost some of their original revolutionary energy and in general took a more traditional turn.

The Rock Drill (plaster model mounted on a drill, 1915)





Wyndham Lewis
British, born U.S.A., 1884—1957
The Crowd (Revolution). c. 1915
Oil and pencil on canvas, 6′7″ × 5′1/2″
The Trustees of the Tate Gallery, London

Wyndham Lewis was the most articulate spokesman for the short-lived movement called Vorticism, which for a few years injected feverish life into the London art scene, though what it represented is hard to pin down. A statement by Lewis in the catalogue of the group's only exhibition, held in London in 1915, announced that its three cardinal characteristics were "ACTIVITY . . . SIGNIFICANCE . . . ESSENTIAL MOVEMENT." In his autobiography, published in 1939, he declared: "'Vorticism' accepted the machine-world: that is the point to stress. It sought out machine-forms. The pictures of the Vorticists were a sort of *machines.*"[37] Still later, in 1956, he defined Vorticism as: ". . . what I, personally, did, and said, at a certain period."[38]

Lewis regarded himself as an anti-Futurist, for the Future, he said, appeared to him "just as sentimental as the Past,"[39] and he succesfully sabotaged one of Marinetti's lectures in London in 1914. The Vorticists, nevertheless, were certainly strongly influenced by the Italian Futurists.

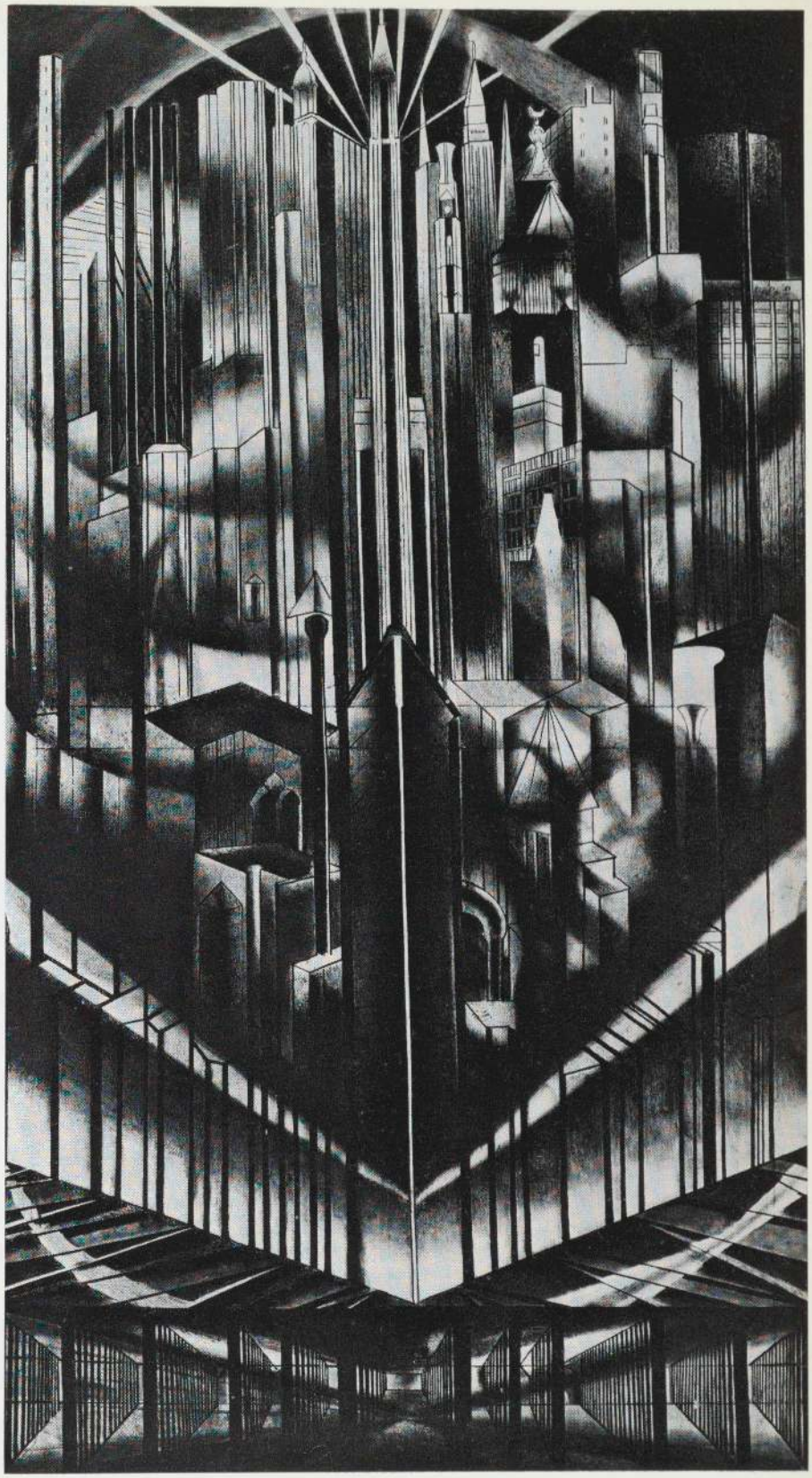
The Crowd, painted in the heyday of English Vorticism, may be regarded as a work of constructivist art before Constructivism. Forces of construction and destruction are juxtaposed and in battle. The painting is built up of zones of action, defined by different kinds of mechanical and geometrical forms, new and unseen in architecture at that time. Instead of human beings, there are a few robot-like figures. But the most remarkable feature of the painting is its play of scale, which gives it great monumentality. What happens within it seems to happen on a universal level.

A Vorticist, lately, painted a picture in which a crowd of squarish shapes, at once suggesting windows, occurred. A sympathiser with the movement asked him, horror-struck, "are not those windows?" "Why not?" the Vorticist replied. "A window is for you actually A WINDOW: *for me it is a space, bounded by a square or oblong frame, by four bands or four lines, merely."*
— Wyndham Lewis, 1915.[40]

Joseph Stella

American, born Italy, 1877—1946

New York Interpreted, III: The Skyscrapers. 1920—1922
Oil on canvas, 8′3¾″ × 4′6″
The Newark Museum



Joseph Stella, like Epstein, was in Paris during the climactic year 1912, where he met a number of the avant-garde artists and saw the Futurist exhibition at Bernheim-Jeune. The first works that he painted after his return to America were strongly under the influence of the Futurists, especially Severini. Within a few years, however, Stella began to paint semi-abstract canvases in a style that was distinctively his own: *Brooklyn Bridge,* and the series of five huge paintings, *New York Interpreted,* of which *Skyscrapers* is one.

To Stella, New York was the embodiment of all the elements of modern civilization, and he wanted to render it thus. These paintings were to bear no judgment on the city, raise no hymn to it, tell no tourist anecdote. "New York is my wife,"[41] he said, and he spoke of the "towering, imperative vision" that the city imposed on him.

The city appeared to him as an enormous lattice, constructed by barbaric cyclopes and constantly moved by the vibrations of light and nocturnal sound. He sought to render by his colors the metallic, "steely" quality peculiar to New York.

The Futurists had insisted on dynamic motion; Stella offers a frozen Futurism, in which motion is captured by repeated verticals. The skyscrapers rise like pipes in an organ, while beneath the city the subway tunnels repeat their rhythms on a smaller scale. Instead of motion, there is stability; instead of giving a fugitive impression, Stella stresses what is both typical and symbolic. "His city soars but it has the solidity of steel and stone."[42]

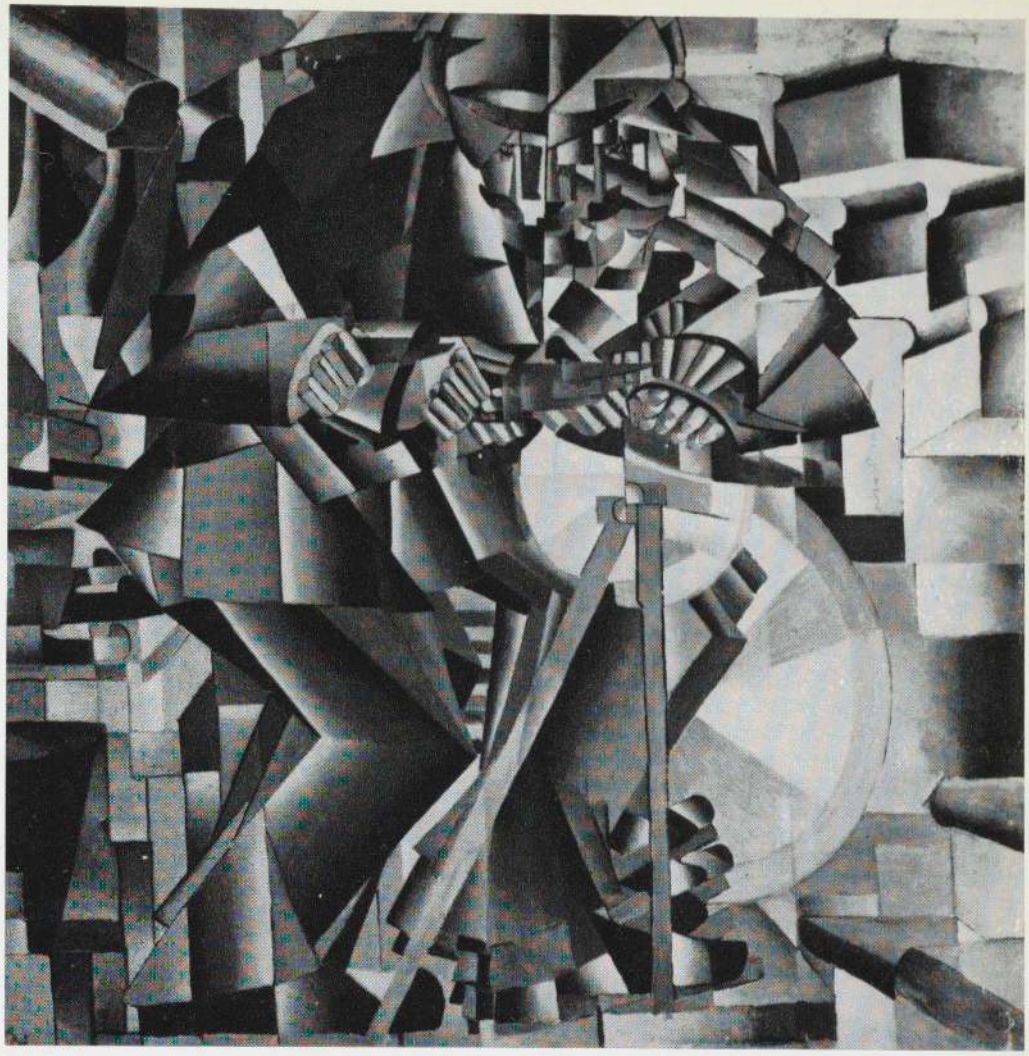
Natalia Goncharova
Russian, 1881—1962
The Clock. 1910
Oil on canvas, $41^{3}/_{8} \times 31^{1}/_{8}$″
Staatliche Museen, Nationalgalerie, Berlin

In the years just before and after 1910, most of the revolutionary trends in modern art found an international meeting-ground in Russia, especially Moscow. Futurism, known almost immediately by the translation in 1909 of Marinetti's Manifesto, was a literary as well as an artistic movement. In painting, it was blended with Impressionism and Cubism to form a distinctive style, one of whose leading exponents was Natalia Goncharova.

Generally speaking, the Russian Futurists seem to have had a more profound interest in the mechanical world than their Italian counterparts, who were mostly concerned with spectacular machines that embodied the sensation of speed and emitted loud noise. The Russians made more serious attempts to interpret the machines' complexity and understand their principles. The paintings that they produced, however, were often less formally accomplished and elegant than those of the Italians.

It is interesting that the Futurist program of propagating the new machine world should have developed in two European countries, Italy and Russia, which had had relatively little contact with modern industry. Perhaps only a Russian artist would have thought of making a pictorial interpretation of a clock. In most of Europe, the mechanization of time took place so long ago that everyone takes it for granted. (Only in the monasteries of Greece, such as those on Mount Athos, is the interval between sunrise and sunset still counted out as twelve hours, irrespective of season, just as in the early Middle Ages.)

By standardizing time and routinizing the hours in which man works and plays, the clock may well be the mechanical device that has most greatly changed human life; yet oddly enough, it has rarely formed the subject for painting. In Goncharova's picture, it is clearly associated with speeded-up productivity (compare Chaplin's *Modern Times*, page 157).



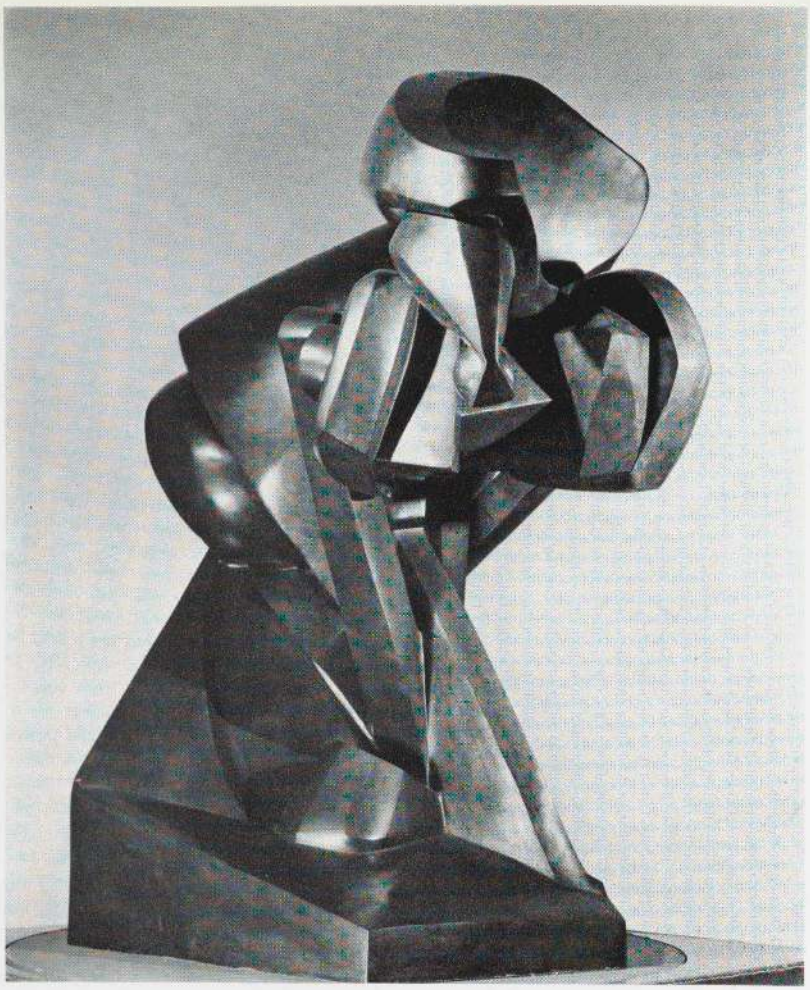
Kasimir Malevich
Russian, 1878—1935
Knife Grinder
c. 1912
Oil on canvas,
$31^3/_8 \times 31^3/_8''$
Yale University
Art Gallery,
New Haven,
Collection of
the Société Anonyme

Kasimir Malevich's *Knife Grinder* seems to have particular affinities with Léger's early Cubist painting, which was well known in Russia at the time through exhibitions and reproductions. The stairs also bring to mind those in Duchamp's *Nude Descending a Staircase* of the year before (see page 75), though of course successive steps are an obvious device to use in a pictorial description of rhythmic movement.

Malevich had previously painted a number of pictures showing figures engaged in various kinds of occupations, but this is his only preserved machine subject. Here the man has become one with his machine, as his eyes concentrate on his task and his foot works the pedal that revolves the grindstone. The painting is a monument to the happy relations that may exist between a man and a very simple, transportable, outdoor device which he owns, operates, and uses to make his living.

The year after he painted this picture, Malevich's style changed radically. He abandoned Cubism and developed a non-representational type of painting, which he called Suprematism and which he believed could best express the pure world of feeling. Many Suprematist compositions are of squares or circles, perhaps the most famous being *White on White* of 1918, in the collection of The Museum of Modern Art.

Malevich and Tatlin were leaders of the two extremes of advanced art in Russia around the years of the First World War and the Revolution. Malevich was a mystic, who came to believe in an art freed of all material or utilitarian considerations: "... the efficiently mechanized world could truly serve a purpose if only it would see to it that we (every one of us) gained the greatest possible amount of 'free time' to enable us to meet the only obligation to nature which mankind has taken upon itself — namely to create art."[43] Tatlin, on the other hand, who called his program the "culture of materials," declared that he was a "materialist constructivist" (in the 1920s, he called himself a "productivist"), and most of his later works are related to problems of technology (see pages 107—109, 144—145).



Raymond Duchamp-Villon
French, 1876—1918
Large Horse (Le Cheval majeur). 1914; cast no. 1 of second enlarged version, 1966
Bronze, 59″ high
Collection Mrs. Alan Wurtzburger, Stevenson, Maryland

Raymond Duchamp-Villon's *Large Horse* is the first sculpture to give form to the idea of the machine as a creation independent of nature. A series of preparatory studies shows that Duchamp-Villon began with a rather traditional, realistic conception of a horse and rider. Gradually the sculpture grew more and more abstract; the rider disappeared, while the horse became increasingly less like a creation of *nature* and increasingly more like a creation of *man* — the machine.

Although certain parts of the sculpture resemble shafts and pistons, the *Horse* has rather few formal references to actual mechanical elements. The impression of movement and function results from the same kind of economy and straightforwardness that a designer of machines uses to achieve the most efficient performance of his apparatus. Welcoming the mechanical age, Duchamp-Villon declared that he had almost reached "the point where one views life in such a way that it no longer appears except in the form of a higher dynamics."[44] In contrast to Futurist works, however, in which the rendering of movement generally tends to be confused, complex, and pictorial, Duchamp-Villon's *Horse* is lucid and architectural. Concentrating on an essentially static form, the artist built up tensions within it; the impression of movement derives, as in Cubism, from multiple intersecting perspectives. By an intellectual effort of great integrity, Duchamp-Villon charged the form of the *Horse* with such power that it became, in Matisse's words, a "projectile,"[45] while some of his other contemporaries called it "The Mechanical Horse, almost Steam."

In evolving his concept for this sculpture, Duchamp-Villon's ideas about the machine were surely influenced not only by the Futurists, but also by his younger brother, Marcel Duchamp, and other artists of their circle at Puteaux. In particular, it is easy to recognize the similarity between the form of the horse's head and the central parts of Duchamp's painting of 1912, *The Bride* (see page 76) — referred to by Duchamp as an "agricultural machine." A creature with no human forms, the bride nevertheless, according to Duchamp's own descriptions, functioned both as a human being and as a machine (in a metaphor similar to that implied by the term "electronic brain").

Robert Delaunay. French, 1885—1941
Eiffel Tower (La Tour Rouge). 1911
Oil on canvas, 49 1/2 × 36 1/8″
The Solomon R. Guggenheim Museum, New York

The tower that Gustave Eiffel and the young Swiss engineer Maurice Koechlin constructed for the Paris International Exposition of 1889 has become a monument to the nineteenth century's practical science and technical utopianism. (Eiffel, born in 1832, was of the same generation as Jules Verne). A triumph of experience gained from bridge building, the Eiffel Tower is the brilliant solution to the problem of reaching a maximum height (just under a thousand feet) while using a minimum of material.

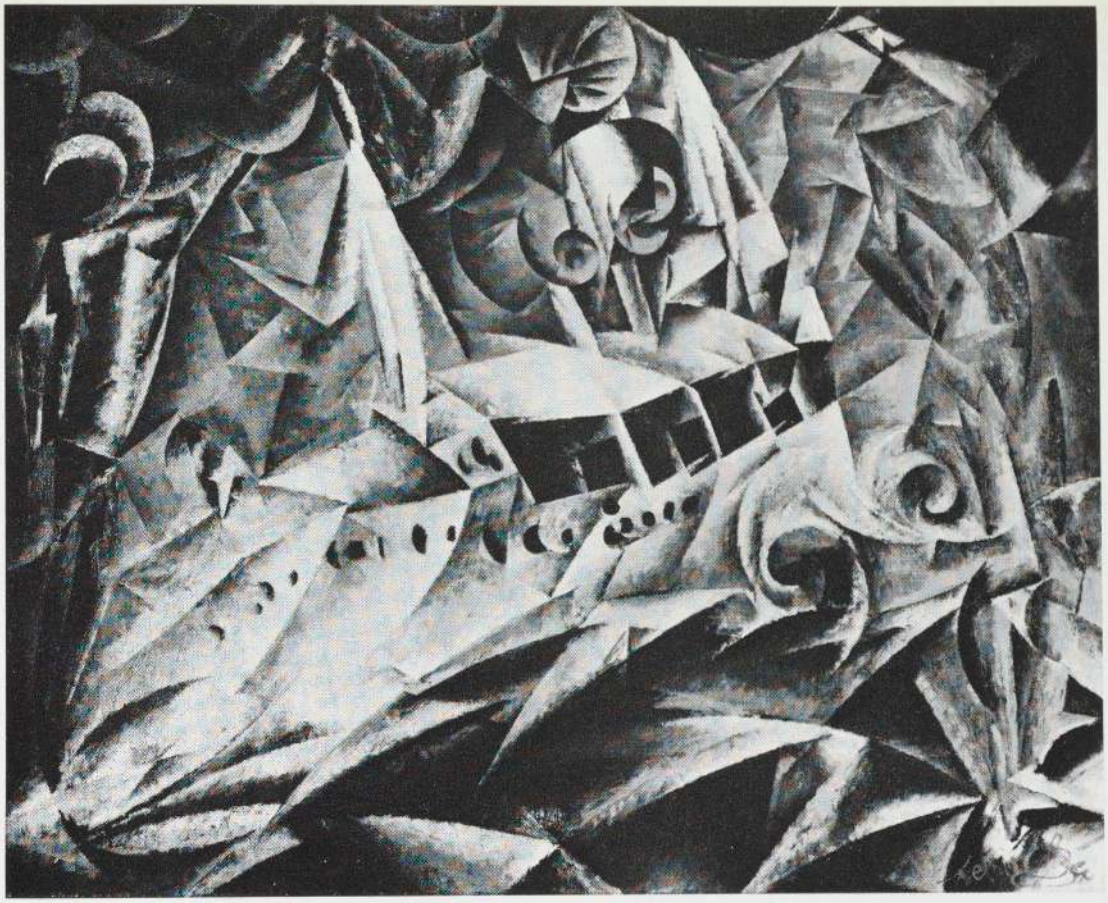
In spite of its rationality, the Tower was not at all appreciated by cultivated Parisians of the time, who resented it only as the rape of their fine, cultured city by technology. Just a month after the government and the city signed their contract with Eiffel, a group of three hundred right-thinking leaders of society protested in the name of good taste. The Tower might have corresponded to their ideas for bridge construction but not to their ideas for architecture. It was a time of divorce between reason and emotion; and though this "unnecessary" Tower is perhaps the most interesting sculpture of the nineteenth century, it was a long time before it was accepted as such. It was a popular success at the Exposition, but revenues from entrance fees declined thereafter, to rise again only after 1904.

The first artists to include the Tower in their pictures were probably Seurat, who painted it while it was still under construction, and *le douanier* Rousseau, who placed it in the background of his 1890 self-portrait. Pioneers in other fields also paid tribute to it; for example, the Brazilian aeronaut Santos-Dumont circled it in a spectacular dirigible flight.

Around 1910, the Tower was rediscovered by artists and poets, among them Guillaume Apollinaire, who made it the subject of one of his *Calligrammes*, and Raymond Duchamp-Villon, who wrote an article on it in 1913. Besides praising its virtuoso economy of materials (he pointed out that if the iron used in its construction were melted down into a square plate of the same area as its base, the plate would be less than 2 1/2 inches thick), Duchamp-Villon admired its beauty and daring: "Across from Gothic Notre-Dame, the true tower of modern Paris rises on the Champ de Mars. Both works . . . are born of the same desire to build and both fulfill a similar dream of superhuman exaltation."[46]

It was above all Robert Delaunay who, beginning in 1909, made the Tower a central subject of his painting. Like other artists of the time, he found that the Tower presented a dynamic interplay of spaces, a place where forces interacted, and where the moving spectators themselves became part of the drama. It provided them with the "fourth-dimensional experience" of space-time that they were constantly discussing, and it was also a symbol of the new, dynamic, technical world which it had heralded when first it was built. To seize that feeling, a new kind of painting had to be invented. The poet Blaise Cendrars has described Delaunay's paintings of the Eiffel Tower:

He disjointed the Tower to fit into his frame, he truncated it and bent it over to give it its three hundred meters of dizzy height. He adopted ten views, fifteen perspectives. One part is seen from below, another from above, the houses surrounding the Tower are taken from the right, the left, from a bird's eye view, from the ground . . . .[47]



Lyonel Feininger. American, 1871—1956
Odin I (Leviathan). 1917
Oil on canvas, 32×39½″
Collection Roman Norbert Ketterer,
Campione d'Italia (Lugano)

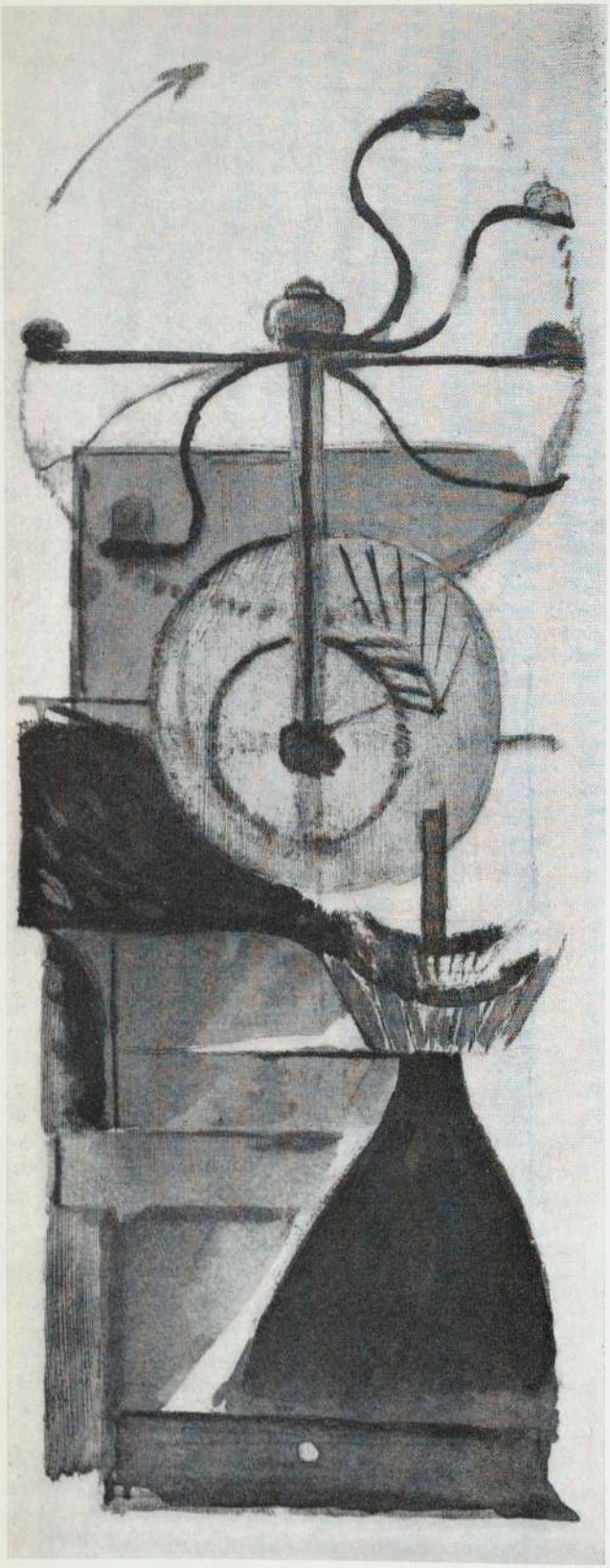
As as child growing up in New York, Feininger was impressed not only by powerful locomotives (see page 47) but also by the boats on the East River, close to his home. "And in the '80's I remember the Hudson, teeming with vessels, schooners, sloops, not to mention the magnificent side-wheelers plying up and down the river . . ."[48]

Years later, at Heringsdorf on the Baltic in 1912, Feininger made notes for his composition of the steamer *Odin* (or *Leviathan*, the name of the huge sea monster traditionally given to big vessels). After numerous sketches in charcoal, he completed this version of the subject. It is one of his rare pictures of steamers; in general he preferred sailboats in his semi-abstract paintings. The steamer in *Odin I,* one of the few interesting paintings of such a subject, is neither humorous nor human. Analytical and severe, it represents the resolution of Feininger's artistic ideas at the time. (*Steamer Odin II,* in the collection of The Museum of Modern Art, was painted ten years later, when he was far more concerned with the atmospheric play of light between sky and sea.)

Odin I is a much more demonic and frightening image than any of Feininger's locomotives. It looks like some powerful evil being thrusting its way ahead through opposing waves at night.

The big ocean-going liners of the early twentieth century were miniature reproductions of the society they served. There was a rigorous class system. Hidden below the elegant superstructures, the enormous machinery was operated by hard-working men, most of whom only occasionally saw the sea and the sun. Competition between the lines led to the building of ships that could push through any kind of weather to meet their schedules, and which therefore became bigger and bigger. The old notion that at sea you must collaborate with nature was entirely abandoned, for now man could force his way through almost any conditions. When the ocean sometimes took its revenge, as with the sinking of the *Titanic*, there was great astonishment.

The steamships developed a subculture of their own, with grim harbors, a rigid hierarchy of ships and men, and small colonies of the great nations that were nothing but coaling stations fringing the major waterways.



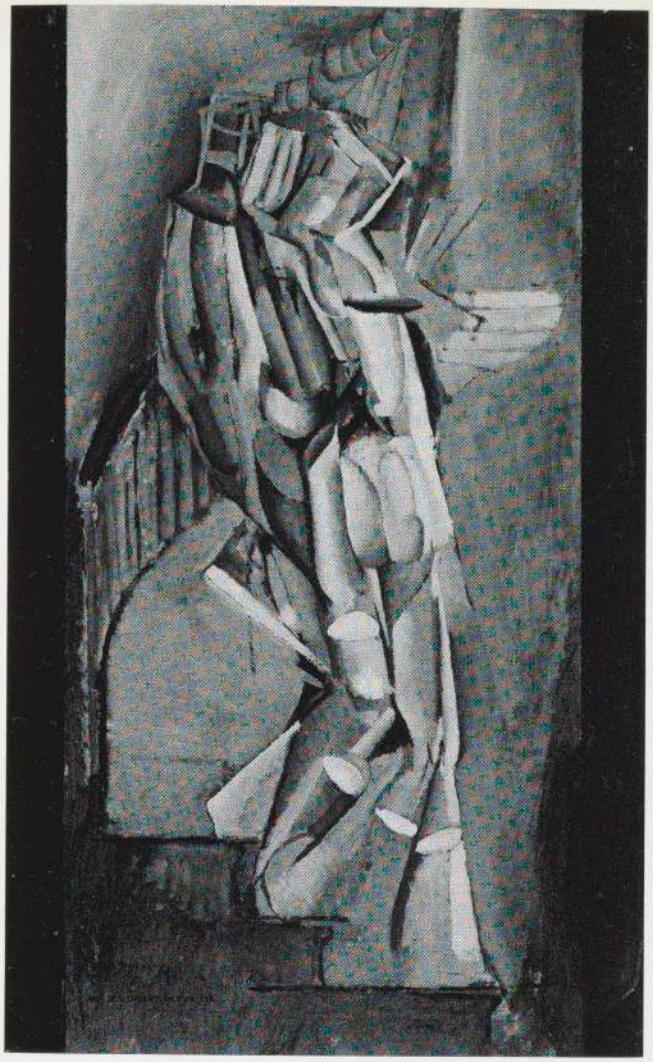
Marcel Duchamp. American, born France, 1887
Coffee Grinder. 1911
Oil on wood, $12^{7}/_{8} \times 4^{3}/_{4}''$
Collection Maria Martins, Rio de Janeiro

Late in 1911, Marcel Duchamp's brother, Raymond Duchamp-Villon, asked some of his friends among the artists to make paintings for his kitchen. Duchamp's contribution was this coffee grinder: "But instead of making a figurative coffee grinder, I used the mechanism as a description of what happens. You see the handle turning, the coffee after it is ground — all the possibilities of that machine."

In this intimate machine-painting, the mechanism is portrayed through its function and personality. Duchamp himself has recognized what a central role this work played in his development. As Harriet and Sidney Janis wrote in 1945:

Duchamp regards the Coffee-grinder as the key picture to his complete work. Looking back through the structure of his achievement, the elements, constantly in one mutation or another, in one degree of complexity or another, are all present in simple form in the Coffee-grinder: *movement, already referred to; the magic of mechanics; and the inimitable flair for pointed irony.*

From the time of the Coffee-grinder, *physical, poetic, esthetic or ironic references to the machine are part of Duchamp's created world; the kinetics of the machine, its dynamics, energy and rhythms, machine-made products, machine forms, and the machine itself formulate its physics, fill its space. In this world, the human mechanism operates like a machine and resembles the machine; natural forces are synchronized with manmade power. Duchamp animates the machine, mechanizes the soul. Between these counter effects, motion becomes pure operation without objective or consciousness.*[49]



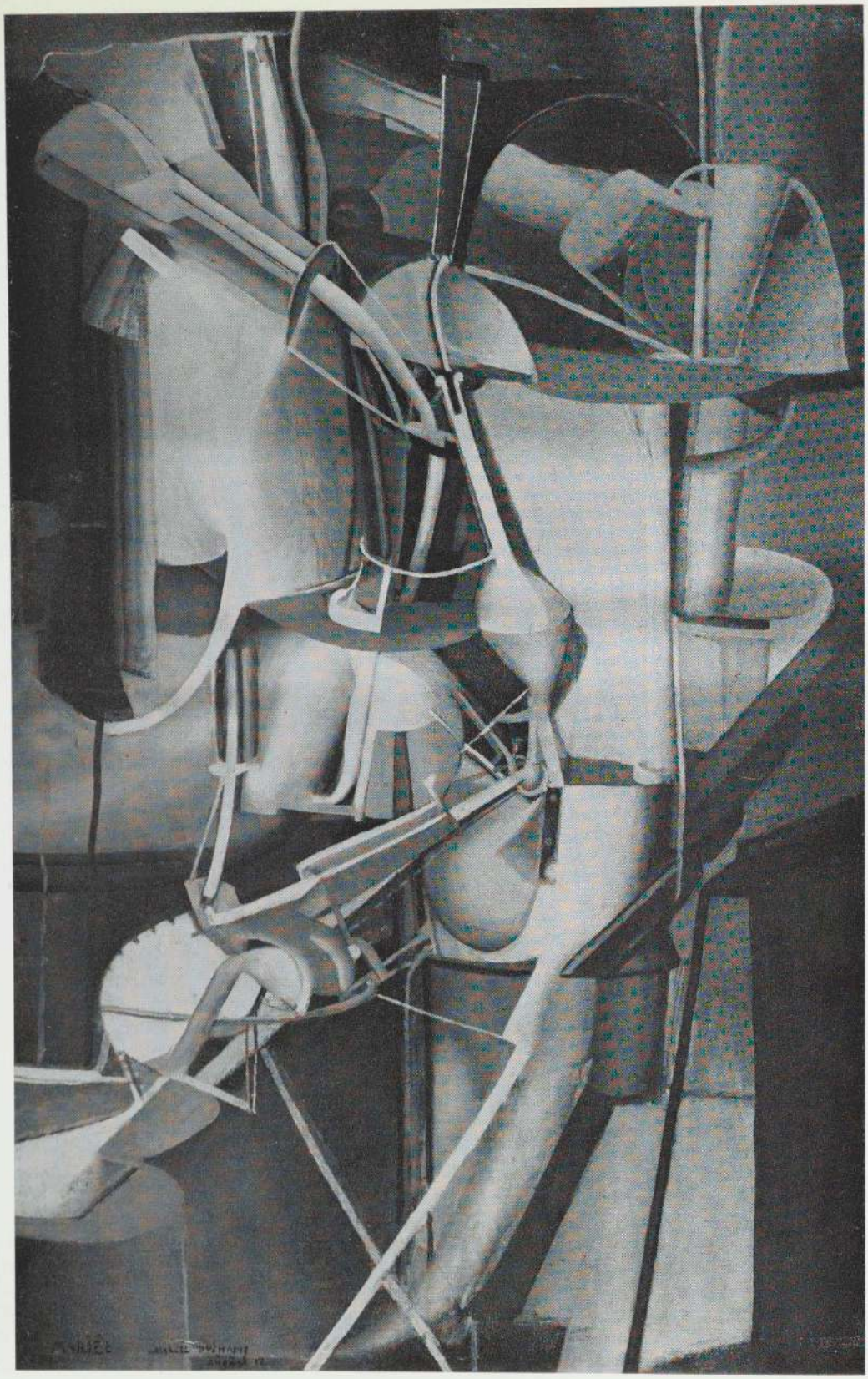
Marcel Duchamp
Nude Descending a Staircase, No. 1. 1911
Oil on cardboard, $37^{3}/_{4} \times 23^{1}/_{2}''$
Philadelphia Museum of Art
(Louise and Walter Arensberg Collection)

Marcel Duchamp
Nude Descending a Staircase, No. 3. 1916
Watercolor, ink, crayon, and pastel over photographic base, $58 \times 35^{1}/_{2}''$
Philadelphia Museum of Art
(Louise and Walter Arensberg Collection)

The first version of the painting that was to create such a sensation when shown in Barcelona and Paris in 1912, and at the Armory Show in New York the following year, dates from the same month as the *Coffee Grinder. Nude, No. 3,* a replica produced by coloring a photograph of the same size as the painting, was made a few years later for Duchamp's friend and patron Walter Arensberg, who regretted not having acquired the original at the Armory Show but subsequently added it to his collection. That Duchamp had in mind no conventional nude is evident in his statement:

. . . it is an organization of kinetic elements, an expression of time and space through the abstract presentation of motion . . . . But remember, when we consider the motion of form through space in a given time, we enter the realm of geometry and mathematics, just as we do when we build a machine for that purpose. Now if I show the ascent of an airplane, I try to show what it does. I do not make a still-life picture of it.

When the vision of the Nude flashed upon me, I knew that it would break forever the enslaving chains of Naturalism.[50]



Marcel Duchamp
The Bride. August, 1912
Oil on canvas, $35^{1}/_{8} \times 21^{3}/_{4}''$
Philadelphia Museum of Art
(Louise and Walter Arensberg Collection)

The Bride is depicted as a well-oiled machine running on "love gasoline." This differs from all earlier mechanistic images of beings: there are no recognizable human forms, and no true machine forms either. The Bride is an entirely *new* being, a creation of man in the same sense that a machine is. In the nineteenth century, the mechanization of man had begun to be transformed into the humanization of the machine. The love-machine, in its basic concept, already foreshadows the electronic brain.

Instead of being the representation of a mechanism in movement, like the *Coffee Grinder, The Bride* is rather the depiction of ideas and the processes of thought. It is an image of thinking and of how thinking functions; and since words are the crystallization of thought, from 1912 on Duchamp's pictures seem to be images of language as much as of anything else.

In such a situation, the rational relationships between the parts of mechanical machines had an all too obvious formal pattern. Symbols like levers, shafts, and so forth were both too simple and too obtrusive. Perhaps for this reason, Duchamp penetrated into a more basic form of science — chemistry. The powers inherent in chemistry are of course more independent of man than is mechanical energy. They involve natural elements, are less subject to external control, and also have to do — like *The Bride* — with the liquids of the body. References within the pictorial apparatus of *The Bride* seem to be drawn principally from a chemical laboratory and apparently refer particularly to processes of distillation.

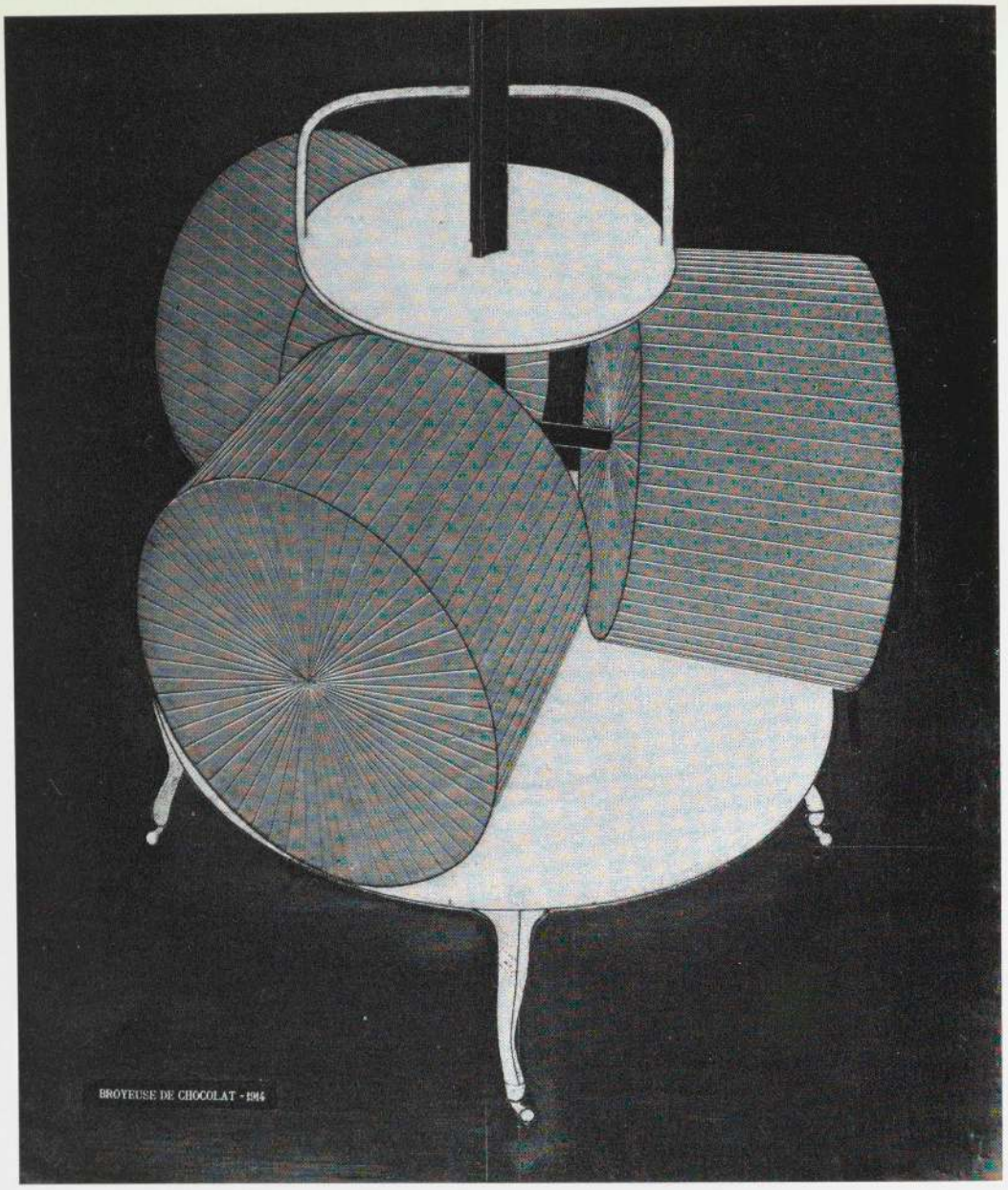
The irrational variety of chemistry is its forerunner, alchemy. Ulf Linde has pointed out the important role that alchemical theories played in the development of Duchamp's mythology of the bride and her bachelors (see pages 79—80). It was at the time when he was in Munich painting *The Bride* that Duchamp began to explore this enormously complex story, which was to find its fullest expression in the *Large Glass* and the multiple notes he made for it.

Question: Would you comment on the use of modern machines and science in your work?
Duchamp: People living in a machine age are naturally influenced either consciously or unconsciously by the age they live in. I think I was conscious enough when I introduced derision into that sacrosanct era. Humor and laughter — not necessarily derogatory derision — are my pet tools. This may come from my general philosophy of never taking the world too seriously for fear of dying of boredom.[51]

Just as Cimabue's pictures were paraded through the streets, our century has seen the airplane of Blériot, laden with the efforts humanity made for the past thousand years, escorted in glory to the [Academy of] Arts and Sciences. Perhaps it will be the task of an artist as detached from aesthetic preoccupations and as intent on the energetic as Marcel Duchamp, to reconcile art and the people.[52]

The prophet who wrote this in 1913 was Guillaume Apollinaire. His prediction is the more remarkable in that, at the time, Duchamp had barely begun to collect his notes for the *Large Glass* and, in terms of actual works, he had executed nothing that might have connected him in any way at all with Blériot's airplane. We know, however, that Apollinaire wrote many of his essays in *The Cubist Painters* in consultation with the artists, and we may therefore surmise that these words reflect Duchamp's own ideas about the kind of work he intended to do in the future. Neither Apollinaire nor Duchamp were at all interested in the political and social aspects of art; what this extraordinary statement anticipates is that Duchamp would change the entire conception of art. How long this might take is suggested by the vastness of the historical perspective that Apollinaire drew.

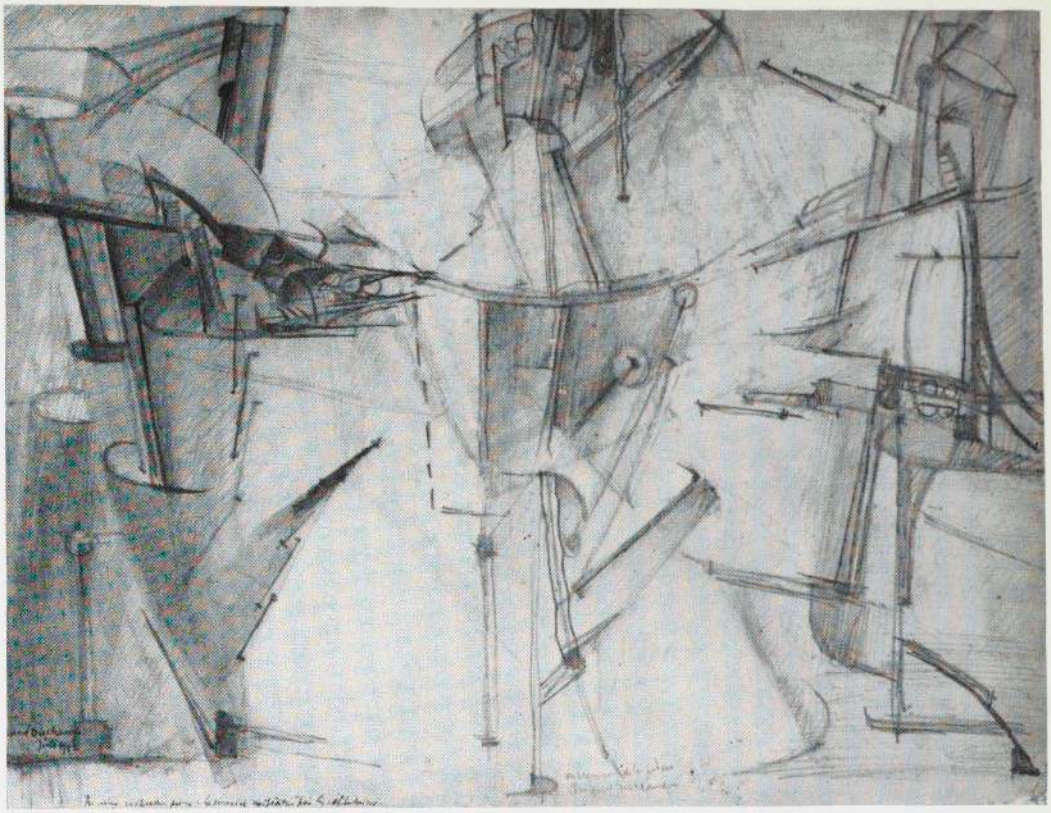
The ultimate result of Duchamp's application of energy is that everything manmade is art. Only two categories remain: art and nature. The production of machines, as manmade, manufactured objects, then comes to play a very specific role: they are manmade-women, or as Picabia (or perhaps Duchamp?) called them, "girls born without mothers" (see pages 82—83).



Marcel Duchamp
Chocolate Grinder, No. 2. 1914
Oil, thread, and pencil on canvas, $25^1/_2 \times 21^1/_4''$
Philadelphia Museum of Art
(Louise and Walter Arensberg Collection)

As a youth in his home town, Rouen, Duchamp had seen a chocolate grinder in operation in a confectioner's window. This image seems to have impressed him greatly, and he made several representations of it. Although by 1912 he had officially decided to abandon oil painting, he took it up again in 1913 to paint the first version. *Chocolate Grinder, No. 2,* a year later, is fabricated of string glued onto the canvas with paint and varnish and sewn at the intersections. Machines are manufactured of whatever kind of materials are required. The introduction of "unworthy" materials was another blow at Renaissance conceptions of art.

The *Chocolate Grinder* is the first painting to depict a machine as an object worthy of a portrait. It is difficult to know how close the likeness is, though in this version the radial threads enhance the impression of movement. The chocolate grinder was destined to become a central figure in the lower part of the *Large Glass*, a "bachelor apparatus" corresponding to the bride in the upper half. As already noted, Duchamp was relatively less interested in mechanics than in the more basic, hidden, and mysterious forces of chemistry. May one conjecture that, just as Duchamp presented *The Bride* to Picabia shortly after it was painted, he also made him a gift, so to speak, of all the beautiful forms of the mechanical machine?



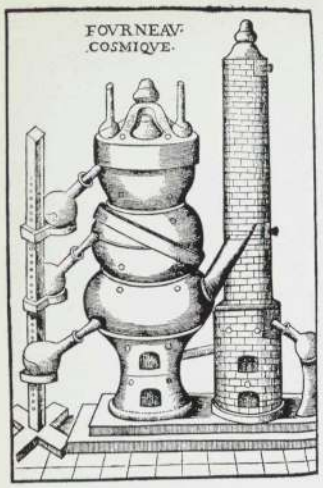
Marcel Duchamp
The Bride Stripped Bare by the Bachelors (first study for the *Large Glass*). 1912
Pencil and wash, $9^3/_8 \times 12^5/_8''$
Cordier and Ekstrom, Inc., New York

This drawing was done in Munich in July, 1912, during the same sojourn in which Duchamp produced *The Bride.* Below his signature and the date at the bottom left, it bears the inscription: *Première recherche pour: la mariée mise à nu par les célibataires,* and in the center: *Mécanisme de la pudeur/Pudeur mécanique.*

The unusual subject of the disrobing of a bride by two bachelors has unexpected precedents. Ulf Linde has found some specific examples indicating that the underground science, alchemy, was one of the main sources of inspiration for Duchamp when he evolved the mechanics of the *Large Glass.*[53] The scene of the undressing of the young maiden is depicted in many alchemical treatises. We reproduce an illustration for a text by the philosopher Solidonius, in which the loss of color that the alchemists' material undergoes in the course of liquefaction and transmutation is likened to a young virgin being divested of her rich apparel on the eve of her nuptials, to offer herself to her bridgeroom in all her splendid nudity.[54]

Many notations for the *Large Glass* in Duchamp's *Green Box* seem to be his subsequent elaboration of ideas that originated within the system of alchemical mysticism. The "Great Work" of the alchemists was to produce gold by effecting the "philosophical marriage" of the baser, dry, male element, sulphur, and the volatile female element, mercury. These are frequently represented by a king dressed in red and a queen robed in white. The generative operation took place within a "cosmic oven," whose lower and upper parts, again, were respectively male and female;[55] the mercury was contained in a vessel of pure glass — a metaphor often applied to the Virgin. It seems likely that the upper part of Duchamp's *Large Glass* relates to the philosopher's mercury, which is the principle both of the universal love of nature and of redemption through work; while the lower part, the bachelor's apparatus, is connected with the alchemical concept of sulphur.

Bride Stripped Bare. From a manuscript of the philosopher Solidonius (after Eugène Canseliet, *Alchimie*)



Cosmic Oven
Woodcut from
Annibale Barlet,
La Théotechnie ergocosmique,
Paris, 1653
(after Kurt Seligmann,
Magic, Supernaturalism, and Religion)

Other notes in the Green Box also refer to "an arbor-type of the Bride." This has its parallels in the (seemingly paradoxical) alchemical concept of mercury as a naked Virgin and "arbor philosophica."[56] Perhaps the most famous embodiment of alchemical concepts is to be found in the tarot cards, which are directly connected with the Great Work. The cards in this pack, like the documents in Duchamp's *Green Box*, can be constantly reshuffled and reinterpreted. Duchamp makes many references to the *pendu femelle*. The tarot card *Le Pendu* ("Hanged One") represents sacrifice and ordeal; the characteristics associated with it seem to epitomize Duchamp's attitude toward art and life:

The purifications undergone have prepared the strong Soul for the accomplishment of the Great Work. This demands on the part of the operator absolute disinterestedness. If he owns treasures, he should disseminate them for those who will benefit by harvesting them. Renouncing the practical course taken by most human beings, he should have the courage for generous self-forgetfulness and the disavowal of any irresistibly agitating love.[57]

Mercury as Virgin and "Arbor Philosophica"
Woodcut, from *Pandora*,
Basel, 1588
(after C. G. Jung,
Psychology and Alchemy)

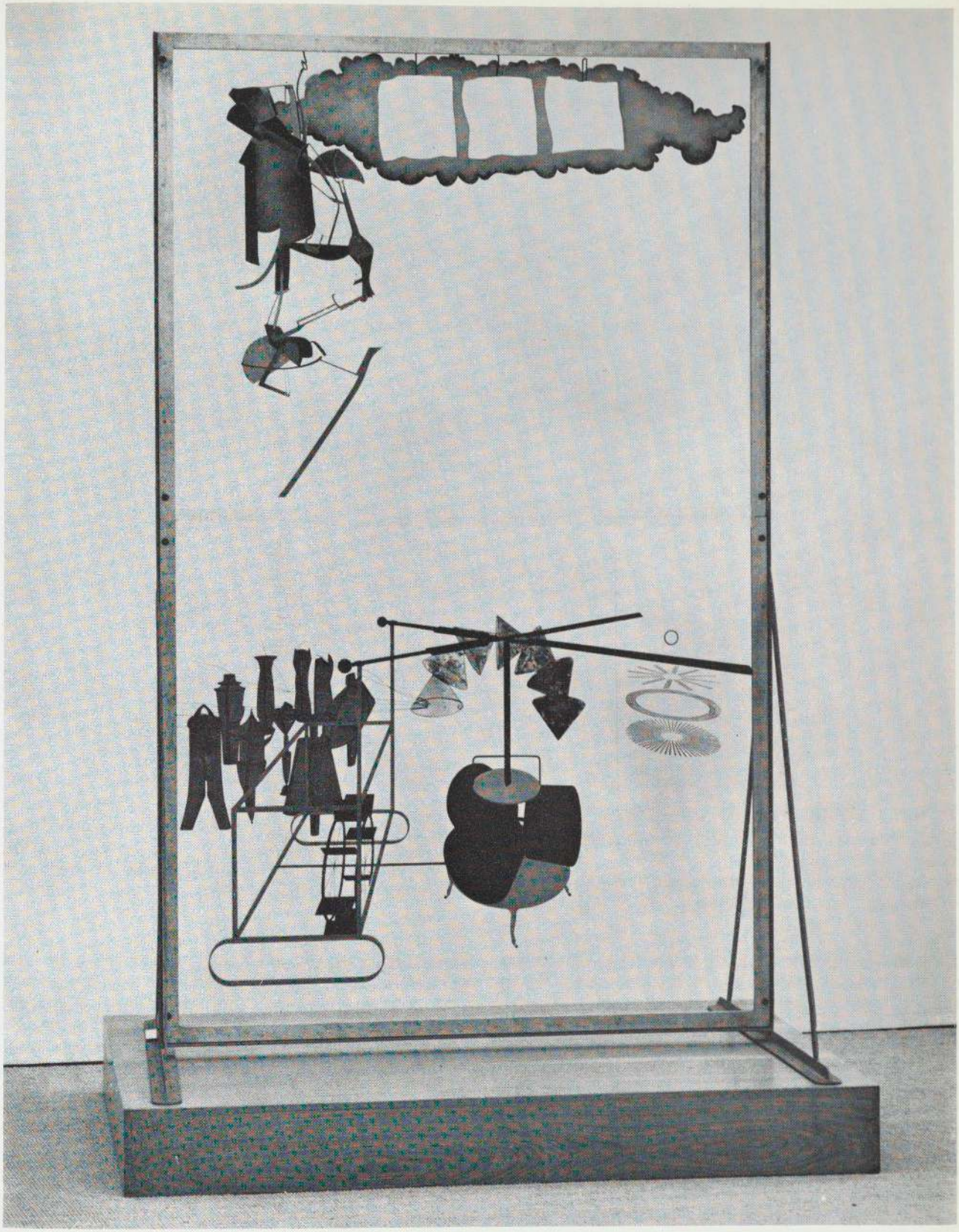
Marcel Duchamp
The Bride Stripped Bare by Her Bachelors, Even (the *Large Glass*). Original 1915—1923; replica by Marcel Duchamp and Ulf Linde, 1961
Oil, lead, lead wire, foil, dust, and varnish on glass, 9′3″ × 6′7/8″
Moderna Museet, Stockholm

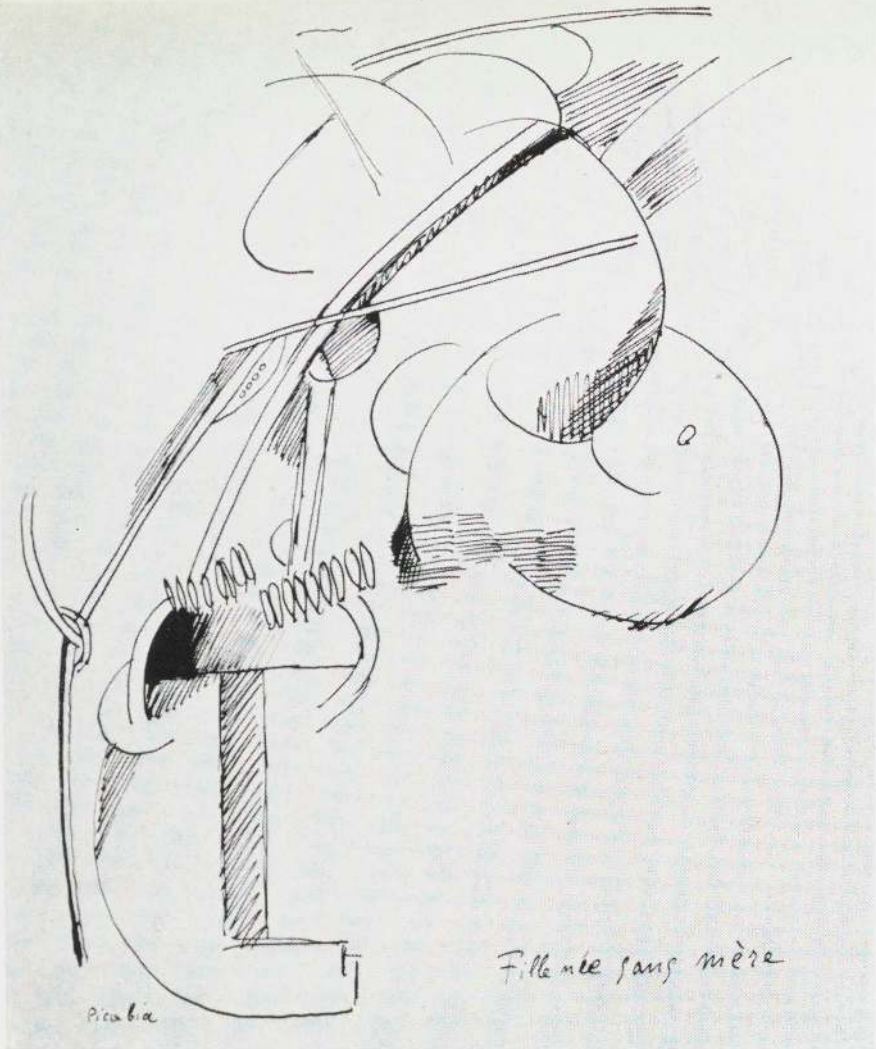
After his initial researches, begun in 1912, Duchamp worked on the *Large Glass* itself for nine years, from shortly after his arrival in America in 1915 until he abandoned it, unfinished, in 1923. It is probably the largest single project in modern art and may also be the most important.

It is a "painting" on glass, but most of the materials used are not conventional artists' materials. It contains many dynamic elements, but no physical movement. Asked whether he had intended it as the sketch for a mobile construction, Duchamp replied: "Not at all. It is like the hood of a car; the part that covers the motor."[58] There is, of course, one kind of actual movement, for the relations between the forms on the glass and those seen through it, or reflected in it, constantly change as the spectator moves. Another kind of movement is implicit and plays a more important role. All the elements in the painting are easy to distinguish separately, but they are obviously related to one another like cogwheels in a machine: one part is decisive for the next.

Many texts have been written to explain and comment on the work. Duchamp himself has indicated its significance for him as regards the mechanical world: "The composition obviously partakes of an attitude toward machines, an attitude not in the least admiring but ironic, which I must share with Raymond Roussel, as manifested for me in the production of his *Impressions of Africa* which I saw about 1910."[59] Actually, it was in 1911 or 1912 that Duchamp and Picabia, together with Guillaume Apollinaire, attended a production of Roussel's play, in which, as in the writings of Alfred Jarry, machines are intimately connected with sex.

The *Large Glass* can be read as an intricate machine. Its mechanics are described in detail in the documents regarding its genesis, inventory, and instructions for use that Duchamp published in 1934 (intentionally presented unbound and in random order.)[60] With the help of this collection, one can distinguish a kind of verbal movement, also; a constant change in the functions or identities of the different parts is produced by ambiguities and puns. The ambiguities become multiplied when one looks at the glass itself. Perhaps these changing significations can be regarded as among the more important fuels for the machine of the bride and the bachelors. The most intimate and sentimental feelings and relations of the human race are treated in the language of an instruction manual; and the relations between the bride and her bachelors are hardly conventional ones.



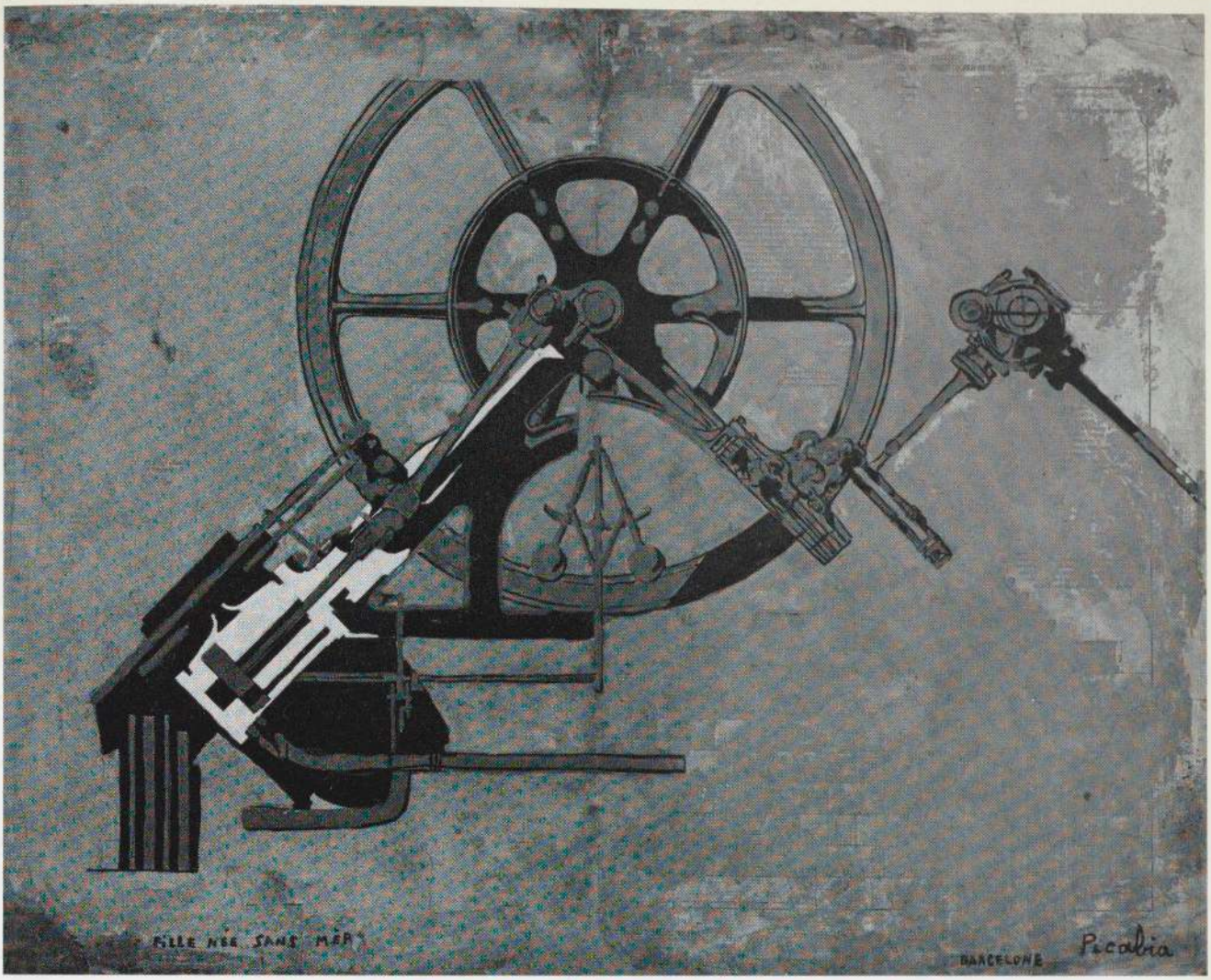


Francis Picabia. French, 1879—1953
Fille neé sans mère (Girl Born without a Mother). c. 1915
Pen and ink, $10^{3}/_{8} \times 8^{1}/_{2}''$
The Metropolitan Museum of Art, New York
(Alfred Stieglitz Collection, 1949)

One of the most fruitful encounters in all modern art was that which took place in 1910 between Marcel Duchamp and Francis Picabia, eight years his senior. For both men, all existing modes of art seemed inadequate for the expression of modern concepts, and therefore new means had to be found.

Central to their thinking were ideas about the machine and its erotic significance. After attending together the performance of Roussel's *Impressions of Africa* (see page 80), the two artists must have had many discussions on this theme in the years during which Duchamp was developing the ideas that were to culminate in the *Large Glass;* and his gift of *The Bride* to Picabia in 1912 can hardly have been made without reference to its content.

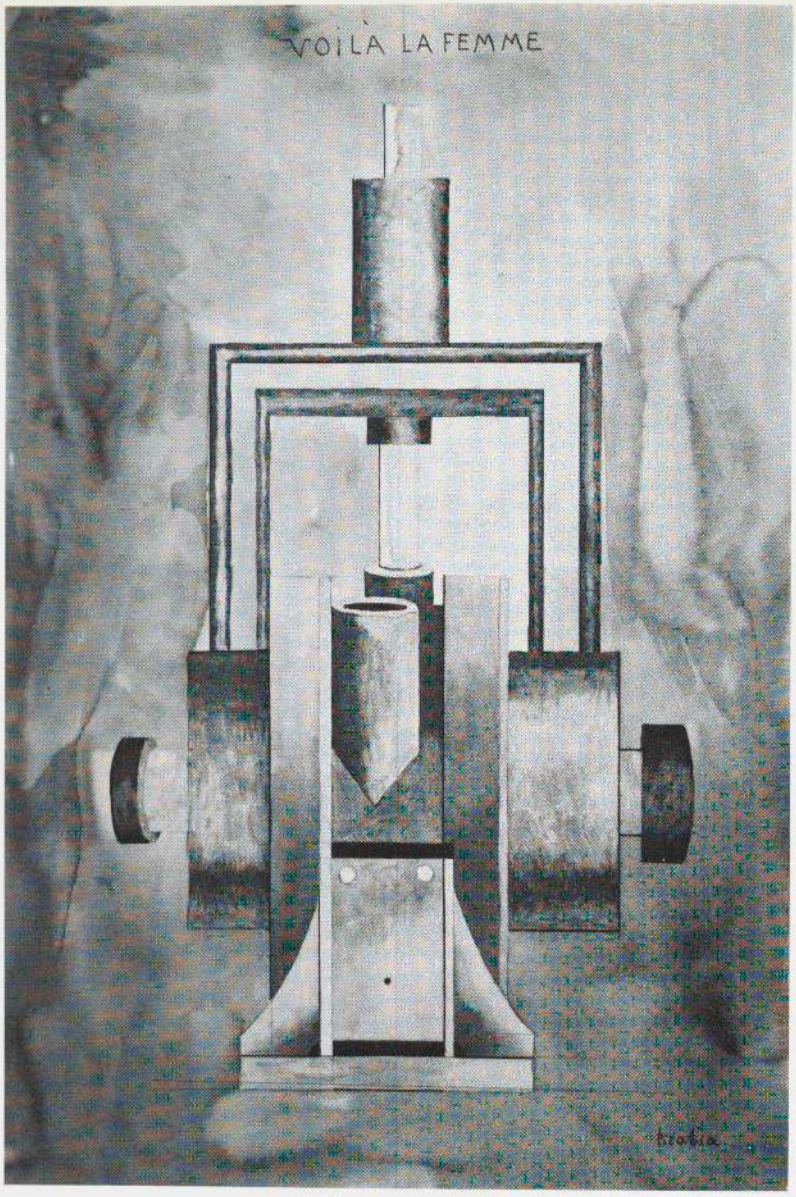
On the vessel that brought Picabia and his wife to the United States for the first time, in 1913, to attend the Amory Show in New York, he became fascinated with a dancer, Mlle Napierkowska. His memories of her seem to have become interwoven with his ideas about the mechanical world. It was not, however, until he arrived in New York on his second visit, in 1915, and renewed his close contacts with Duchamp, that Picabia fully discovered the potentialities of the machine. In an interview that he gave in Duchamp's studio that October, he declared:



Francis Picabia
Fille née sans mère (Girl Born without a Mother)
c. 1917
Gouache on railway-machine diagram, $19^{5}/_{8} \times 25^{1}/_{2}''$
Collection Mr. and Mrs. Arthur A. Cohen, New York

This visit to America . . . has brought about a complete revolution in my methods of work . . . . Prior to leaving Europe I was engrossed in presenting psychological studies through the mediumship of forms which I created. Almost immediately upon coming to America it flashed on me that the genius of the modern world is in machinery and that through machinery art ought to find a most vivid expression . . . I don't know what possibilities may be in store. I mean simply to work on and on until I attain the pinnacle of mechanical symbolism.[61]

Picabia, perhaps acting on a suggestion made by Duchamp, called the machine the "girl born without a mother" — a female being, created by man. It may be significant, with reference to Duchamp's ideas about alchemy, that its practitioners regarded alchemy as a magical means of fertilization whereby a child can be generated without a mother. The phrase "daughter born without a mother" to characterize the machine had been used by Paul Haviland in an article that appeared in the autumn of 1915 in *291*, the review published by Alfred Stieglitz, with whose gallery Picabia had been closely associated ever since his first visit to America. Picabia himself subsequently gave the title *La Fille née sans mère* to the collection of poems and drawings that he published in Lausanne in 1918.

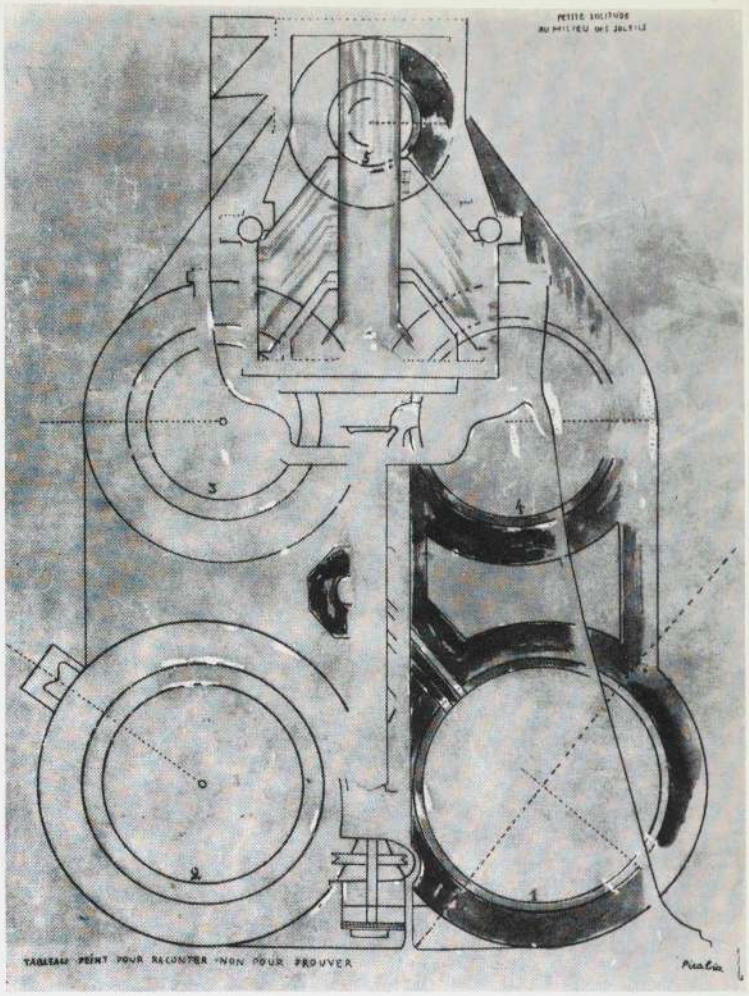


Francis Picabia
Voilà la femme (Behold the Woman). 1915
Watercolor, oil, and gouache, $28^{3}/_{4} \times 18^{7}/_{8}$″
Collection Robert Lebel, Paris

Voilà la femme is one of Picabia's first machinist paintings. It is of a relatively simple kind, in which machine forms completely dominate the pictorial language. The female apparatus ("girl born without a mother") is a kind of pump or compressor. This monumental image reveals how impressed Picabia was by machines when he first discovered them.

As a background to understanding the content of the works from Picabia's machinist period, 1915 to about 1922, one should realize how turbulent a life the artist led during those years. Born in France of a Cuban father and a French mother, he made two trips between Europe and New York during the war years, with the threat of being charged with desertion from French military service constantly hanging over his head. His energies were divided between participation in the artistic activities of his friends in America and the diplomatic missions to Cuba that were the pretext for his transatlantic voyages. His sentimental life was extremely confused, his health became undermined by drugs and alcohol, and he suffered from neurasthenia.

For Picabia, machines represented a new, unsentimental, "mechanical" kind of life that he tried to lead, free from any conventional restrictions or responsibilities. The idea that machines have no morals was one that he found highly attractive. He used his love of the machine as a platform for a pyrotechnic display of his attitude toward life — skeptical, ironical, hedonistic.

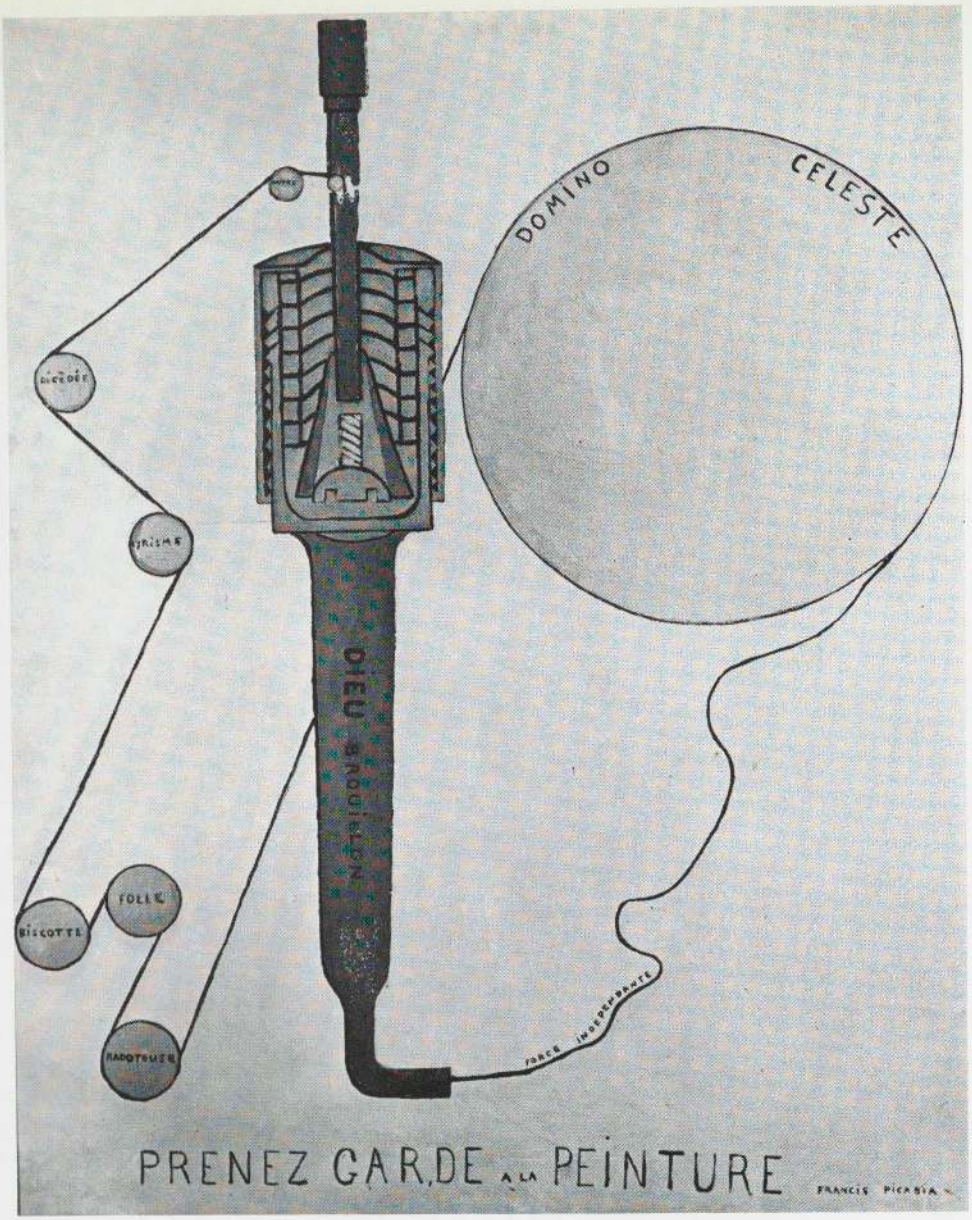


Francis Picabia
Tableau peint pour raconter non pour prouver (Picture Painted To Relate Not To Prove). 1915
Pen and ink and gouache on tracing paper, 8×6″ (composition)
Collection Carl Fredrik Reuterswärd, Stockholm

This is the sketch for an important machine painting that has now disappeared (as has *Cannibalism,* another work of Picabia's in which the influence of Duchamp's *Large Glass* is strongly apparent).[62] In the finished painting, the structure of the machine is more monumental. Picabia treated his machines with a free hand, taking away details, adding color. As William S. Rubin has pointed out, these works, by comparison with the illustrations in mail-order catalogues or newspaper advertisements on which some of them were based, "are as different from their commercial models as are Lichtenstein's paintings from the cartoons that inspired them. Their layout, distribution of accents, and firm contouring reflect a hand and eye still informed by the taste and discipline of Cubism."[63]

The inscription at the top, "Little loneliness in the midst of the suns," refers to the female sex-organ. Picabia's hinting at the endless love-life of machines is sometimes obvious, at other times, as in this case, discreet and private. The title and inscription are typical of the privacy of the jokes in the texts that Picabia provided as accompaniment for his pictures. He held deep convictions about the strength of machines. Their strong plastic forms not only pleased him aesthetically but also symbolized his philosophy of Nietszchean superiority. In creating the machine, man had actually been more powerful than God, because he had succeeded in creating a being stronger than himself. Part of this superiority game was to confuse the spectator.

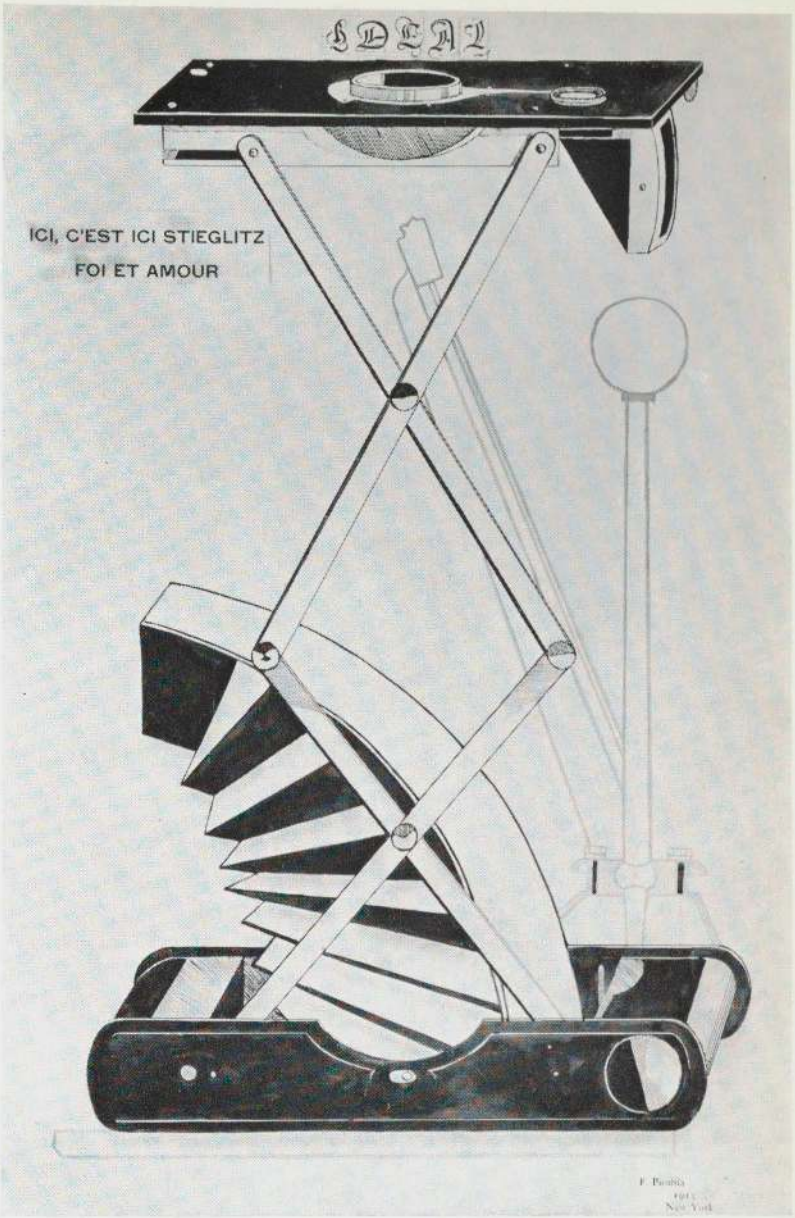
Most of Picabia's machine paintings have very interesting titles, and many also contain inscriptions. However confusing they may seem, he himself declared that they were highly relevant: "In my work the subjective expression is the title, the painting is the object. But this object is nevertheless somewhat subjective because it is the pantomime — the appearance of the title; it furnishes to a certain point the means of comprehending the potentiality — the very heart of man."[64] The relation between a painting and its title sometimes seems close, at other times more haphazard. In a world of exaltation, the inscriptions act like mental catapults, throwing our fantasy out in all directions.



Francis Picabia
Prenez garde à la peinture (Beware of Wet Paint)
c. 1916
Oil, enamel, and metallic paint on canvas, $36^1/_2 \times 28^3/_4''$
Moderna Museet, Stockholm

After returning to Europe from his second visit to the United States, Picabia settled for a while in Barcelona and began to publish a review, which he called *391* after Stieglitz's *291*. It was issued intermittently from Barcelona, New York, Zurich, and Paris between 1917 and 1924. In the second number, one of his friends described the aesthetic shared by Picabia's circle:

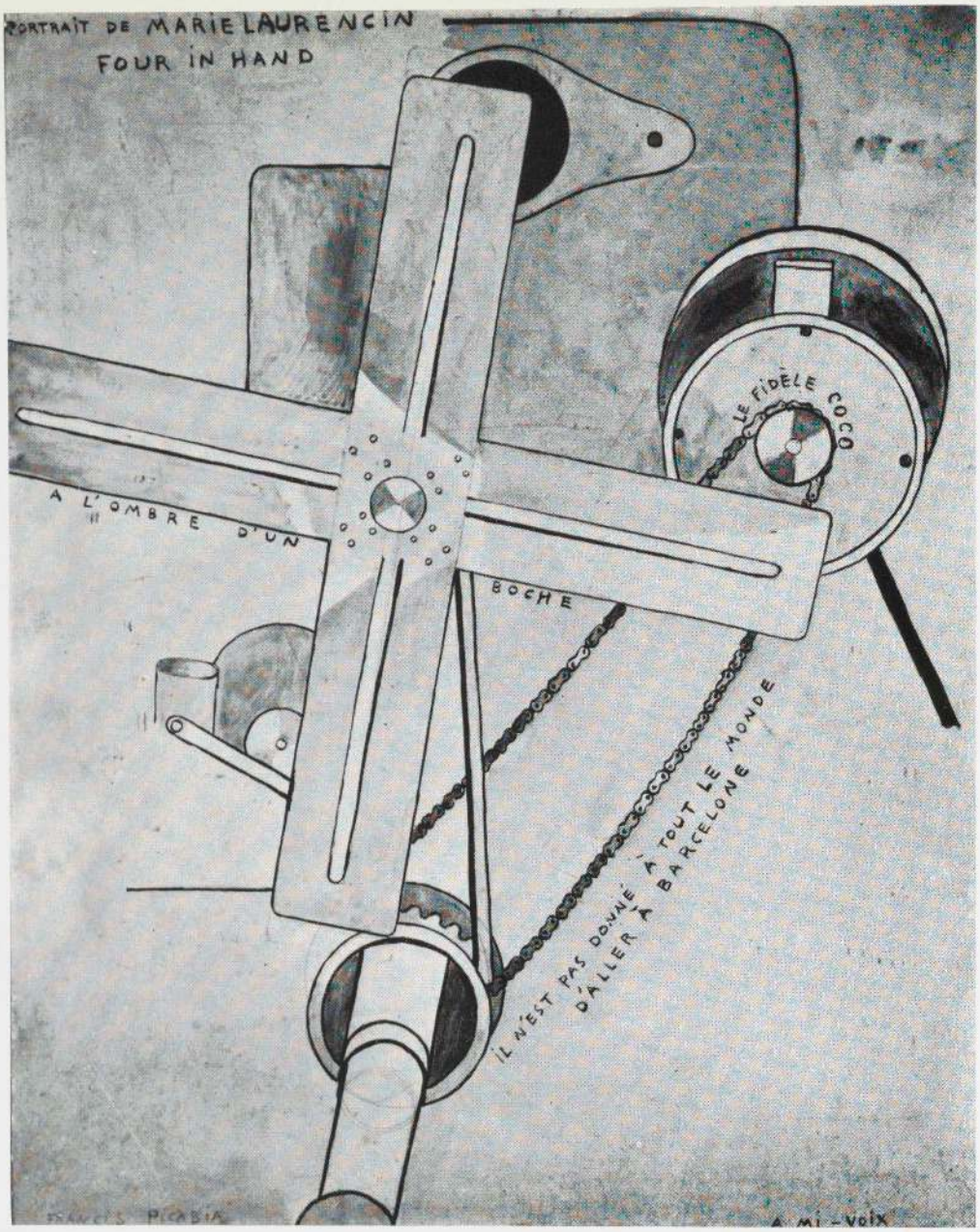
. . . [To an artist of this sort] the knowledge of an object "in itself" is regarded as secondary; the principal thing is the expression of the extremely variable plastic reactions that objects can provoke among themselves, and — as regards man — the mental states that determine the spectacle of those reactions . . . . The world of ideas and forms appears like a sympathetic cosmos filled with correspondences, relationships, and resemblances. He perceives what may be the common link between a flower and a combustion engine, between a line and an idea, a color and a memory, a love and a chemical phenomenon, a biblical personage and a doctrine of art, a piano and a comb, the sea and a streetcar. What might be taken in him as an affectation of the comic is only the result of a pure ingenuousness, a strong and sincere desire to express everything human by the most direct means. His only objective is to trust, to project into material form the realities of his inner self. So every work of art becomes the representation of a private world, re-created in a man's image.[65]



Francis Picabia
Ici, c'est ici Stieglitz
(Here, This Is Stieglitz). 1915
Pen and red and black ink, $29^{7}/_{8} \times 20''$
The Metropolitan Museum of Art, New York
(Alfred Stieglitz Collection, 1949)

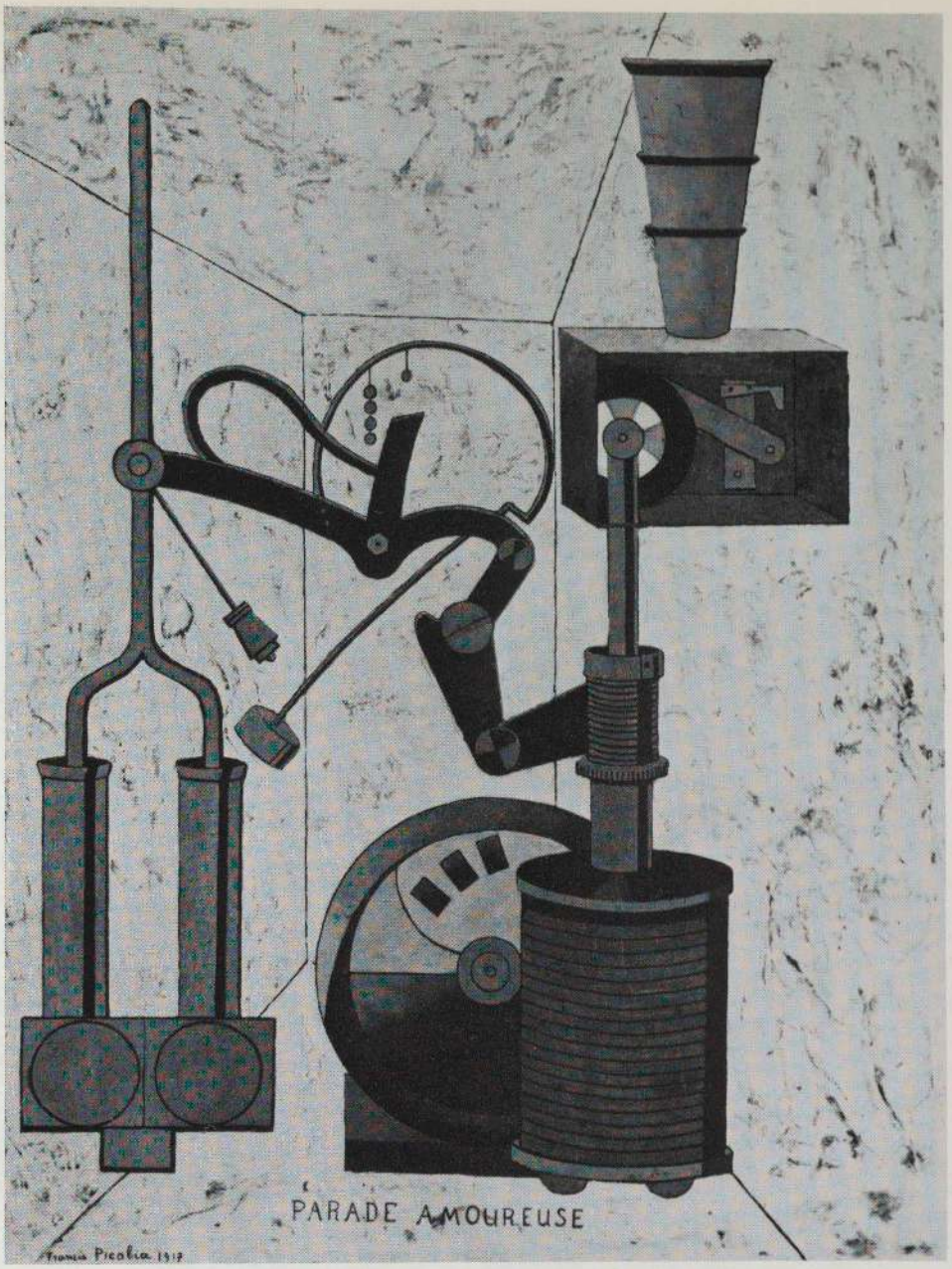
Picabia sometimes used in an explicit way the inviting possibilities that machine forms offered for symbolism. The meaning of these symbols, however, could be understood only by his closest friends and was completely confusing for all others. Confusion was an intentional principle in his art; and Picabia's pictures often seem to gain more from evocation than they might from a precise knowledge of their meaning.

His portrait of Alfred Stieglitz appeared in 1915 on the cover of the July-August issue of *291*. William Camfield has recently explained the circumstances that account for Picabia's portrayal of Stieglitz as a broken camera and for the accompanying inscriptions.[66] After the Armory Show of 1913, Stieglitz felt that the work he had set out to do, the introduction of modern art in the United States, had been accomplished, and he was therefore planning to close his gallery. Some of his younger associates disagreed, feeling that much still remained to be done to help Americans discover themselves through art and photography. Marius de Zayas, a close friend of Picabia's, expressed this view strongly in an article in the same number of *291* for which Picabia's portrait served both as cover and as pictorial equivalent. It may be interpreted: Here, this broken-down camera is Stieglitz, who in spite of his faith and love has failed to attain his ideal.



Francis Picabia
Portrait de Marie Laurencin. c. 1917
Watercolor, 22×17⅞″. Collection Mrs. Barnett Malbin, Birmingham, Michigan
(The Lydia and Harry Lewis Winston Collection)

Like *Ici, c'est ici Stieglitz*, this is another of Picabia's mocking machine-portraits. Marie Laurencin was among the group of avant-garde painters and poets from Paris who settled in Barcelona during the war, where Picabia and his wife met them on returning to Europe in 1916. According to Gabrielle Buffet-Picabia, Picabia associated the vivacious, lively Marie Laurencin with a ventilator — a breath of fresh air in this closed and isolated circle.[67] The inscriptions relate directly to the life of his model: *à l'ombre d'un boche* refers to the fact that her husband was a German, whose nationality indeed shadowed their lives during the war; *le fidèle Coco* was her dog. Such a mingling of his own private reactions with literal facts in the biography of his subject was typical of Picabia. He intentionally used this kind of mixture in his art to denote the interplay between what is easily understandable and what is completely incomprehensible.

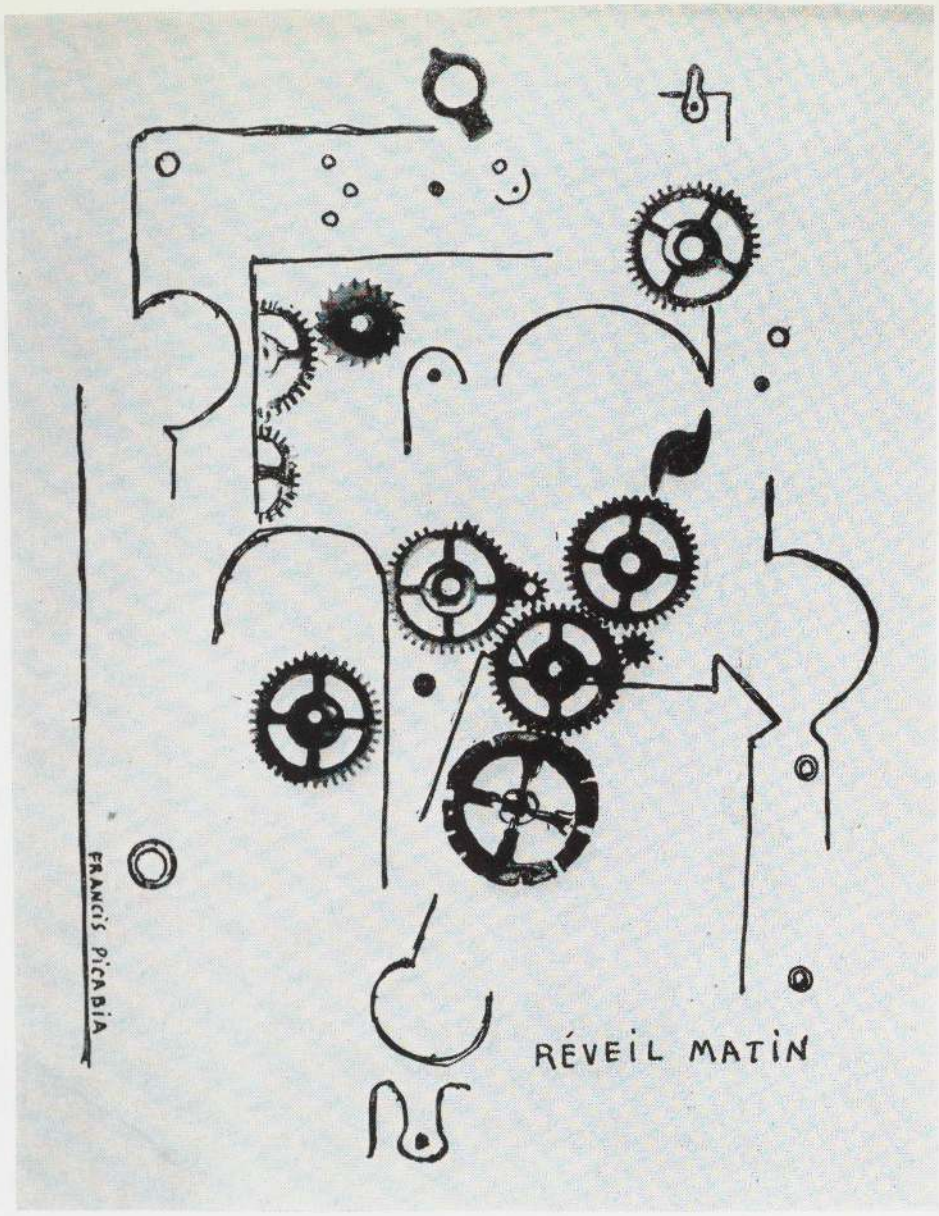


Francis Picabia
Parade amoureuse (Amorous Parade). 1917
Oil on canvas, 38×29″
Collection Mr. and Mrs. Morton G. Neumann, Chicago

Parade amoureuse is one of the most ambitious of Picabia's surviving machine paintings, and a highly characteristic example of his great gift for marrying title and picture. Nothing in the completely irrational, non-functional machine depicted here suggests an erotic situation, beyond that which is implicit in many machines. The title, however, adds a great deal. By triggering our imagination and at the same time increasing our confusion, it enhances the effect that the painting has upon us.

Once Picabia realized the potentiality of machine symbolism, he felt that any combination, any absurdity, was possible and worth trying. In the words of Marcel Duchamp: "Picabia, being very prolific, belongs to the type of artist who possesses the perfect tool: an indefatigable imagination."[68]

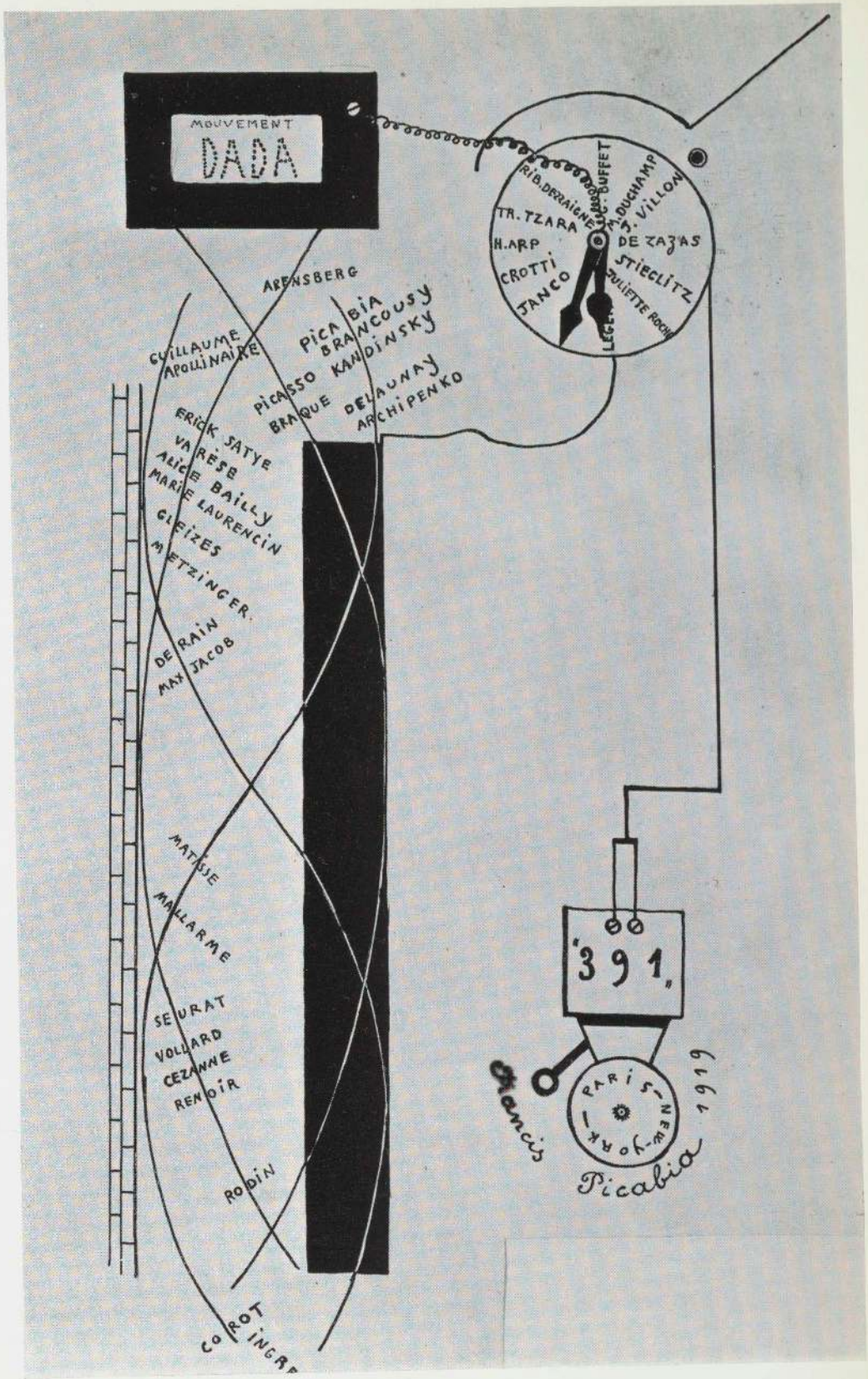
This is one of the first examples in which we see the influence of de Chirico's uptilted perspective, which appears so often in Dadaist works (see pages 110, 120).



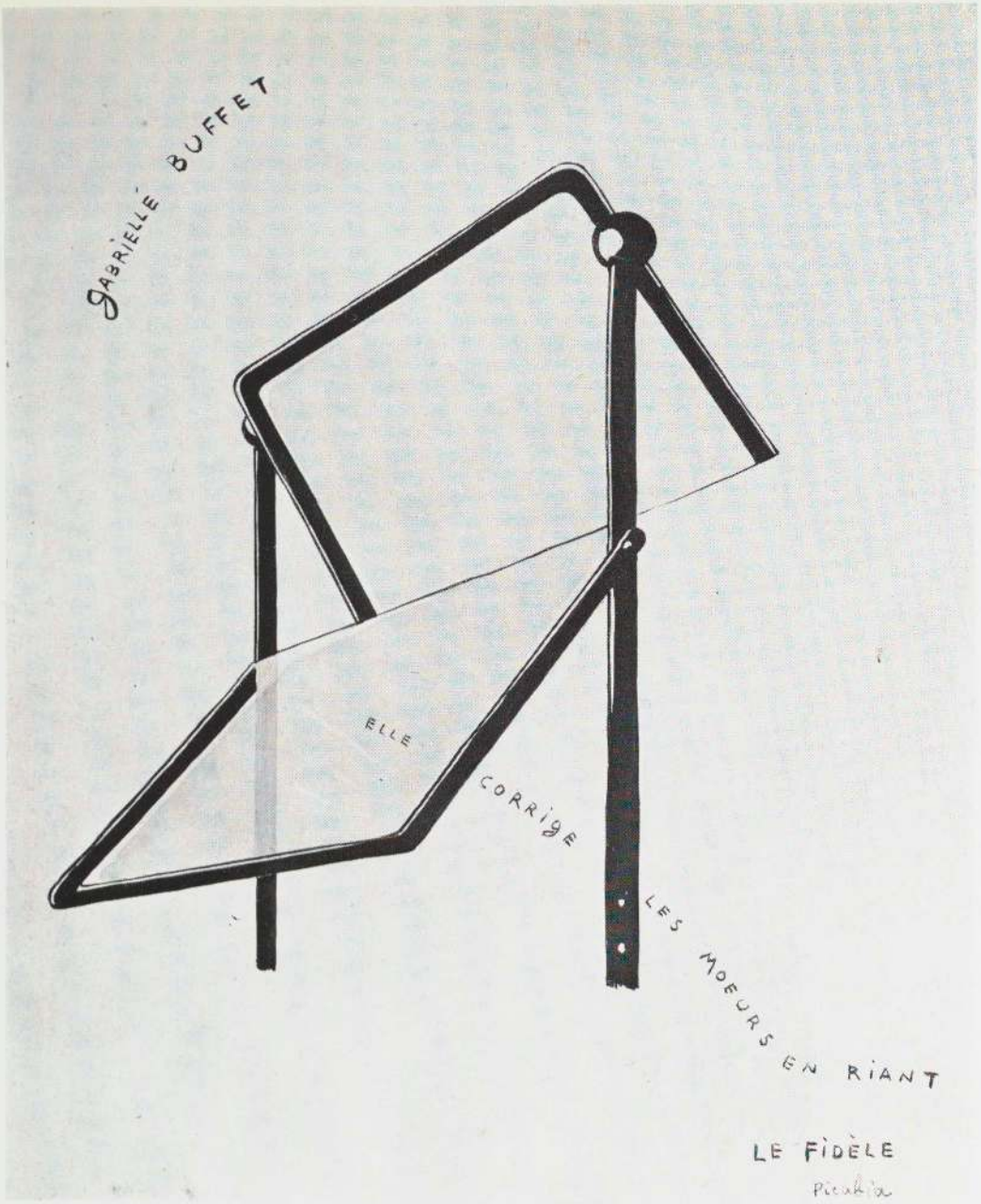
Francis Picabia
Réveil Matin (Alarm Clock). 1919
Ink, 12½×9″
Collection
Mrs. Barnett Malbin,
Birmingham, Michigan
(The Lydia and
Harry Lewis
Winston Collection)

In February, 1918, Picabia went to Switzerland for treatment of neurasthenia. In Lausanne, he published the collection of 51 poems and 18 drawings that he entitled *La Fille née sans mère* (see page 83). It immediately attracted the attention of the Dada group in Zurich, and a few months later Tristan Tzara began a correspondence with Picabia — who up until then had not even heard the word "Dada." Early the following year, the Picabias went to Zurich to visit the Dadaists, who, they discovered, had been working for several years in a direction very similar to that of Picabia, Duchamp, and Man Ray.

The meeting of 391 *and* Dada *was celebrated in new issues of* 391 *and of* The Dada Review. 391 *appeared on bright pink paper. Arp, Tzara, Picabia and myself contributed to the two magazines, not only with individual work but by the execution in common of an illustration for Dada Nos. 3 and 4. Every detail of this illustration is still fresh in my mind. The medium was an old alarm clock which we bought for a few cents and took apart. The detached pieces were bathed in ink and then imprinted at random on paper. All of us watched over the execution of this automatic masterpiece.*
— Gabrielle Buffet-Picabia, 1951.[69]

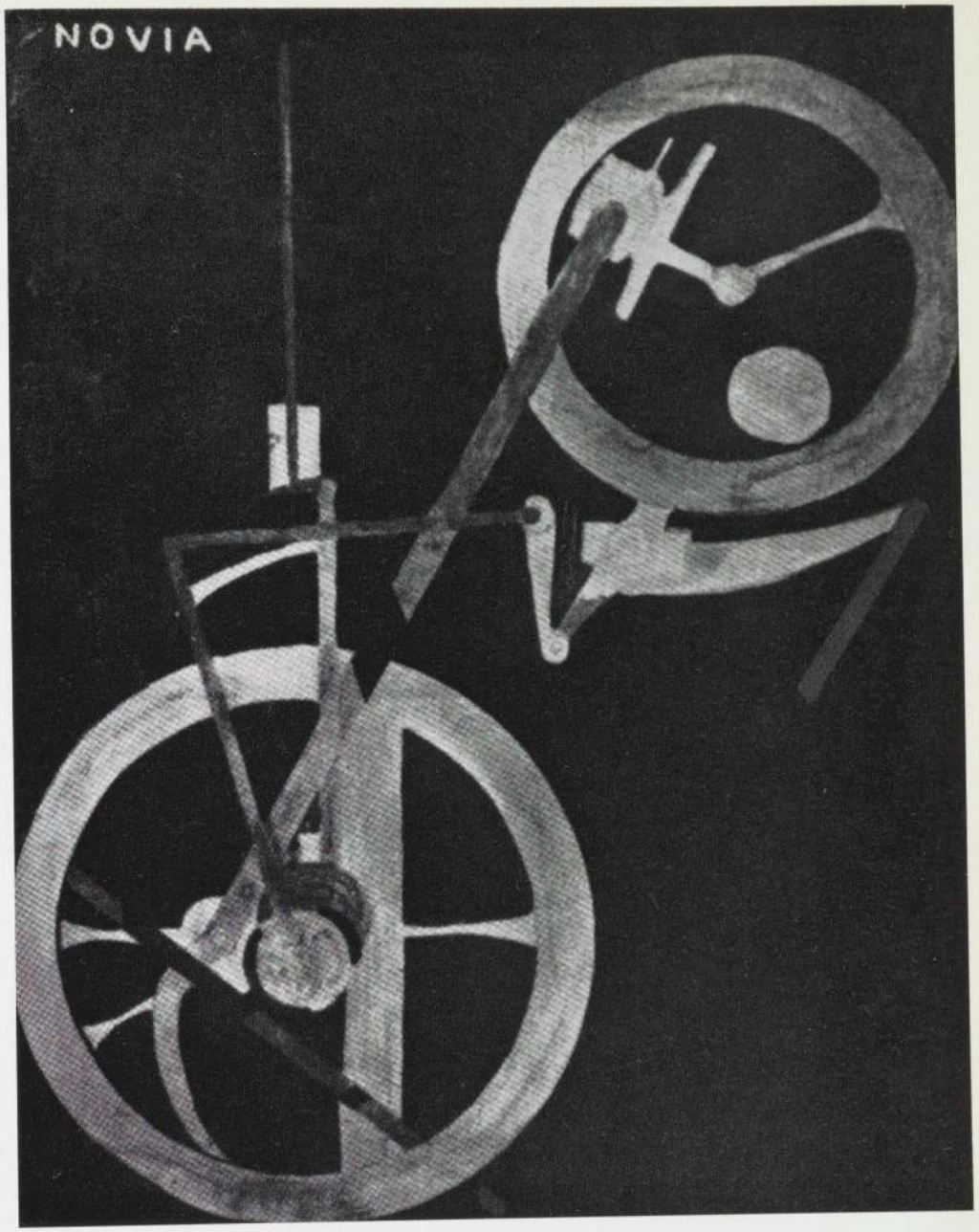


Francis Picabia
Mouvement Dada (Dada Movement). 1919
Pen and ink, $20\frac{1}{8} \times 14\frac{1}{4}$" (irregular; sheet)
The Museum of Modern Art, New York



Francis Picabia
Le Fidèle (The Faithful One). c. 1917
Gouache and watercolor, 23×18½″
Collection Mr. and Mrs. Arthur A. Cohen, New York

"Laughing, she corrects manners," and "The Faithful" inscribed above his signature, are Picabia's tributes to his wife. Richard Hunt has written of Picabia's erotic machine-pictures: ". . . their common unit is the measure of irony; to compare man's most subtle feelings, and his most passionate, noble, yet murderous ardor to the movements of a machine is to indulge a very haughty sarcasm and a great deal of auto-irony ('Making love is not modern; yet it is still what I love best.')."[70]



Francis Picabia
Novia (Bride). 1917
Oil, $45^{5}/_{8} \times 35''$
Formerly collection
Tristan Tzara, Paris

There are several versions of *Novia;* one appeared on the cover of the first issue of Picabia's review *391.*[71]

Picabia's machine pictures may be divided into categories. *Novia* belongs to the freest, most impressionistic type, in which machine elements are rendered without any concern for their possible functioning. At the opposite extreme are faithful reproductions of engineering drawings, in which the mechanical objects appear almost entirely unchanged, except for the addition of color (e.g. *Fille née sans mère,* page 83), or slightly altered by retouching (e.g., *Tableau peint pour raconter . . .* , page 85). A third kind includes ordinary objects, such as the camera in *Ici, c'est ici Stieglitz* (page 87) or the windshield in *Le Fidèle* (opposite). The free drawings with vaguely mechanistic associations with which Picabia illustrated his poems, as in his volume *La Fille née sans mère,* constitute a fourth type. Finally, there are drawings, very geometric in effect, that show strictly linear elements, sometimes with the lines or background heightened with color (e.g., *Tickets,* 1917).[72]

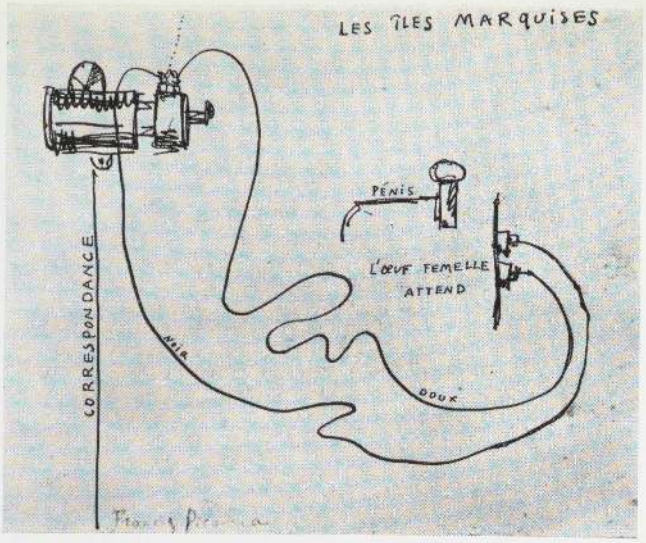
Francis Picabia

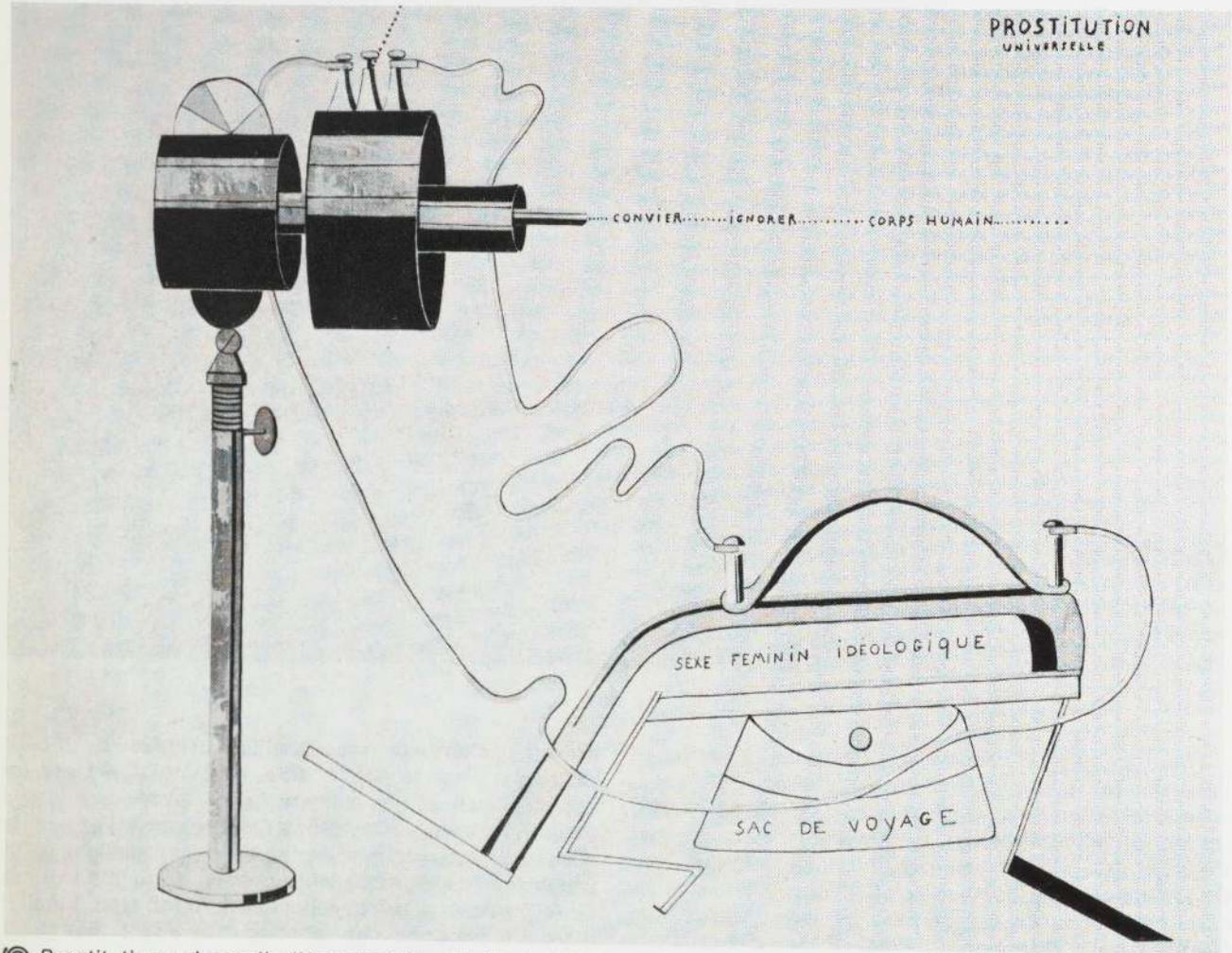
Les Iles Marquises (The Marquesas). c. 1916—1917
Ink, $8^{5}/_{8} \times 10^{1}/_{2}''$. Collection Paride Accetti, Milan

How freely Picabia applied titles to his machinist works is shown by the fact that the sketch for *Prostitution universelle* is inscribed *Les Iles Marquises.*

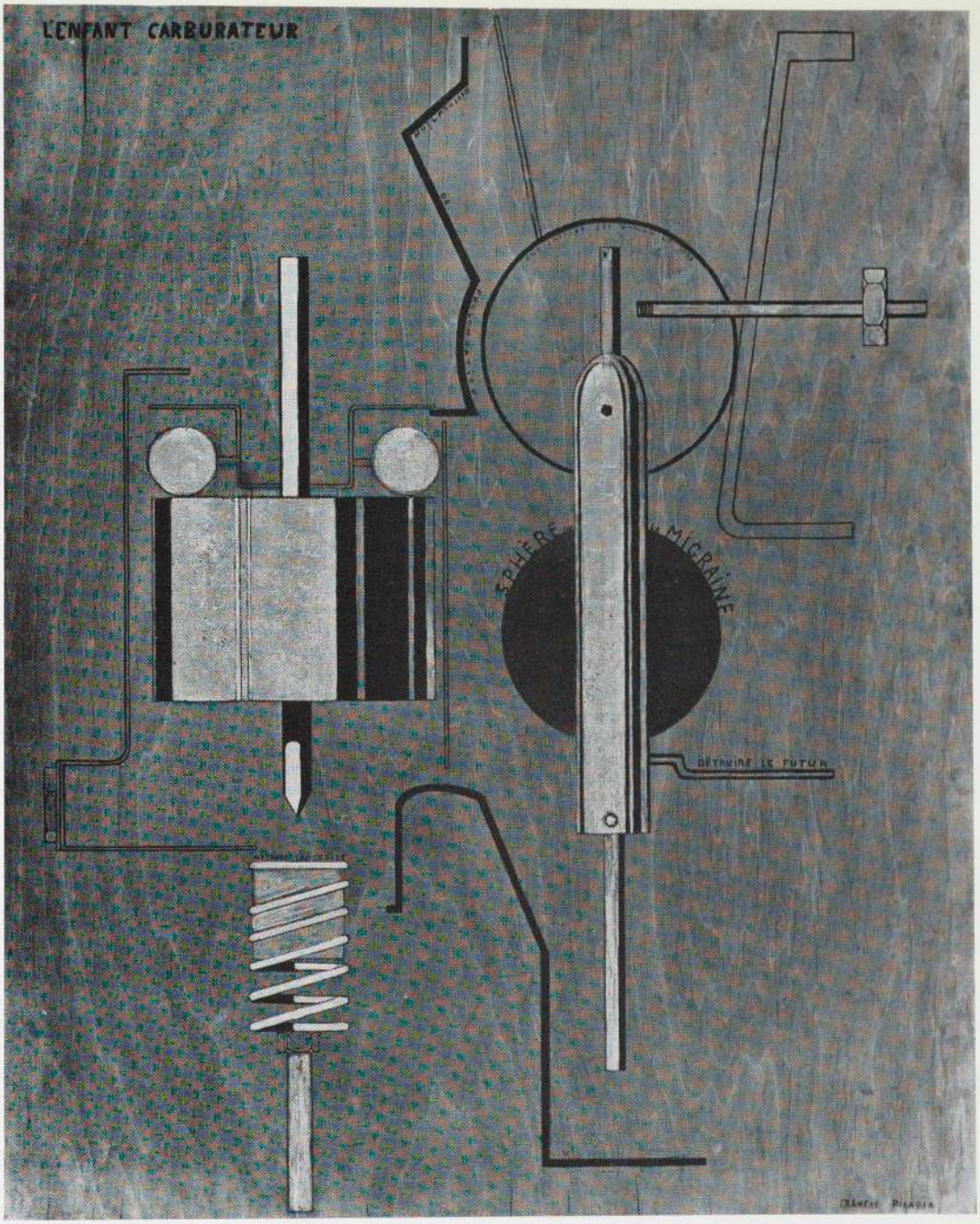
In 1921, when public interest in Picabia's paintings was at its height, a French journalist attacked his use of engineering diagrams, advertisements, and instruction manuals as sources. Picabia wrote:

So Picabia has invented nothing, he copies. Yes, he copies the working-drawing of an engineer instead of copying apples. To copy apples is understandable to everyone; to copy a turbine is idiotic. In my opinion, what is even more idiotic is that Les Yeux chauds [*one of his paintings at the Salon d'Automne*], *which yesterday was indadmissible, should now, simply because it represents a convention, have become a painting intelligible to all.*[73]





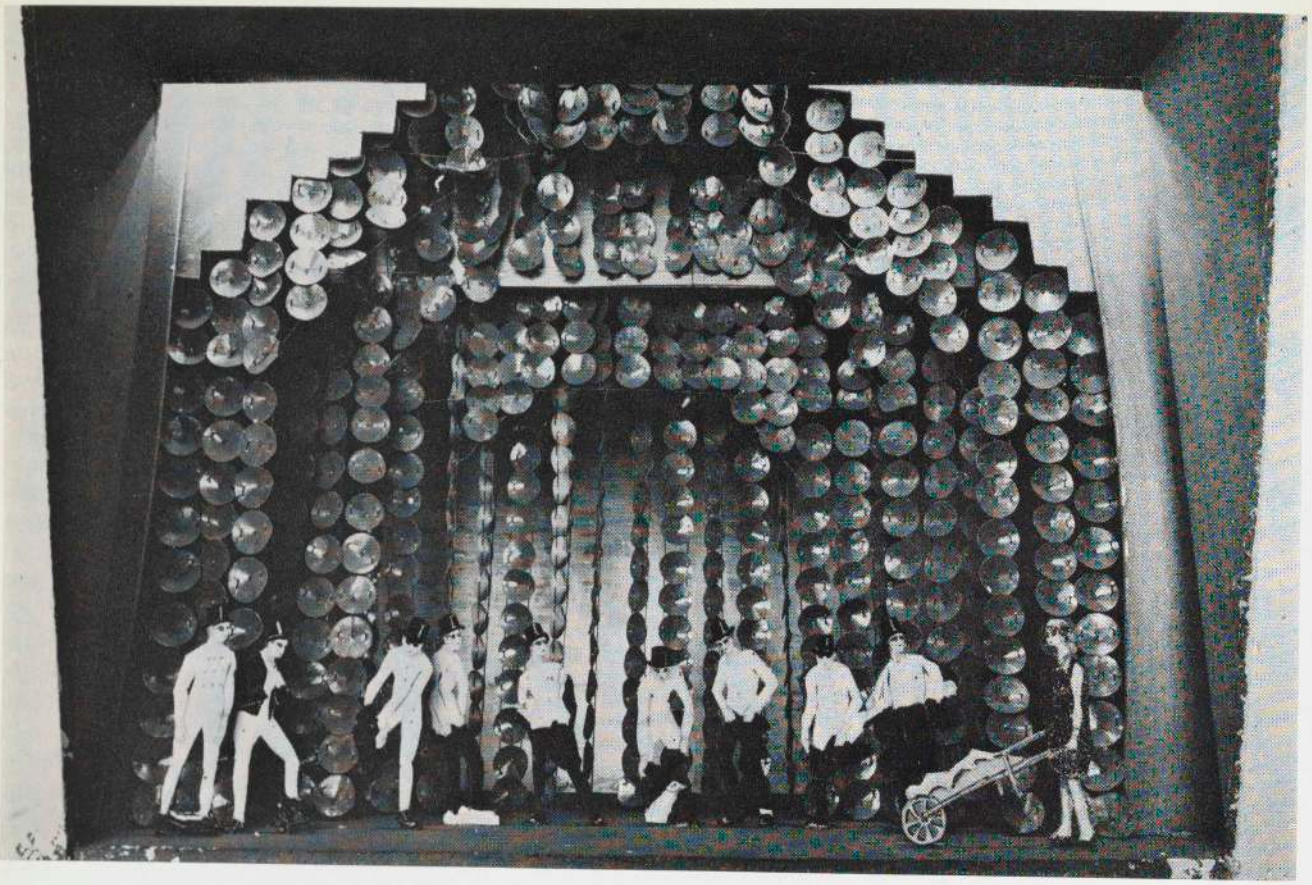
Prostitution universelle (Universal Prostitution). 1916. Ink and tempera on cardboard, $31^{3}/_{4} \times 43^{3}/_{4}''$
Yale University Art Gallery, New Haven, Collection of the Société Anonyme



Francis Picabia
L'Enfant Carburateur (Child Carburetor). c. 1919
Gouache and oil on wood, $49^{3}/_{4} \times 39^{7}/_{8}$″
The Solomon R. Guggenheim Museum, New York

Child Carburetor is one of the works of Picabia most closely based on an engineering diagram. Since the carburetor within an automobile's motor performs the vital function of achieving the proper mixture of gas and air to ensure the firing of the cylinders, its erotic symbolism can readily be connected with the Bride's "love-gasoline" in Duchamp's *Large Glass.*

In this painting, black is used with metallic gold and silver to suggest the beauty that Picabia saw in machine forms. During his lifetime, he owned a long series of powerful sport cars. Fast, funny, free, unexplored, and independent of old institutions, they were the perfect embodiment of Picabia's life-style; moreover, their functional shapes, which had nothing to do with nature but were wholly manmade, symbolized man's creative power.



Francis Picabia
Stage model for "Relâche." 1924
Gouache on cut paper and cardboard with wire and thread, 15½″ high × 20″ wide × 8″ deep
Dansmuseet, Stockholm

Although Picabia had formally severed his connection with the Dadaists some time before, in 1924 he undertook to design the settings and costumes for a ballet to be produced in Paris at the end of the year by Rolf de Maré's Ballets Suédois. It bore the typically Dadaist title *Relâche,* which is the word used to denote that a theatre is closed because the season has been suspended or a performance canceled. With unanticipated irony, the opening performance at the Théâtre des Champs-Elysées, planned for the end of November, had to be postponed because of the illness of the choreographer and leading dancer, Jean Borlin; when the ballet was finally produced a week later, he came on stage in a wheelchair.

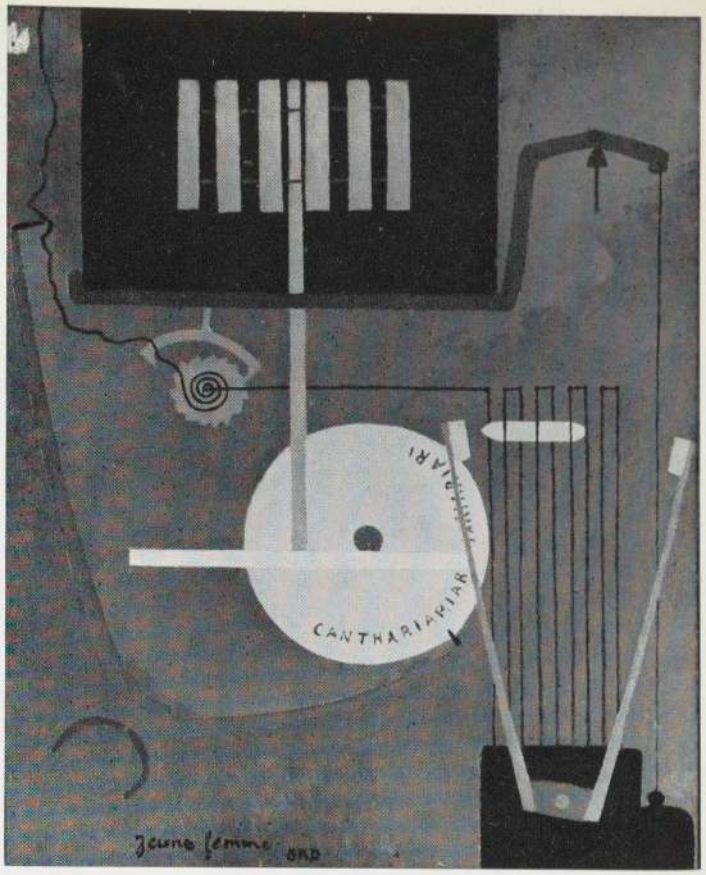
Picabia's decor for *Relâche* is the culmination of his machinist period. At the raising of the second curtain (partly transparent and bearing insulting texts), the spectators were blinded by 370 spotlights with metal reflectors directed toward them. The intensity of the lighting varied with the rhythms of Eric Satie's music.

The ballet was composed of two short parts; as Satie hated intermissions, Picabia undertook to provide instead a twenty-minute film. He wrote the scenario in twenty-four hours, and a young film maker, René Clair, shot it in three weeks. It was given the title *Entr'acte,* "an interlude from the boredom of monotonous life and conventions full of hypocritical and ridiculous respect."

Shortly after the opening of *Relâche,* which received only twelve performances, Picabia withdrew from the cultural life of Paris. He built a villa in the south of France and did not come back to Paris to live until 1936.

Now, what can be said of Relâche *itself? It is perpetual motion, life, it is the minute in which we seek to be happy; it is light, riches, luxury, love, free from the conventions of shame; without a moral for the stupid, without artistic researches for snobs:* Relâche *may equally well be alcohol and opium as sports, strength, and health; it is baccarat or mathematics.*

Relâche *is the optimism of happy people, in which you will see a very beautiful woman, a very handsome man, many very handsome men; overpowering lights, all whirling in a movement as rapid and agreeable as that we experience when riding in a 300-horsepower car on the best highway bordered with trees that seem bent by the illusion speed produces . . . .* — Picabia, 1931.[74]



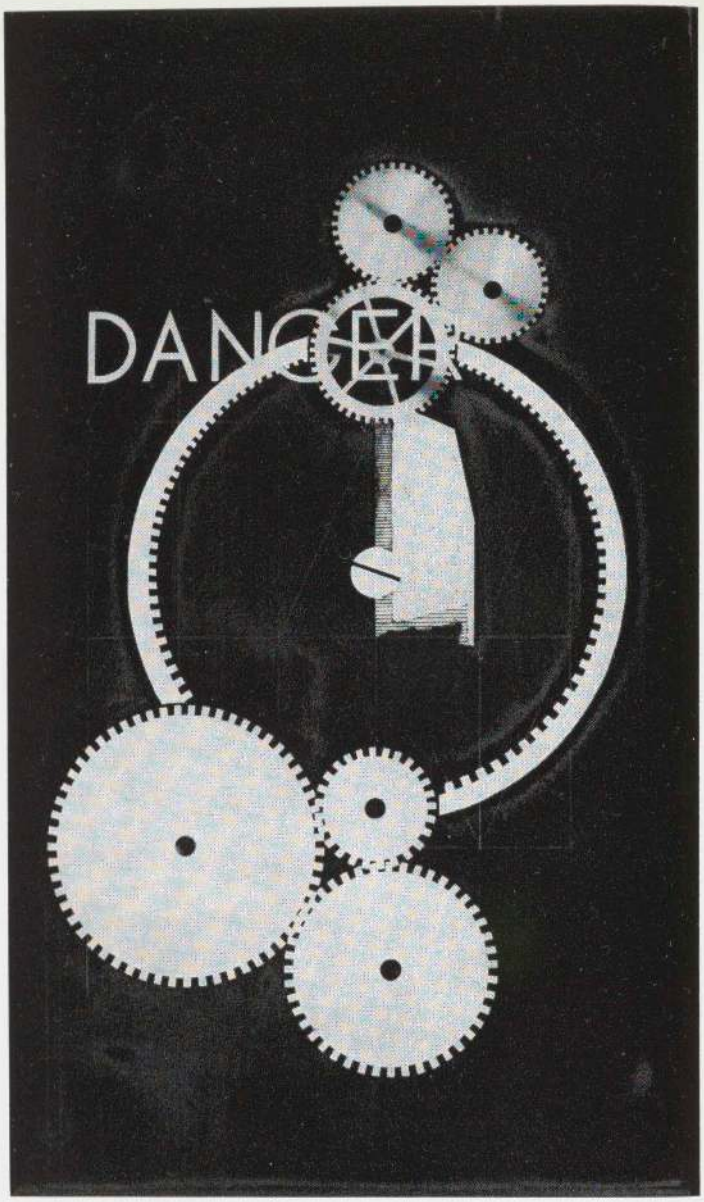
Georges Ribemont-Dessaignes
French, born 1884
Young Woman. c. 1918
Oil on canvas, $28^{3}/_{4} \times 23^{5}/_{8}$″
Yale University Art Gallery, New Haven, Collection of the Société Anonyme

In 1918, a number of writers in Paris — among them André Breton, Louis Aragon, and Paul Eluard — saw Dada periodicals from Zurich and became aware of what had been going on there during the war years. The following year, Duchamp came back from New York and stayed with Picabia. They established contact with the Paris Dada group, which was soon joined by Tristan Tzara, who came from Zurich toward the end of 1919. Other artists in the circle were Duchamp's sister Suzanne, her husband Jean Crotti, and Georges Ribemont-Dessaignes, a painter and writer known to Duchamp from his frequent visits to Puteaux before the war.

Discussions among the Paris Dadaists were on a metaphysical plane, concerned with the situation of art. Duchamp seemed to them to have removed the support and border lines for traditional concepts of art. The main problem was how to fill the resulting vacuum by continuing to express oneself through images. The *Large Glass* and related works, such as the *Chocolate Grinder,* provided major inspiration. Ribemont-Dessaignes has described Duchamp as: ". . . a comet that crosses and attracts the solar system without our knowing whether it belongs to it or not. It is in the midst of space on the same road as dada, but with other seasons, days and nights. It will never pass over the same route but its light and the trail of its light has been seen."[175]

With readymades such as the *Bicycle Wheel* (page 102), Duchamp had declared that all manmade objects were art. Machines, as manmade makers of objects, then moved upward in the hierarchy, while to paint nonfunctional machines was to create a new superart. Images of irrational, mocking machines gave artists the opportunity to introduce new forms, unpredicted and dynamic, and new materials. As symbols of process, of new, dynamic, ever changing concepts, machines epitomized the complexity of the situation that Duchamp had created. Many of these machines were a kind of mocking self-portrait; the artists saw themselves as irrational machines producing irrational products, just as rational machines produced rational products.

The paintings of Ribemont-Dessaignes were strongly influenced in subject matter and technique by Picabia's machinist works. Perhaps because he found it impossible to create new pictorial images of his own, Ribemont-Dessaignes eventually abandoned painting altogether to devote himself to other forms of Dadaist (and later, Surrealist) expression. Duchamp has paid tribute to his role: "He acted 'Dada' and he gave Dada the support of his acute sense of revolt . . . . he went beyond an anti-painting or anti-writing attitude. The deepest a-metaphysical metaphysics of Dada were in great part the contribution of Ribemont-Dessaignes."[176]

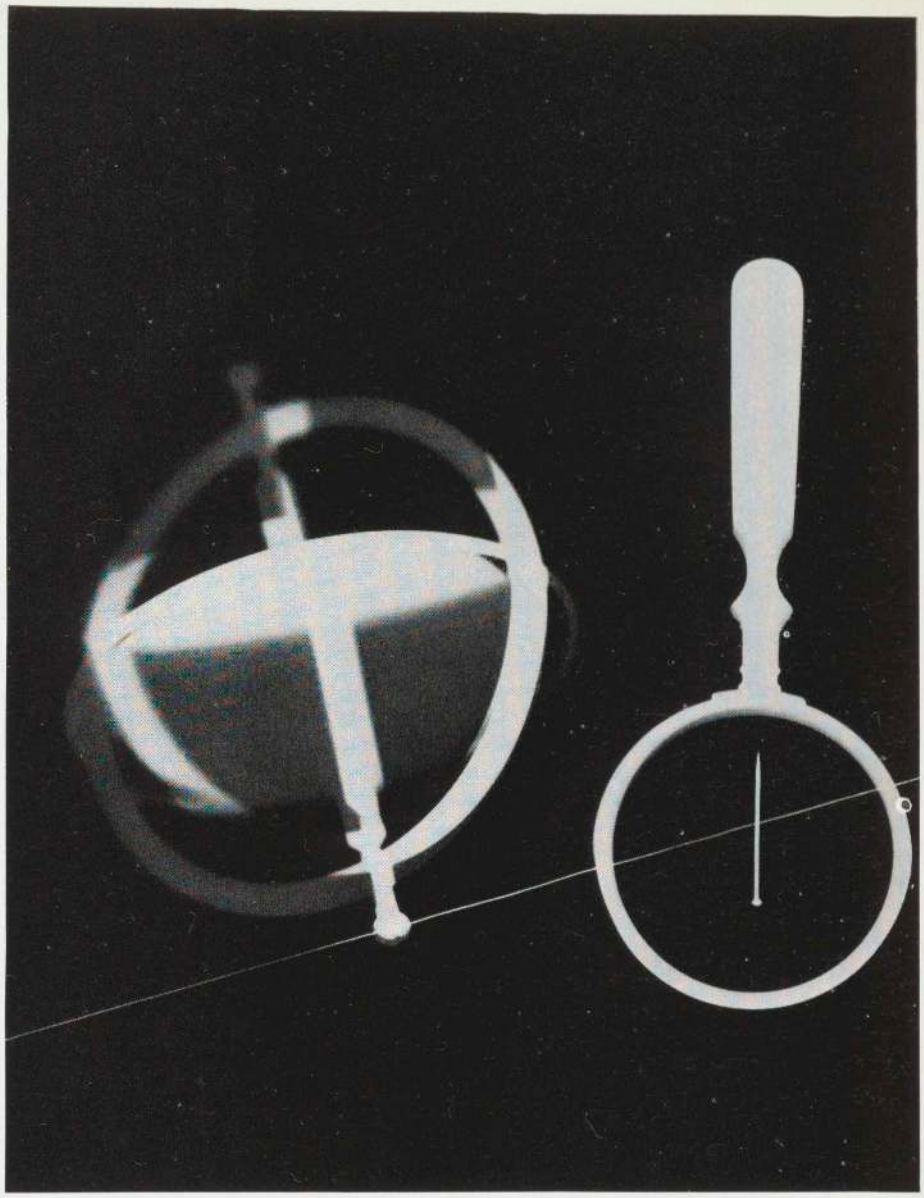


Man Ray. American, born 1890
Dancer/Danger (L'Impossibilité). 1920
Oil, airbrushed on glass, 24×16″
Collection Mme André Breton, Paris

Man Ray was closely associated with the proto-Dada activities of Duchamp and Picabia in New York. In 1920, he joined Duchamp, Katherine S. Dreier, and others in founding America's first museum of modern art — the Société Anonyme, whose collection is now in the Yale University Art Gallery. In his autobiography, Man Ray relates that he decided to include in an exhibition of the new museum "... my latest painting — an airbrush composition of gear wheels, which had been inspired by the gyrations of a Spanish dancer I had seen in a musical play. The title was lettered into the composition: it could be read either DANCER or DANGER."[77] *The Impossibility* is either identical with this painting or is a variant of it.

Like so many other artists of this century, Man Ray began as a technician. He earned his living as draftsman for a company that specialized in engineering and machinery. To speed up his work, he made use of an airbrush and one day was inspired to use it in his own art. It allowed him "to paint a picture, hardly touching the surface — a purely cerebral act, as it were."[78]

Man Ray has described *Dancer/Danger,* one of the paintings he produced in this way, as a kind of revenge on all the uninspiring rationality that he ordinarily had to depict. Three cogwheels locked together is a mechanical atrocity; of course, they cannot turn. The big wheel is another offense to the most basic mechanical laws: its cogs are not of the same size.

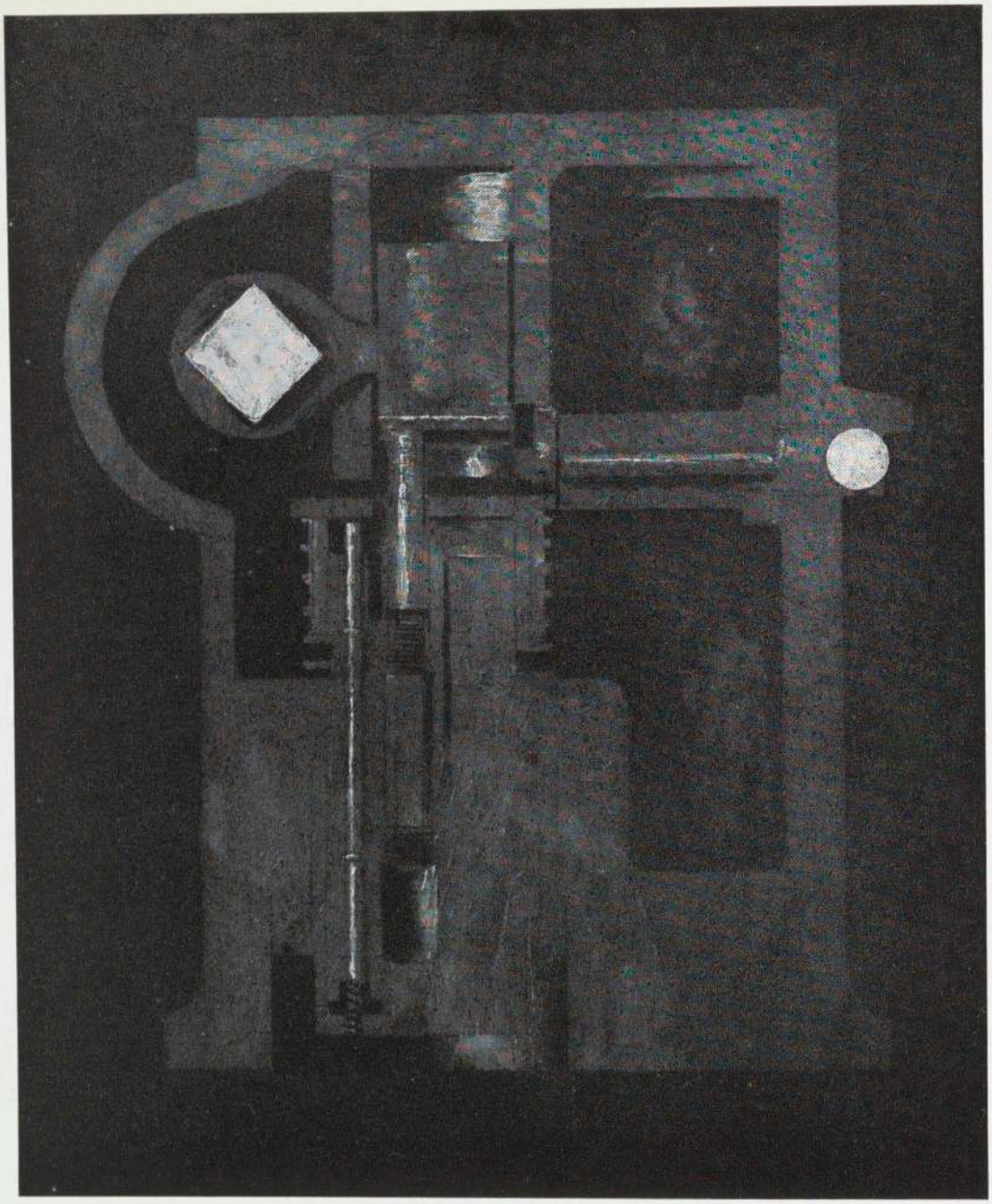


Man Ray
Rayograph. 1922
Photogram, $9^{7}/_{8} \times 7^{1}/_{4}''$
The Museum of Modern Art, New York
(gift of James Thrall Soby)

In July, 1921, Man Ray arrived in Paris, where he immediately joined Picabia, Duchamp, and others of the Dada group. While pursuing his career as a painter, he supported himself by photography. One day, an unexposed "sheet of photo paper got into the developing tray . . . and as I waited in vain a couple of minutes for an image to appear . . . I mechanically placed a small glass funnel, the graduate and the thermometer in the tray on the wetted paper. I turned on the light; before my eyes an image began to form . . . distorted and refracted by the glass more or less in contact with the paper and standing out against a black background . . ." He gave the name "Rayographs" to the accidentally discovered process, "startlingly new and mysterious."[79]

Thus, with his usual direct approach and taste for simplification, Man Ray took away the optical and mechanical side of photography and let chemicals do the whole job. As if in mockery of the mechanical world, he often showed in his Rayographs some scattered machine parts, useless but beautiful.

In Berlin at about the same date, the Hungarian painter László Moholy-Nagy was making photograms similar to Rayographs by placing three-dimensional objects on light-sensitive paper: ". . . thus not only were contours recorded and, in the case of translucent objects, texture as well, but also cast shadows. The photogram technique has been enriched by modulating the light which is allowed to fall on the object-strewn paper."[80]



Morton Livingston Schamberg

American, 1881—1918

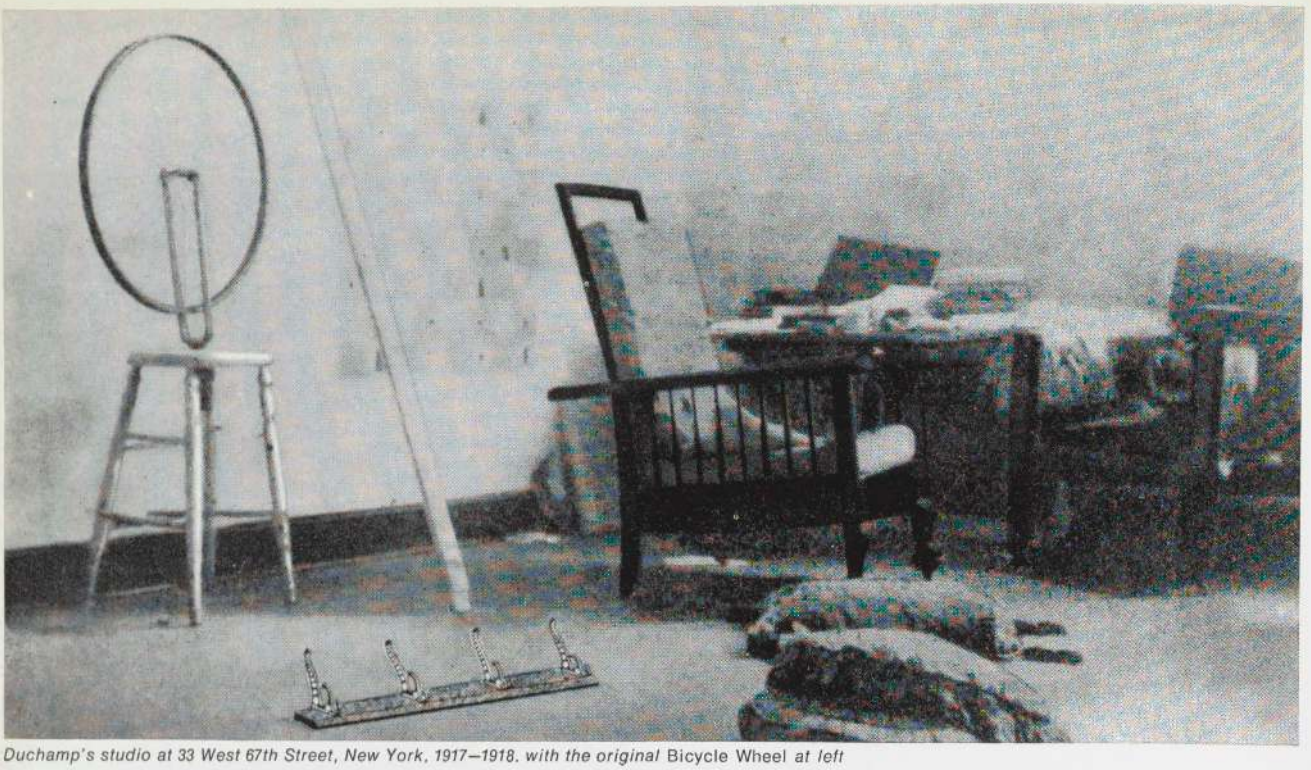
Untitled. 1916. Oil on wood, 19½×15½″
Collection Mrs. Jean L. Whitehill, New York

The Philadelphia artist Morton Schamberg, like Picabia, sometimes found inspiration in catalogue illustrations. This mechanical abstraction is supposedly based on a stocking machine reproduced in a catalogue borrowed from his brother-in-law, a manufacturer of ladies' hosiery; but as his brother observed when he saw the painting: "... the goddamn thing wouldn't work."[81]

Schamberg, who knew Picabia and Duchamp when they lived in New York, was one of the first to create machine compositions, in part inspired by theirs, yet representing quite another conception. Instead of becoming subjectively involved with the symbolism of machines, Schamberg's interest was purely in their forms. He creates an isolated world, complete in itself—a microcosm of quiet beauty and asymmetrical balance, ruled by laws of logic. His work reflects his natural self-control. Many years after his death, Duchamp recalled his personal charm and declared: "I felt quite close to him in his grasp of one 'future' which is our 'today'."[82]

Morton Livingston Schamberg
God. c. 1918
Miter box and plumbing trap, 10 1/2″ high
Philadelphia Museum of Art

In his studio on Chestnut Street, Schamberg had a leaky washbasin, which he never succeeded in repairing. Perhaps this inspired the interest in plumbing that is reflected in several of his paintings but most notably in the assemblage he called, with highly blasphemous overstatement, *God*. With this work, Schamberg picked up Duchamp's idea of the readymade and adapted it in a personal way. The juxtaposition of a miter box and plumbing trap differs in spirit from, for example, Duchamp's assisted readymade *With Hidden Noise* (1916) — two brass plates framing a ball of twine, with an unknown object concealed inside it. Schamberg's approach remains formal rather than literary; *God* actually has the same tactile qualities as his paintings. It is more consciously and less mockingly "art" than a work to which it is obviously related — the up-ended urinal that Duchamp christened *Fountain* and submitted to the Society of Independents exhibition of 1917, under the name "R. Mutt." In this connection, one also cannot forget Duchamp's statement when protesting the refusal of the hanging committee to show his entry as sculpture: "The only works of art America has given are her plumbing and her bridges."[83]



Duchamp's studio at 33 West 67th Street, New York, 1917–1918. with the original Bicycle Wheel *at left*

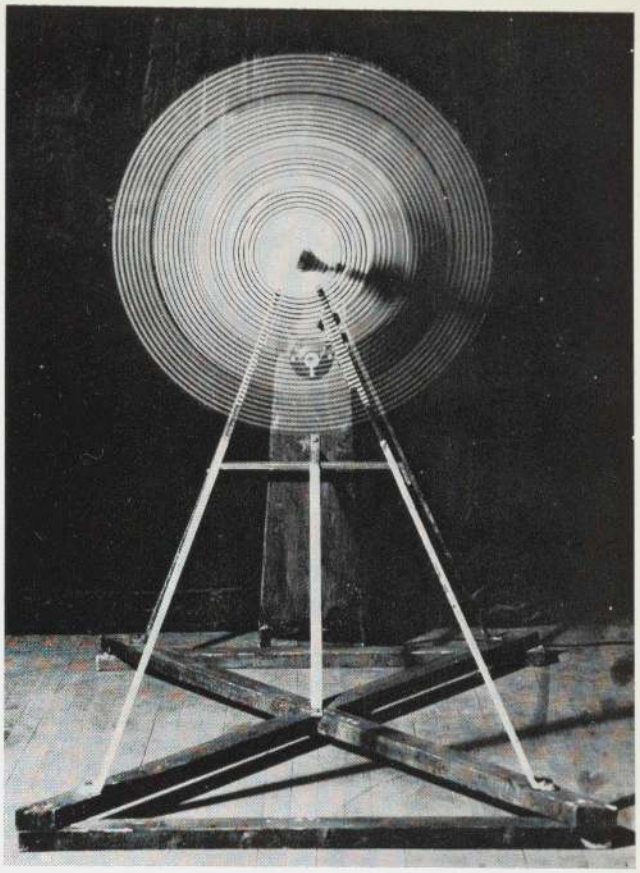
Marcel Duchamp. American, born France, 1887

Bicycle Wheel. Original 1913, lost;
replica by Per Olof Ultvedt and Ulf Linde, 1960
(not illustrated)
Bicycle wheel on wooden stool, 53 1/8" high
Moderna Museet, Stockholm

In 1913, Marcel Duchamp fastened a bicycle wheel upside down on a kitchen stool as an invitation to everyone to spin it. This was the first of his "readymades" — in André Breton's definition, "manufactured objects promoted to the dignity of art through the choice of the artist."[84] It is the first modern work of art to use actual motion to express its meaning. Two years earlier, in painting the *Coffee Grinder* (page 74), Duchamp had defined a mechanism through its movement. In the *Bicycle Wheel,* the machine no longer has a function. The motion is isolated, and a quite different question is posed: What is the border line between art and reality?

To understand the readymades, one must relate them to collage, discovered by Braque and Picasso a year or so before. If the artist is no longer depicting reality, but instead using parts of this reality, such as pieces of oilcloth or newspaper, as parts of his picture, how then can you decide what a work of art should be? The readymades represented Duchamp's answer to this question; they were "a form of denying the possibility of defining art."[85] As he said years later: "I came to feel an artist might use anything — a dot, a line, the most conventional or unconventional symbol — to say what he wanted to say."[86] This proposition can be demonstrated by choosing: it is the act of choice that is decisive. Duchamp chose a series of very different objects from the machinemade category: a bottle rack, a snow shovel, a steel comb, a typewriter cover — about fifteen in all, exclusive of replicas. One seems close to the conclusion that machines become the artists. Duchamp left the *Bicycle Wheel* untitled but gave other readymades titles intended to excite the imagination.

Marcel Duchamp
Rotary Glass Plate (Precision Optics). 1920
Motorized construction: painted glass and metal, 3′11½″ high×3′4″ wide×6½″ deep
Yale University Art Gallery, New Haven, Collection of the Société Anonyme



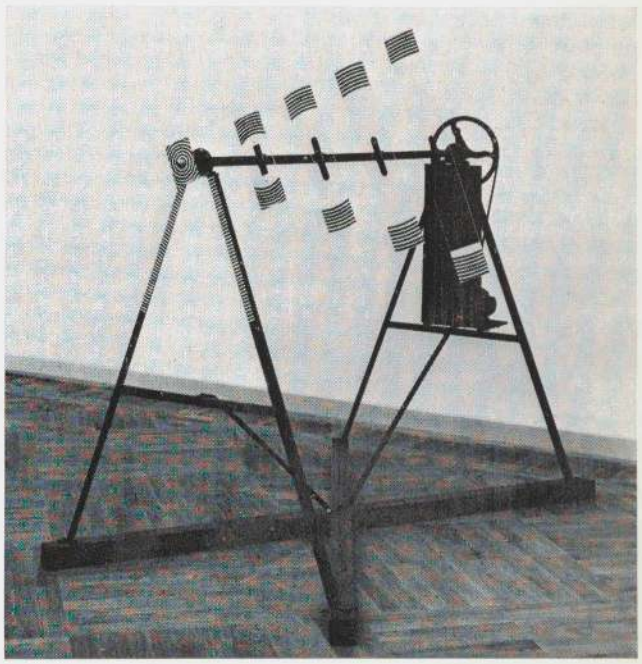
When Duchamp constructed the *Rotary Glass Plate* in 1920, he went even farther than he had with his ready-mades in abandoning conventional ideas about what constitutes a work of art. Almost half a century later, we still experience a certain difficulty in recognizing this machine as such. Man Ray, who photographed it when it was ready for its first trial, described it as: "a strange machine consisting of narrow panels of glass on which were traced parts of a spiral, mounted on a ball-bearing axis connected to a motor. The idea was that when these panels were set in motion, revolving, they completed the spiral when looked at from the front."[87]

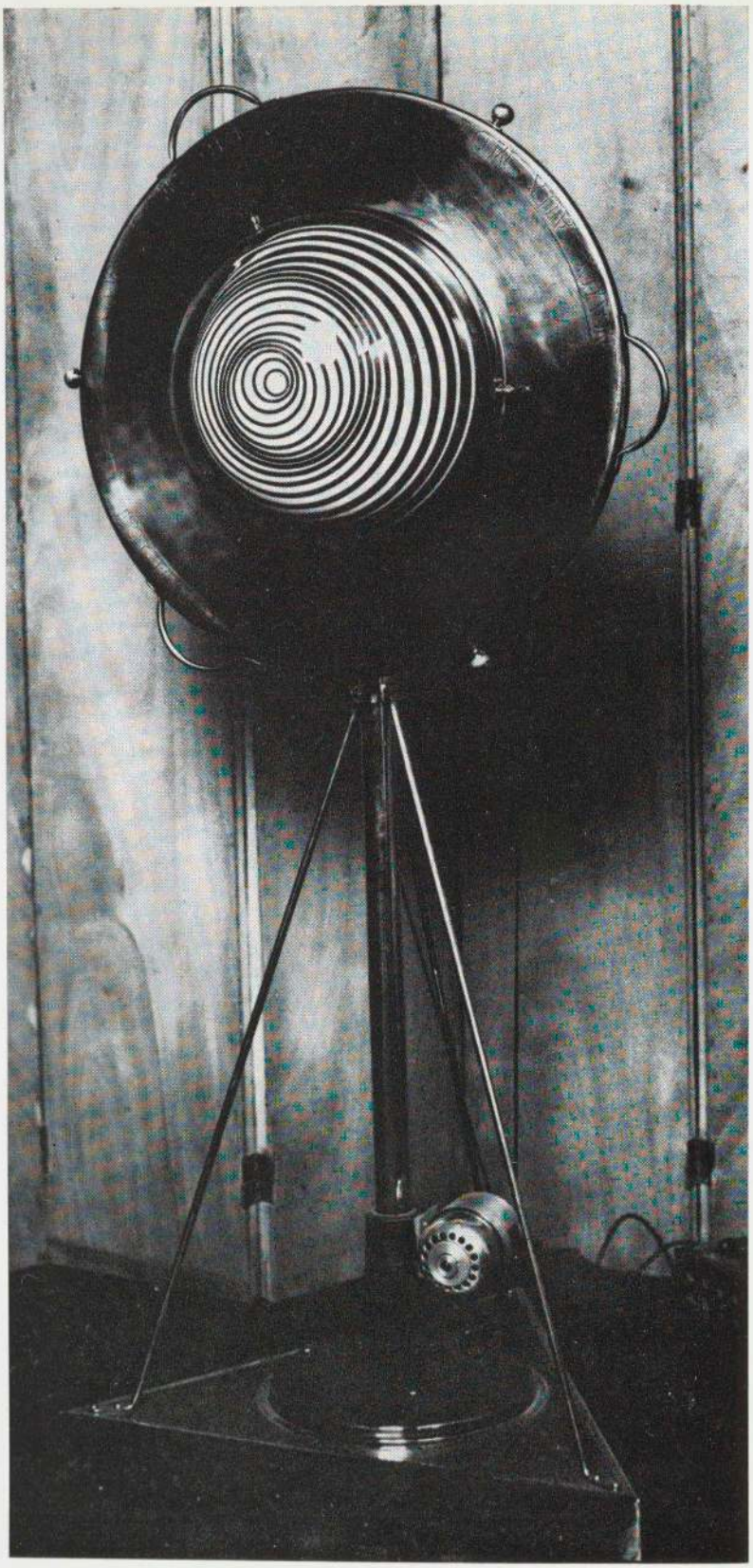
As is often the case with Duchamp, the meaning of this art machine is a kind of visual pun. When the blades of the three-dimensional construction are set in motion, that is, when the fourth dimension is added, a spectator placed directly in front will perceive continuous circles, dematerialized and two-dimensional. Thus, by the addition of the fourth dimension, space becomes reduced to a flat, intangible surface.

An earlier effort of Duchamp's to create an interplay of several dimensions was his *Three Standard Stoppages* of 1913—1914, described by a note in the *Green Box:* "...a straight horizontal thread one meter long falls from a height of one meter on to a horizontal plane twisting *as it pleases* and creates a new image of the unit of length." In this case, of course, the element of chance enters in (used here for the first time in a work of art, and used both as technique and subject).

Duchamp was very interested in the theories and speculations of two French mathematicians, Poincaré and Jouffret, who had written about a non-Euclidean, fourth-dimensional geometry. This postulated that our three-dimensional world could be regarded as a kind of shadow cast by a fourth-dimensional reality, just as a three-dimensional object casts a two-dimensional shadow. Underlying Duchamp's optical machines is this concept of a gliding system of dimensions and realities.

Marcel Duchamp
Rotary Glass Plate (Precision Optics). Original 1920; replica by Per Olof Ultvedt, Magnus Wibom, and K.G.P. Hultén, 1961
Motorized construction: painted plexiglass and metal, 4′9″ high×3′10″ wide×6′4″ deep
Moderna Museet, Stockholm

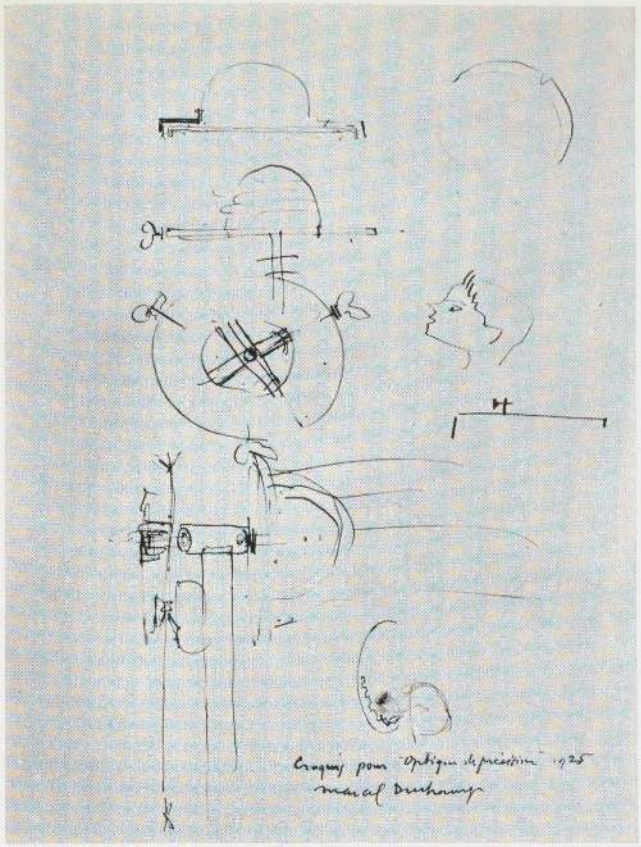




Marcel Duchamp
Rotary Demisphere (Precision Optics)
1925
Motorized construction:
metal, painted wood, velvet, and glass,
59″ high × 28″ wide × 20″ deep
Collection Mrs. William Sisler, New York

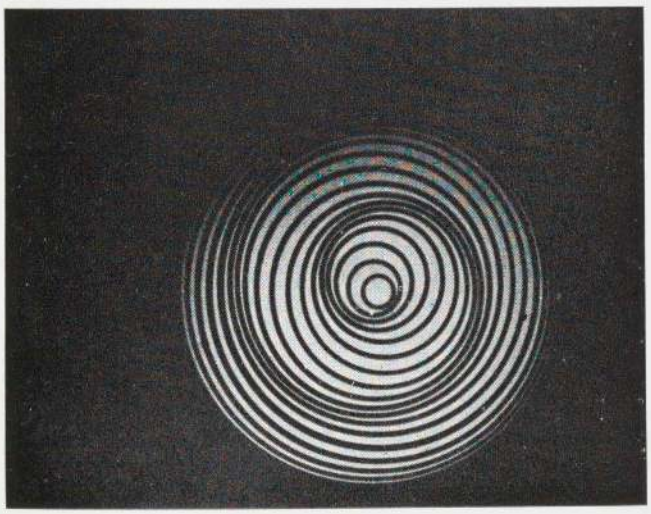
This is Duchamp's most elaborate visual-pun machine. A series of letters that he wrote from March to October, 1924, to Jacques Doucet, who had commissioned it, shows the pleasure that he took in its construction. The power of an electric motor is used to cause a white demisphere, painted with a series of black eccentric circles, to revolve. The rotation makes the demisphere appear dematerialized and seem to recede into depth instead of protruding. The visual pun is accompanied by a verbal one engraved on the outer edge of the encircling copper ring: *Rrose Sélavy et moi esquivons les ecchymoses des esquimaux aux mots exquis.*

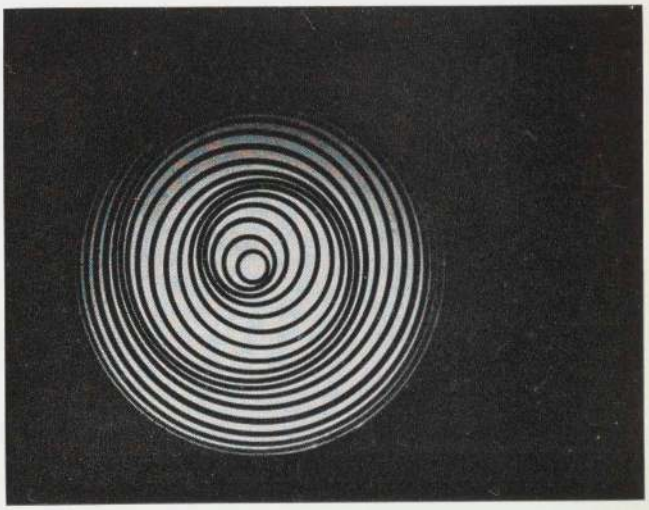
Duchamp took the same painstaking care in choosing and placing the machine parts for the construction and the details of its base as a traditional sculptor would take in handling the clay from which he models his sculpture. After the machine was completed, however, he wrote Doucet that he hoped it would not be lent for exhibition: "All exhibitions of painting or sculpture disgust me. And I would like to avoid associating myself with them. I should also regret if this globe were to be regarded as anything other than 'optics'."[88]



Marcel Duchamp
Sketch for Precision Optics. 1925
Ink, $10^{5}/_{8} \times 8^{1}/_{4}$". Philadelphia Museum of Art
(Louise and Walter Arensberg Collection)

Marcel Duchamp
Frames from projected stereoscopic film (left, green; right, red). 1920
$3^{3}/_{4} \times 7^{1}/_{4}$", including holder
Collection Man Ray, Paris





As early as 1920, Duchamp had anticipated the optical effects that he would achieve with *Rotary Demisphere*. According to Man Ray: ". . . Duchamp came to me with projects; he had conceived an idea for making three-dimensional movies. Miss Dreier had presented him with a movie camera, and he obtained another cheap one — the idea was to join them with gears and a common axis so that a double, stereoscopic film could be made of a globe with a spiral painted on it." Most of the film was spoiled in developing, but: ". . . we did save some film, two matching strips which, on examination through an old stereopticon, gave the effect of relief."[89] Because of technical difficulties and lack of capital, the project for what would have been one of the first three-dimensional films was abandoned.

In 1926, the year after the completion of *Rotary Demisphere,* Man Ray and Marc Allegret helped Duchamp produce the film *Anemic Cinema* (the title is an anagram). It was made by filming nineteen rotating discs, which alternately bore designs and inscriptions by Duchamp. Still later, in 1935, he developed these ideas further in a set of six "Rotoreliefs" — cardboard discs, printed on both sides with circular compositions, which when placed on a record player "turning at an approximate speed of 33 revolutions per minute, will give an impression of depth, and the optical illusion will be more intense with one eye than with two."[90] Still disdaining art exhibitions, Duchamp presented these works at a little stand he rented at the Concours Lépine, an annual fair for inventors of gadgets held near the Porte de Versailles. In this way, the most influential artist of this century demonstrated his contempt for the art world by taking his place among the technicians; but perhaps this should be balanced by a saying attributed to him: "I don't believe in art. I believe in artists."

Naum Gabo. American, born Russia, 1890

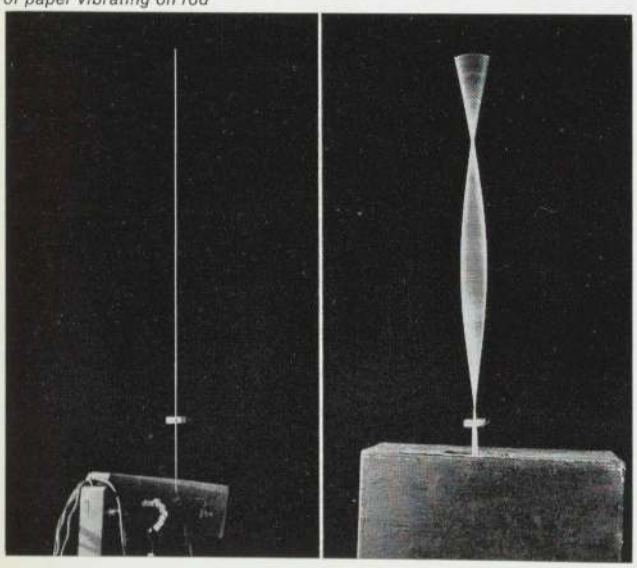
Kinetic Sculpture: Standing Wave
Original 1920, Tate Gallery, London;
reconstruction by Wit Wittnebert, 1968 *(not illustrated)*
Metal rod with electric vibrator, over-all height including base 24 1/4"

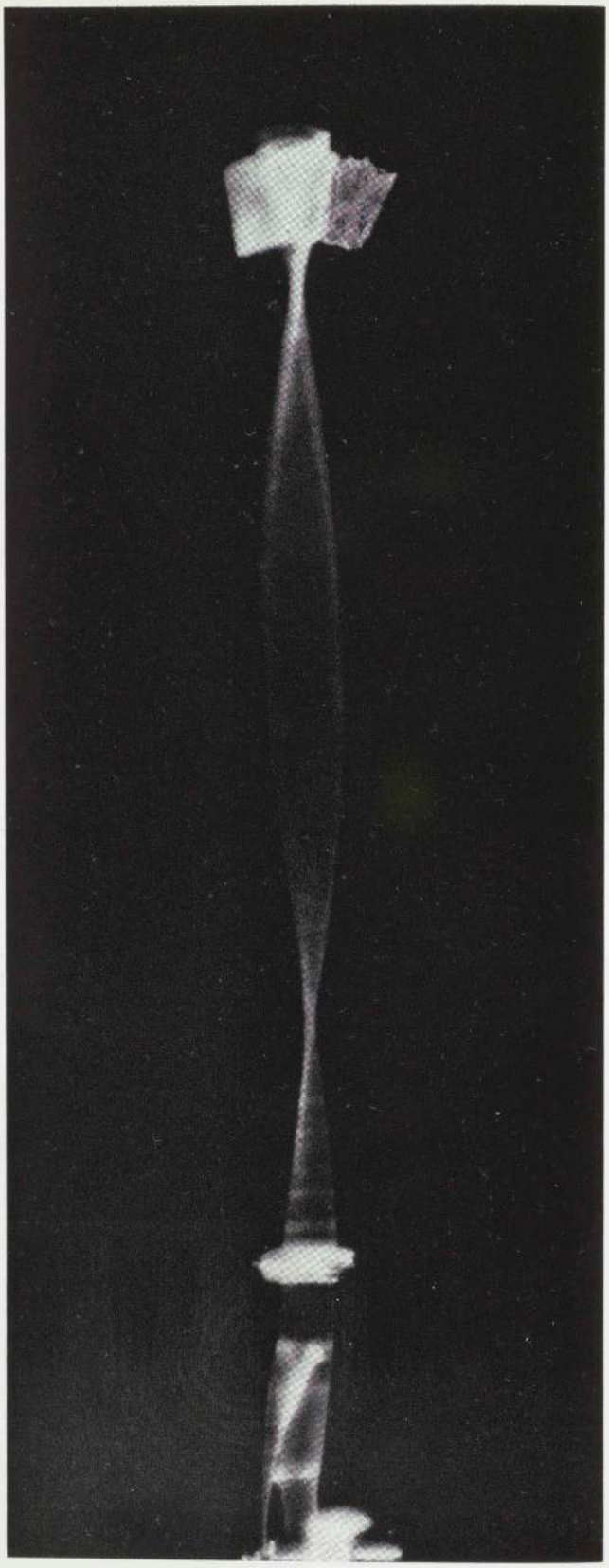
In 1920, the same year in which Duchamp constructed his *Rotary Glass Plate* in New York, Naum Gabo in Moscow made this sculpture by attaching a thin metal rod to the vibrator from an old electric doorbell. These two independent experiments were the first works in which artists used motors as an expressive means.

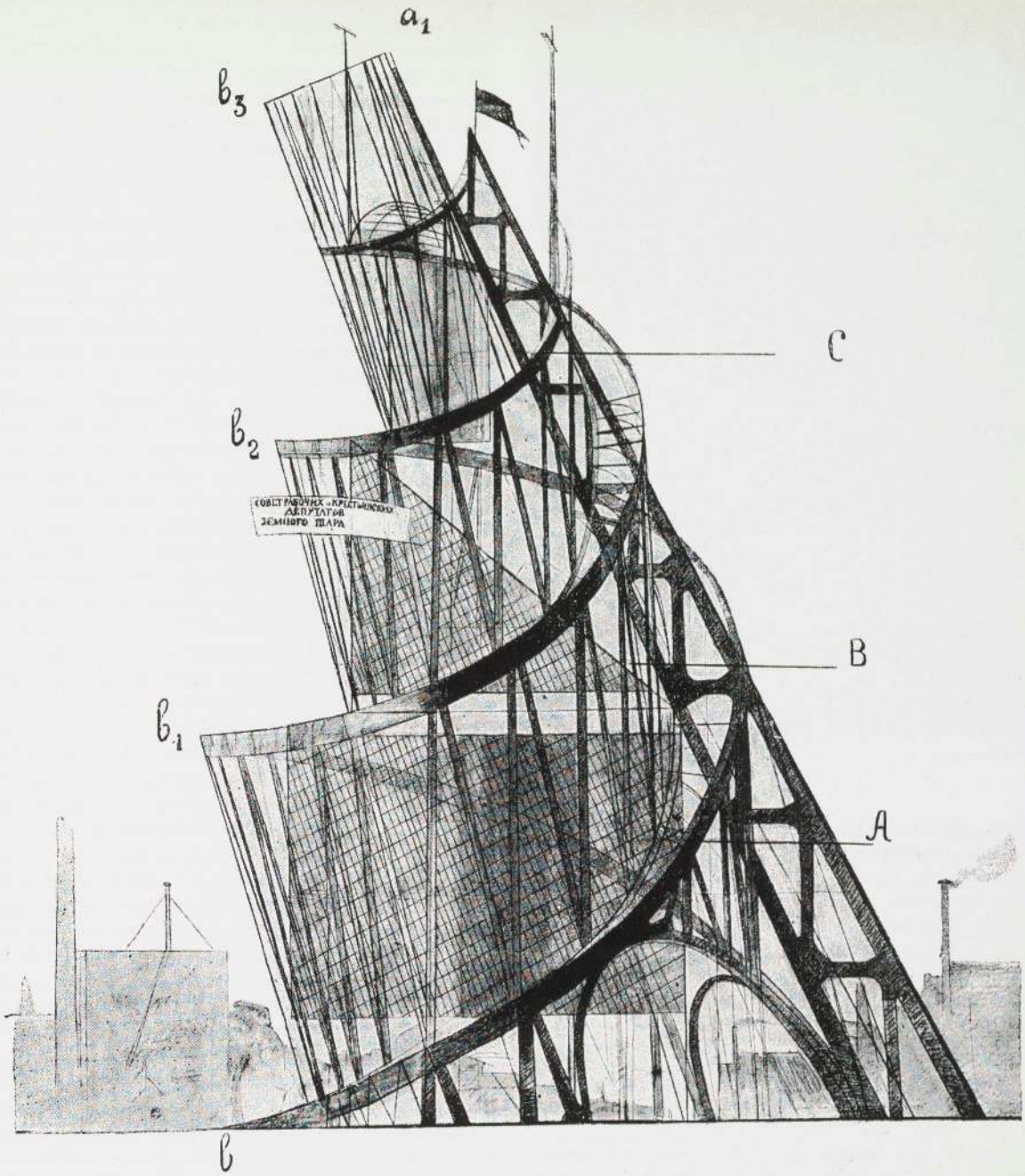
Five years before, while in Norway during the war, Gabo, then only twenty-five years old, built the first of his "constructed heads" out of intersecting planes of plywood. Artists such as Archipenko, Lipchitz, and Picasso had already extended the Cubist interest in space and multiple planes, and in 1914 Boccioni in the Technical Manifesto of Futurist Sculpture had proclaimed the need to "break open the figure and enclose it in environment"; but Gabo went further. For the first time, he dematerialized sculpture by making the edges of his plywood planes define the space, which became the form. In this conception, he was influenced by the scientific, mathematical, and philosophical ideas he had absorbed while a student in Munich.

In *Standing Wave,* Gabo took a step beyond his earlier sculpture by creating a completely dematerialized volume, which consists of the space defined by wavelike movements of a thin metal rod set into vibration by a source of energy. The machine is thus put at the service of art. Gabo, however, resented the need for anything so cumbersome as a motor and decided that "only future developments in heat and radio power will permit as yet unpredictable kinetic solutions."[91]

Sculpture at rest, in motion, and (at right) old photograph with piece of paper vibrating on rod







Monument for the Third International, drawing (reproduced in Nikolay Punin's pamphlet on the tower, 1920)

Vladimir Tatlin. Russian, 1885—1953
Monument for the Third International
Original model for tower, destroyed, 1920;
reconstruction by Arne Holm, Ulf Linde, Eskil Nandorf, Per Olof Ultvedt, and Henrik Östberg, 1967—1968
Wood and metal with motor, 15′5″ high
Moderna Museet, Stockholm

The antecedents of Tatlin's tower are the reliefs that he began to make in 1913 on his return to Moscow from a short trip to Paris, where he had been inspired by the constructions that he had seen in Picasso's studio — musical instruments of cardboard or tin. Very soon, however, Tatlin's reliefs departed from Cubist themes and spatial conceptions and became "real materials in

The finished model of the tower, 1920

real space." Abandoning the use of limiting frames or backgrounds, he built "corner reliefs" — constructions suspended across the corners of walls. (At about the same time, Malevich, Tatlin's rival as leader of the new Russian art, was placing his famous painting *Square on Square* in a similar position, influenced perhaps by a traditional Russian way of placing icons). Tatlin's reliefs were very roughly made, and their materials were crudely stuck together. His effort was to move from the abstract to the real and leave aesthetics behind. The materials themselves — wood, iron, glass, and concrete — were chosen because of their symbolic associations with building. In Tatlin's completely original theory, the expressive importance of these materials lay not in their form, but in their actual substance. Whereas Marshall McLuhan was later to proclaim that "the medium is the message," Tatlin was saying that "the material is the message"; he studied materials in a way similar to McLuhan's study of media. Troels Andersen has written: "Tatlin tried to establish a relationship to the real object on a plane that was as abstract as linguistic structures, and which contained as many possibilities of combination. Unlike most of his contemporaries, he did not regard the question of determined *forms* as essential; he was investigating artistic expression's actual form of manifestation, its physical existence."[92]

The development of this conception of the real in art of course entailed the destruction of pre-existing Western aesthetics. In a penetrating article, Ronald Hunt has pointed out that the idea of the destruction of art already had a tradition in Russia going back to more than half a century before the Revolution.[93] Tatlin's ideas, therefore, at once exerted a great influence, because they expressed something that everyone felt necessary in a time of such far-reaching revolutionary changes — the denial of formal values in favor of concentration on content. For the Russian Revolution, form and aesthetics were irrelevant; it was the entire society that had to be changed. *What* was to be done, not *how,* was the question.

Content itself, however, was thought of in terms of ongoing changes rather than final results. According to Tatlin's theory, the importance of the spiral is that it is the most dynamic form. Writing about the Monument for the Third International, he declared: "Here is the resolution of the most difficult problem of culture, that of unifying the utilitarian and the purely creative form. Just as the triangle, with its balance of parts, is the best expression of the Renaissance, so the spiral is the expression of our spirit."[94]

The proposed Monument for the Third International, commissioned in 1919 by Narkompros, the People's Commissariat for Education, became the main symbol for the revolutionary redefinition of art. What made the strongest impression was the new way of using materials. For the first time, it seemed possible that an artist-engineer would bring about the long-hoped-for integration of sculpture and architecture.

The tower was conceived as a metal structure. One of the many contradictions in Tatlin's work is that he built the model in wood, though this can probably be explained by the scarcity of materials in Russia during those years, when even wood may have been difficult to obtain. Its height was to be 1,300 feet — over 300 feet higher than the Eiffel Tower; the model was about 15 feet high.

The spiral framework enclosed four glass-walled, rotating chambers. The lowest, a cylinder, was to revolve once a year and be used for conferences and the legislative council of the Third International; above this a slanting pyramid, rotating once a month, was to contain executive activities. Surmounting this was a tall cylinder, and above that, a hemisphere; the cylinder would turn on its axis once each day and would house an information center.

Recently, in the course of reconstructing the model for the tower, Tatlin's conception became apparent. His point of departure was the idea of the rotating chambers to house different functions, and turning at different speeds. Space therefore had to be provided for gears of varying sizes between vertical axes. This gave rise to the tower's slant. To support his construction, Tatlin sur-

rounded the rotating chambers with an inclined cone made of vertical members slanting toward each other at the top. A big diagonal girder would provide communication up and down the tower. To keep all these parts together, Tatlin encircled them with two spirals. Horizontal steps connected these spirals to the cone enclosing the inner chambers. The construction of the tower is thus a very logical one, based on the requirements of the functions it was to fulfil.

Hunt has termed Tatlin's ideas for this work "mechanolatry at its most romantic." Tatlin, like Marinetti, claimed to have a "machine-heart," and one of his explanations (though perhaps not the most clear) for including moving parts in the tower was that he wanted them to resemble his heart. His devotion to machines was in fact unlimited. One of his pupils, Yuriy Annenkov, has written:

Tatlin declared that only the mathematically calculated and unvarying proportions of forms, together with the appropriate use of materials with maximum economy — that is, the complete lack of caprices, emotional flights, and the "annoying futilities" of artists — constituted the basis and absolute criterion for beauty. In order to illustrate his theory, he carefully cut up a reproduction of Rembrandt's Syndics of the Drapers Guild, *regrouped the figures portrayed, and pasted it on a piece of paper which elongated the proportions of the original painting. After filling in the gaps with strokes of his pencil, Tatlin claimed, not without reason, that all these arbitrary changes had not occasioned any loss whatsoever in Rembrandt's painting, which retained its values in spite of everything. Then Tatlin opened the case of his watch, admired the perfect mechanism of its tiny wheels and springs, drew out a hardly visible screw, and tried to push it into another place. Immediately, after a jerk, the entire mechanism of the watch lay scattered on the table. And that was the end of the watch. This was his means of demonstrating that art is relative, while mechanics are absolute.*

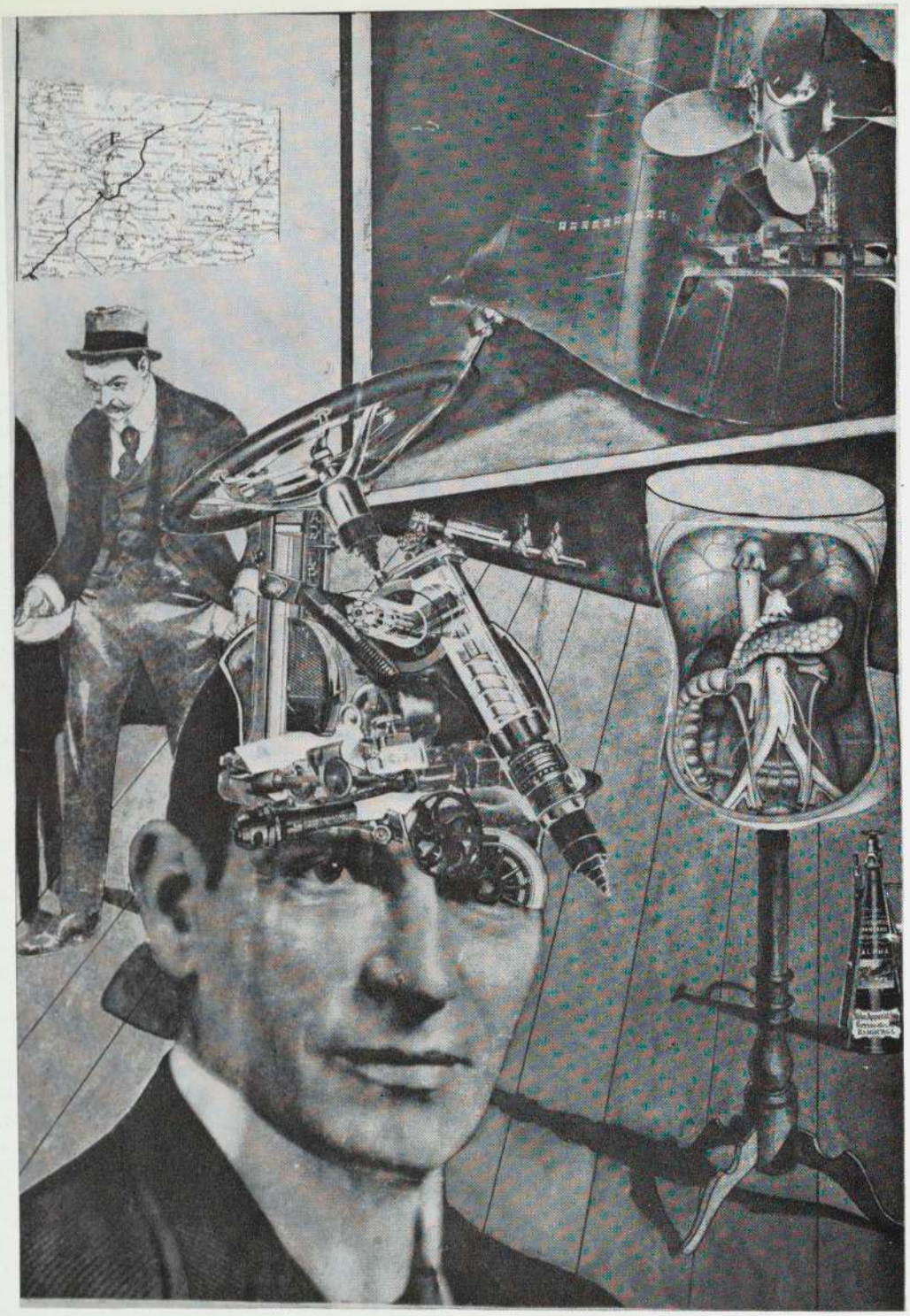
Tatlin used to say that a modern factory at work is the culminating manifestation of our times, surpassing the opera or ballet; that a book by Albert Einstein is certainly more enthralling than any of Dostoevski's novels; and that is why art today should be the standard-bearer, the vanguard, and the incentive for the advance of human culture; to serve this role, it must be useful and constructive.[95]

Tatlin's ideas were taken up by the Productivist group. Many differences of opinion arose among its members, but basically they all agreed that art in the old Western sense was dead. Tatlin himself, besides teaching, designed clothes, constructed an oven, and started to build aircraft (see pages 144—145). The theatre, in particular, seemed to be one art form that could serve as a vehicle for the new theories and the new society. In the 1920s, the programmatic theatre and the film became the principal outlets for the ideas of Tatlin's pupils, the Constructivists and the Productivists.

Reconstruction of model of tower, 1968

The Monument for the Third International was never built. The technical potential to erect it did not exist, and the ideas of the new rulers of Russia were not always as advanced as those of its artists, though they were obliged to consider it. Among those who wrote statements about the Monument were political figures such as Trotsky and Lunacharsky, as well as artists such as Lissitzky, Malevich, Eisenstein, and Tschichold, the writer Ehrenburg, and others. Outside the circle of artists, however, no one seems to have recognized its brilliance. Nevertheless, models of the tower were constructed twice more: in Moscow later in 1920, and in a somewhat altered version for the International Exposition of Modern Decorative and Industrial Arts held in Paris in 1925. In the West, its influence was first strongly felt in Berlin, and Tatlin's theories spread from there. The Bauhaus, founded in 1921 at Weimar, was built around a program that adapted Tatlin's ideas to teaching.

It is only quite recently that the extraordinary richness of Tatlin's conceptions has again been realized to any great extent. Most of his sculptures have disappeared, and the original model for the tower (as well as the two later ones) seems to be lost forever.



Raoul Hausmann. Austrian, born 1886
Tatlin at Home. 1920
Pasted photo-engravings, gouache, and pen and ink, $16^{1}/_{8} \times 11''$
Moderna Museet, Stockholm

While the Spartakists and the tanks of the army were fighting in the streets, the Berlin Dadaists were enthusiastically discussing the new and unknown "machine technology" that they wanted to use in their works. The decisive victory had been won by the revolutionaries

in Berlin and the massive war machine of the Allies, particularly of the Americans, which had greatly impressed the Germans. Now they dreamed of placing new supermachines in the hands of the people rather than of the old rulers, and not as weapons of destruction but as implements to build a new and better society. Tatlin was the idol, the living incarnation of these aspirations, and his Monument for the Third International their most famous symbol.

Photomontage, or rather the collage of photographic images from many sources, was especially elaborated by the Berlin Dadaists. The camera itself is, of course, a machine for picture-making. Photomontage incorporated illustrations, and often letters, from newspapers and magazines. Hausmann, among the first to use the new technique, has told how *Tatlin at Home* took form:

To have the idea for an image and to find the photos that can express it are two different things. . . . One day, I was aimlessly leafing through an American periodical. Suddenly I was struck by the face of an unknown man, and for some reason I made an automatic association between him and the Russian Tatlin, the creator of machine art.

But I preferred to portray a man who had nothing in his head but machines, automobile cylinders, brakes, and steering-wheels. . . .

Yes, but that was not enough. This man ought also to think in terms of large machinery. I searched among my photos, found the stern of a ship with a large screw propeller, and set it upright against the wall in the background.

Wouldn't this man also wish to travel? There is the map of Pomerania, on the wall at the left.

Tatlin certainly wasn't rich, so I clipped out of a French paper a man with furrowed brow, walking along and turning his empty pants pockets inside out. How can he pay his taxes?

Fine. But now, I needed something at the right. I drew a tailor's dummy in my picture. It still wasn't enough. I cut out of an anatomy book the internal organs of the human body and placed them in the dummy's torso. At the feet, a fire extinguisher.

I looked once more.

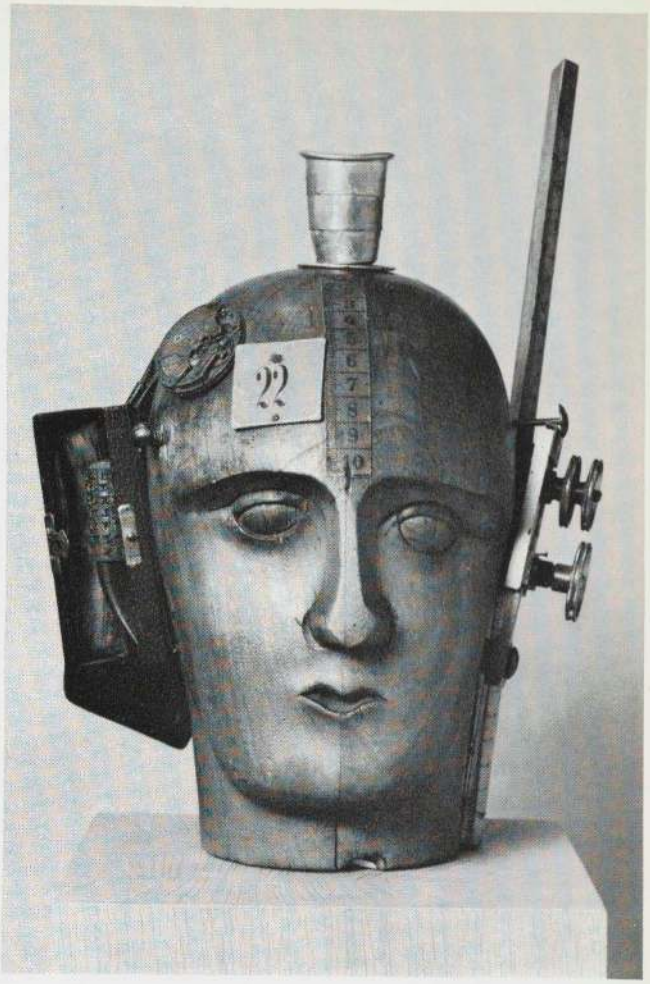
No, there was nothing to change.

It was all right, it was done! — Hausmann, 1967.[96]

One of the fine subtleties of this collage is that its original title is in English — the language of America and its machine civilization.

The Spirit of Our Time and *Tatlin at Home* use similar mechanical elements, yet the former is an ironic lampoon, the latter a tribute to a man whom Hausmann sincerely admired. The two images typify the dual position that some of the Dadaists took toward the machine, and their paradoxical ideas about it.

Hausmann was among the leaders of the Berlin Dadaists and in 1919 founded a review, *Der Dada;* his



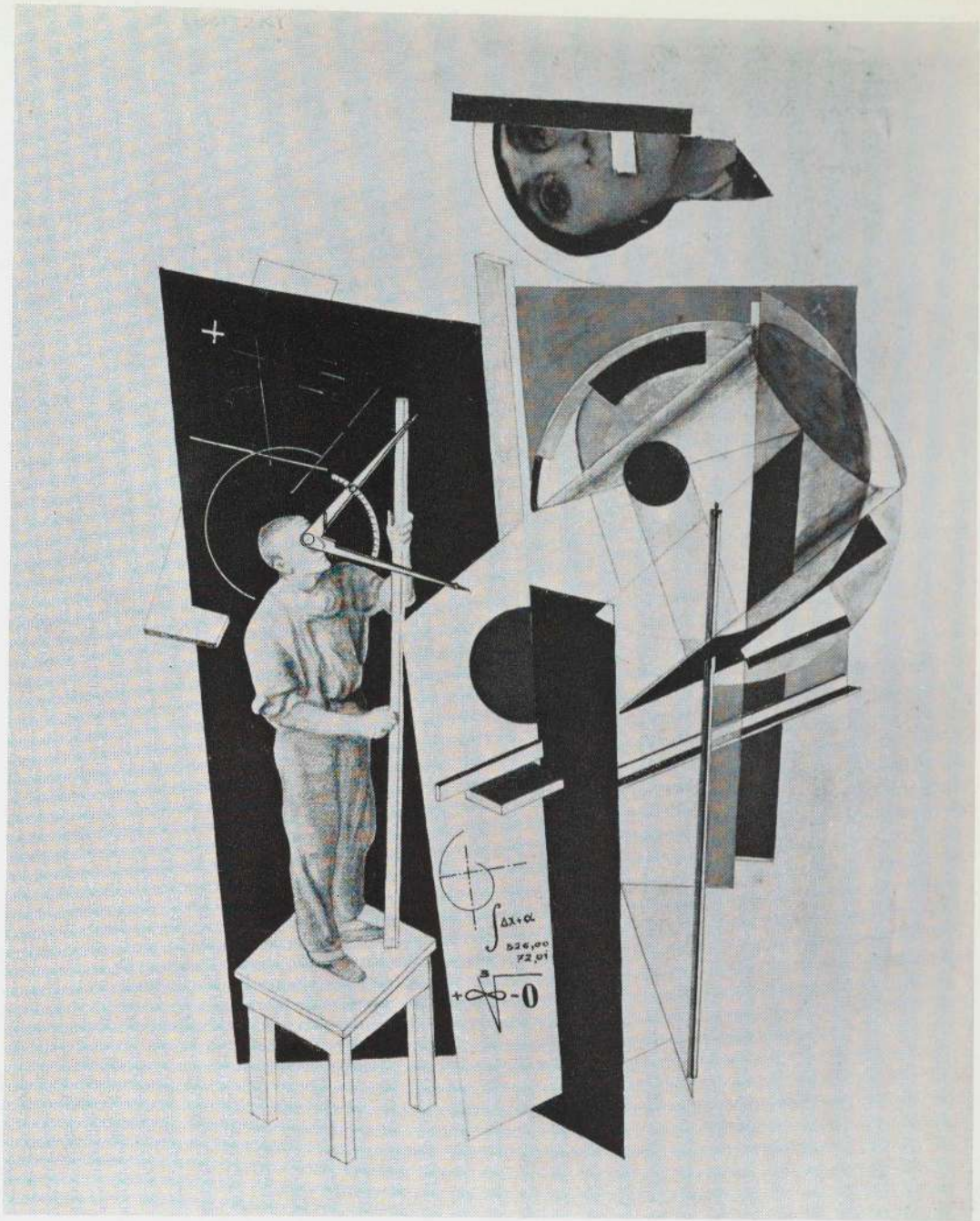
Raoul Hausmann
The Spirit of Our Time. 1919
Wood, leather, and metals, 12⅝″ high
Owned by the artist

writings and his art were both strongly polemical. Being a Dadaist meant for him "having a keen sense of perception and seeing things as they really are." Whereas the Germans thought of themselves as "the nation of thinkers and poets," actually in Hausmann's view "the ordinary man has no more capacities than those that chance has glued on the outside of his skull, his brain remains empty."[97] To express the "spirit of our time," with its readymade, mechanical ways of thinking and acting, he selected a wooden hairdresser's dummy. The head has a naive expression, quite lovable and touching, but lacks any capacity for human thought and feeling. Hausmann has shown it, and its features, being measured and numbered in a hard, "mechanical" way.

"*Art is dead —*
long live Tatlin's new machine art"
(John Heartfield and George Grosz
demonstrating at the
International Dada Fair,
Berlin, 1920)

For the Berlin Dadaists, to adopt Tatlin's ideas was as much a political as an artistic decision. None of them had ever met Tatlin, heard him lecture, or in all probability read anything by him; but at the moment, his Constructivism and his plan for the Monument for the Third International represented the official art of the Soviet Union. Tatlin's theories were readily acceptable to the Berlin Dadaists because they implied the radical overthrow of all traditional Western art.

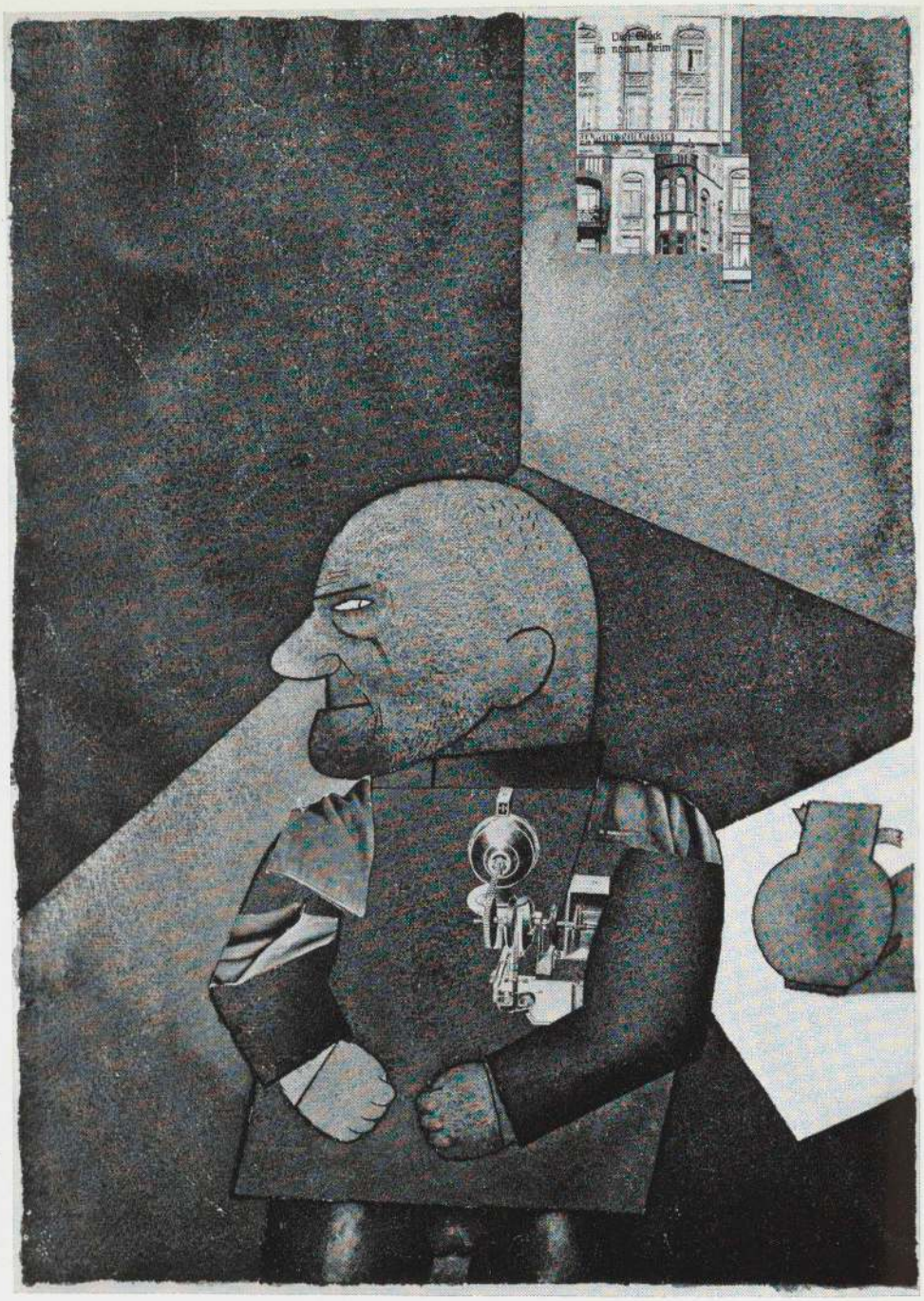
The First International Dada Fair, held in Berlin in June, 1920, was the occasion for particularly anti-bourgeois, antimilitaristic manifestations. The sign reading "Art is dead, long live Tatlin's new machine art." was produced for this Fair; it is shown being carried by two leading Dadaists, George Grosz and John Heartfield, who had changed his name from Herzfelde at the outbreak of the war as a gesture against chauvinism and militarism.



El Lissitzky
(Lazar Markovich Lissitzky)
Russian, 1890—1941
Tatlin Working on the Monument for the Third International
c. 1921—1922
Pencil, gouache, photomontage, 13×9½″
Collection Eric Estorick, London

Enthusiasm for Tatlin and Constructivism in Germany reached a high point in 1922, when the First Russian Exhibition was held at the Galerie van Diemen in Berlin. El Lissitzky, a painter, architect, illustrator, and photographer, who had associated himself with Tatlin in Moscow and who had come to Germany the preceding year, designed and installed one of the exhibition galleries. He used the opportunity to turn it into a demonstration of Tatlin's ideas.

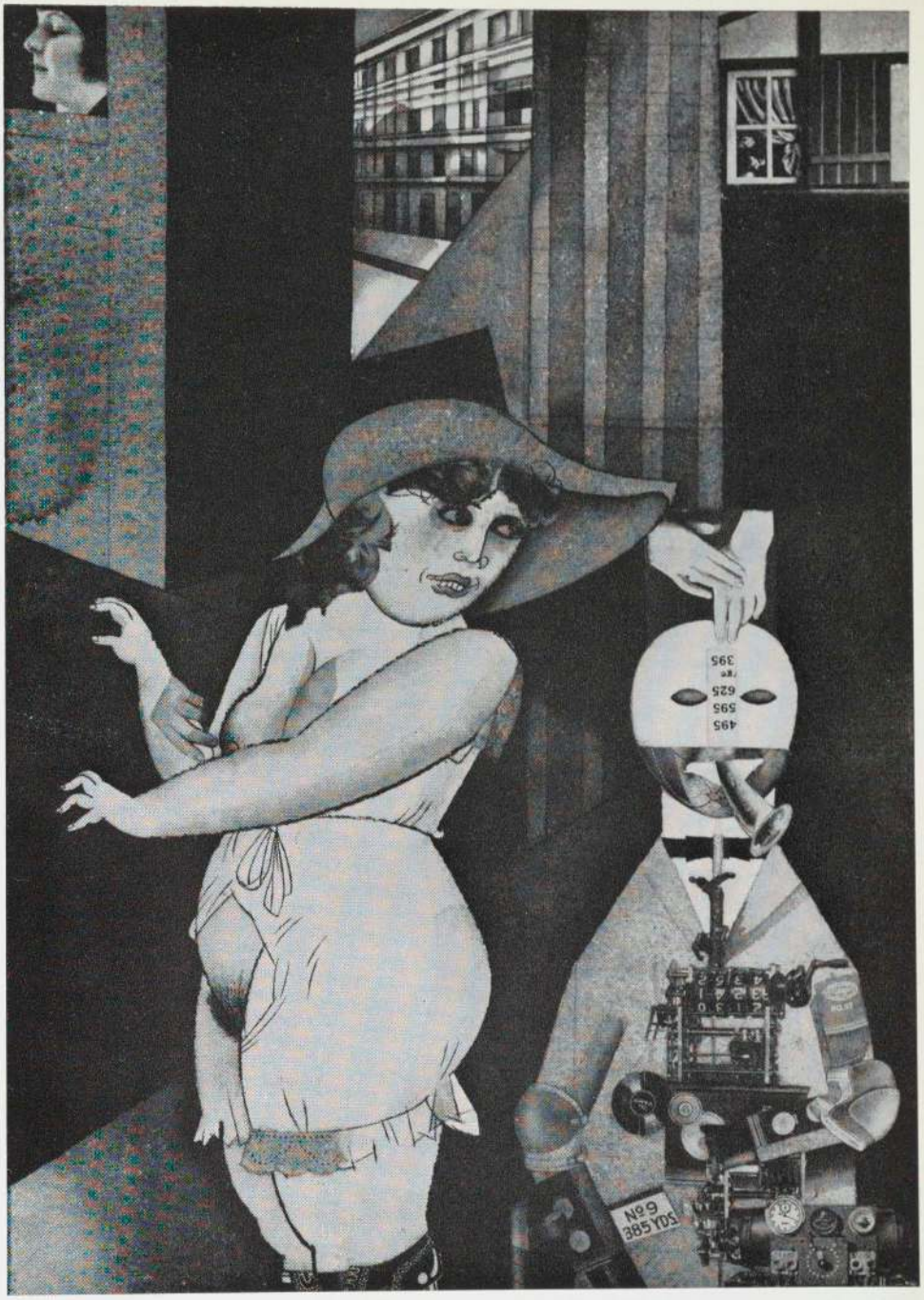
At about the same period, Lissitzky produced this photomontage in homage to Tatlin and his tower. It was originally made to illustrate a book by Ilya Ehrenburg, *Six Novels with Happy Endings,* printed in 1922. Lissitzky was associated with Ehrenburg in Germany in editing a polyglot magazine *Veshch/Gegenstand/Objet,* which promulgated Tatlin's ideas to an international audience. Obviously wishing to further the impression that Tatlin in his machine art worked according to strict mathematical principles, Lissitzky posed him as an engineer surrounded by mathematical symbols.



George Grosz
American, born Germany, 1893—1959
The Engineer Heartfield
1920
Watercolor, pasted postcard, and photo-engraving, 16½×12″ (sheet)
The Museum of Modern Art, New York
(gift of A. Conger Goodyear)

The "machine-heart" that both Marinetti and Tatlin claimed to have appears again in the breast of Heartfield, in this portrait of him by his friend Grosz. These "machine-hearts" have nothing to do with the old mechanistic interpretation of man as a machine but signify the degree of identification with the utopian dream of what machines might achieve in the future. Those who have machines for hearts must be very special and strong men, whose spirits are ruled by no weak, sentimental organs but by instruments of rationality and logic.

This picture, probably a gift by Grosz to his friend, makes ironic reference to one of the several times when Heartfield underwent arrest for his activities against the government. Grosz has portrayed him in a cell, looking like one of the most-wanted men; the inscription in the upper right wishes him "lots of luck in his new home."



George Grosz
"Daum" marries her pedantic automaton "George" in May 1920. John Heartfield is very glad of it (Meta-Mech[anisch] konstr[uiert] nach Prof. R. Hausmann). 1920
Watercolor, pencil, and photomontage, $16^1/_2 \times 11^7/_8''$
Galerie Nierendorf, Berlin

This subtle work of irony and self-mockery, though done in the month of Grosz's marriage, does not relate to that event but to the discussions about art and its role in society, a topic hotly debated by the Berlin Dadaists in 1920. In "George" we recognize, of course, none other than Hausmann's sculpture, *The Spirit of Our Time.* Grosz seems to be trying to bring about a marriage between the social-realist expression in his drawings and prints (represented by the prostitute he so frequently included in them) and the more cryptic, machine-assemblage images of Hausmann and Heartfield, another master of photomontage.

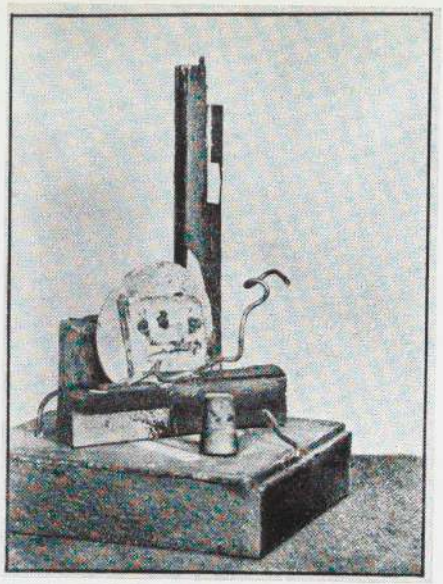
It is interesting to note here an early use of the term "meta-mechanic," whose origin and meaning remain obscure.[98] It was in all probability ironic. In 1954, the same word was reinvented to designate Jean Tinguely's ever-changing reliefs and open-wire constructions (see pages 165—167).

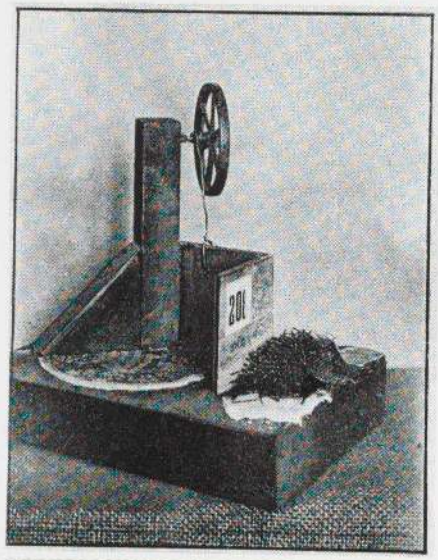
Kurt Schwitters. British, born Germany, 1887—1948

Die Kultpumpe (Cult Pump)

Der Lustgalgen (Gallows of Desire)
Merz sculptures. Originals c. 1920, destroyed; postcards ("*Merzpostkarte*"), 5½×3½″
Collection Ernst Schwitters, Lysaker (Oslo)

Haus Merz (Merz House). 1920
Architectural model, destroyed



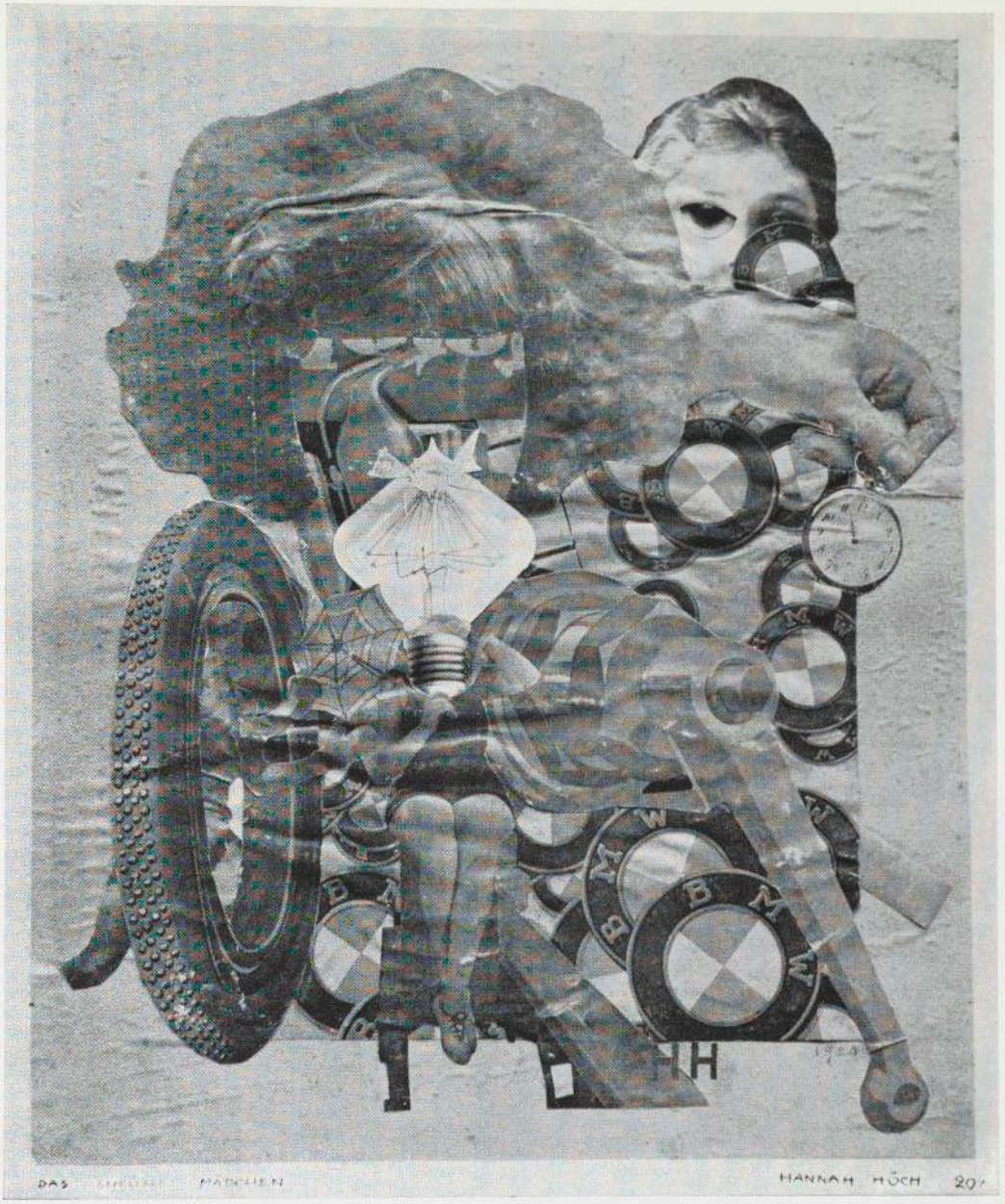


Though closely associated with some of the German Dadaists, with whom, as he said, he shared a love for "nonsense," Kurt Schwitters stood apart from them in many ways and even outspokenly opposed some of their concepts. Whereas they either took an anti-art position or wished to apply Constructivist principles for political purposes, Schwitters was strongly pro-art and quite content to create for his own private enjoyment. His approach, highly personal and complex, was closer to that of Paul Klee, whose works his frequently resemble in their small scale.

In 1918, Schwitters began to make a special kind of collage out of discarded scraps of paper and bits of junk. He gave these compositions the name *Merz,* from the second syllable of the word *Kommerz* that he had cut from an advertisement and used in one of them. Gradually he applied the term *Merz* to all his activities, which included, besides collages and reliefs, poetry and recitations, and the construction of the *Merzbau* — a gigantic, architectonic kind of static sculpture-machine that he built in his house in Hanover in the course of more than a decade. Schwitters also wrote a description for a completely irrational and unrealizable *Merz*-stage, a theatre-machine that would be a total work of art dependent on sensuous rather than literary experience.

The three small objects illustrated here (all presumably now destroyed, like the *Merzbau*) were among the first of Schwitters' three-dimensional works. He mentioned them in an article he wrote in December, 1920, in which he quoted a critic who had described *Merz House,* his first piece of architecture, as "... the cathedral ... absolute art. This cathedral cannot be used. Its interior is so filled with wheels that there is no room for people ... it has no other meaning than an artistic one."[99]

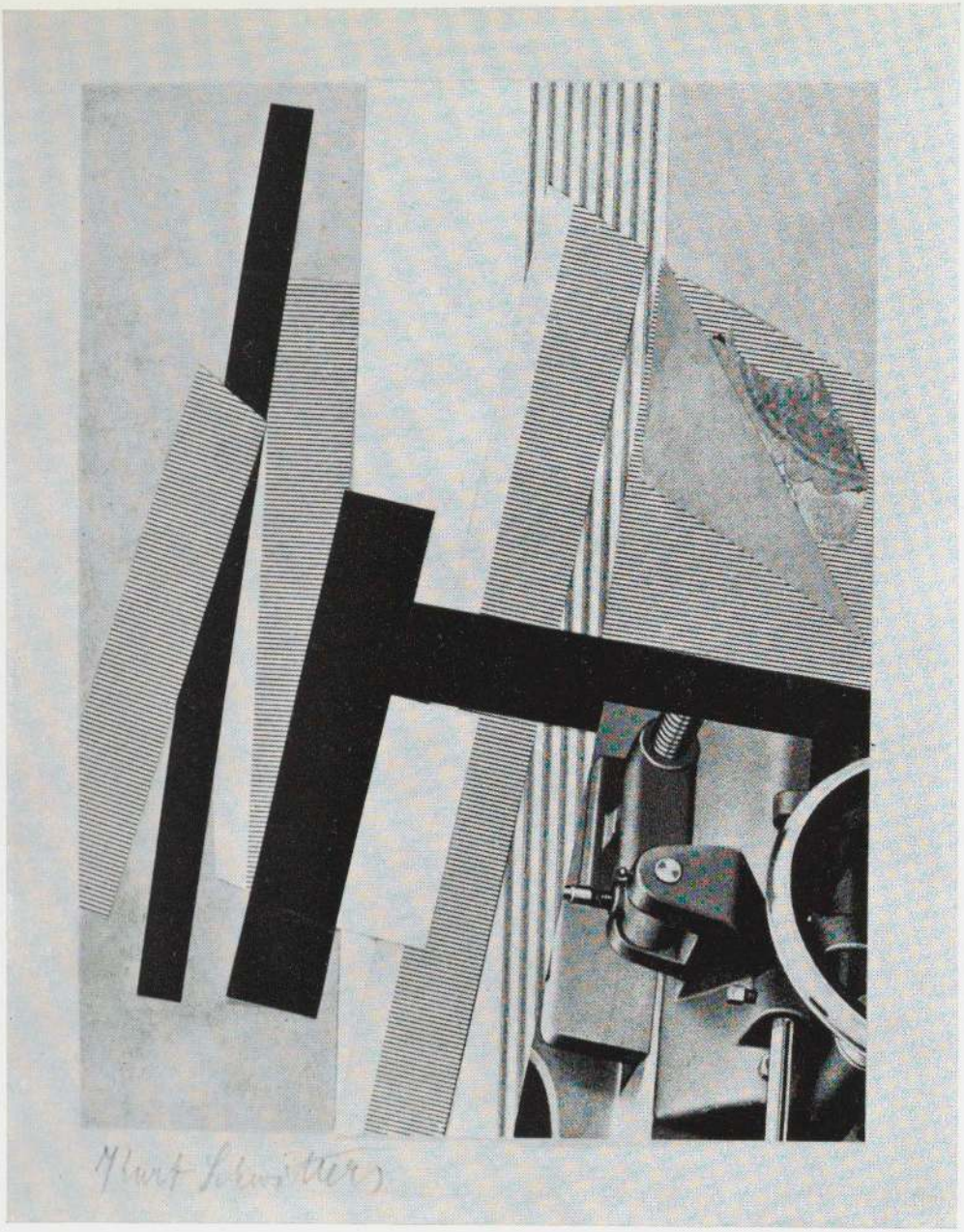
These works are typical of Schwitters' attitude to machines. He was neither impressed by nor afraid of them, but approached them as he did most other products of contemporary civilization. In a detached, unsentimental way, he seems to pity these mechanical bits and pieces that might otherwise be rejected and thrown away. In many of his constructions, the mechanical parts are isolated, exposed, and prominent. A wheel might be broken, yet it was still the central feature of the composition. The titles play an important role; like the objects themselves, they explore the depths of the irrational in a never-ending, elusive way.



Hannah Höch. German, born 1889
Pretty Girl. 1920
Pasted photo-engravings, 15×12¼″
Collection S. & G. Poppe, Hamburg

Hannah Höch was one of the original group of Berlin Dadaists and a particular friend of Raoul Hausmann, from whom she learned the new technique of photomontage. In contrast to her male comrades, she did not feel that this medium should be used "to produce only polemical works, or for applied art . . . but that it could be employed simply for its expressive possibilities and that one should create with it purely aesthetic works."[100] This brought her closer to Schwitters' approach. Höch is, with him, probably the first to use the mechanical repetition of a single element to describe the effects and characteristics of the machine.

Unlike her colleagues in Germany, she also sensed the erotic implications of machines. She had probably seen some of Picabia's work, for the head of her beautiful young girl is a light bulb, and just such an electric light had appeared on the cover of the sixth number of Picabia's *391* in July, 1917, labeled *American Girl*.[101] Höch's girl, however, has a softer charm than Picabia's symbol and appears on very friendly terms with the motorized elements around her.

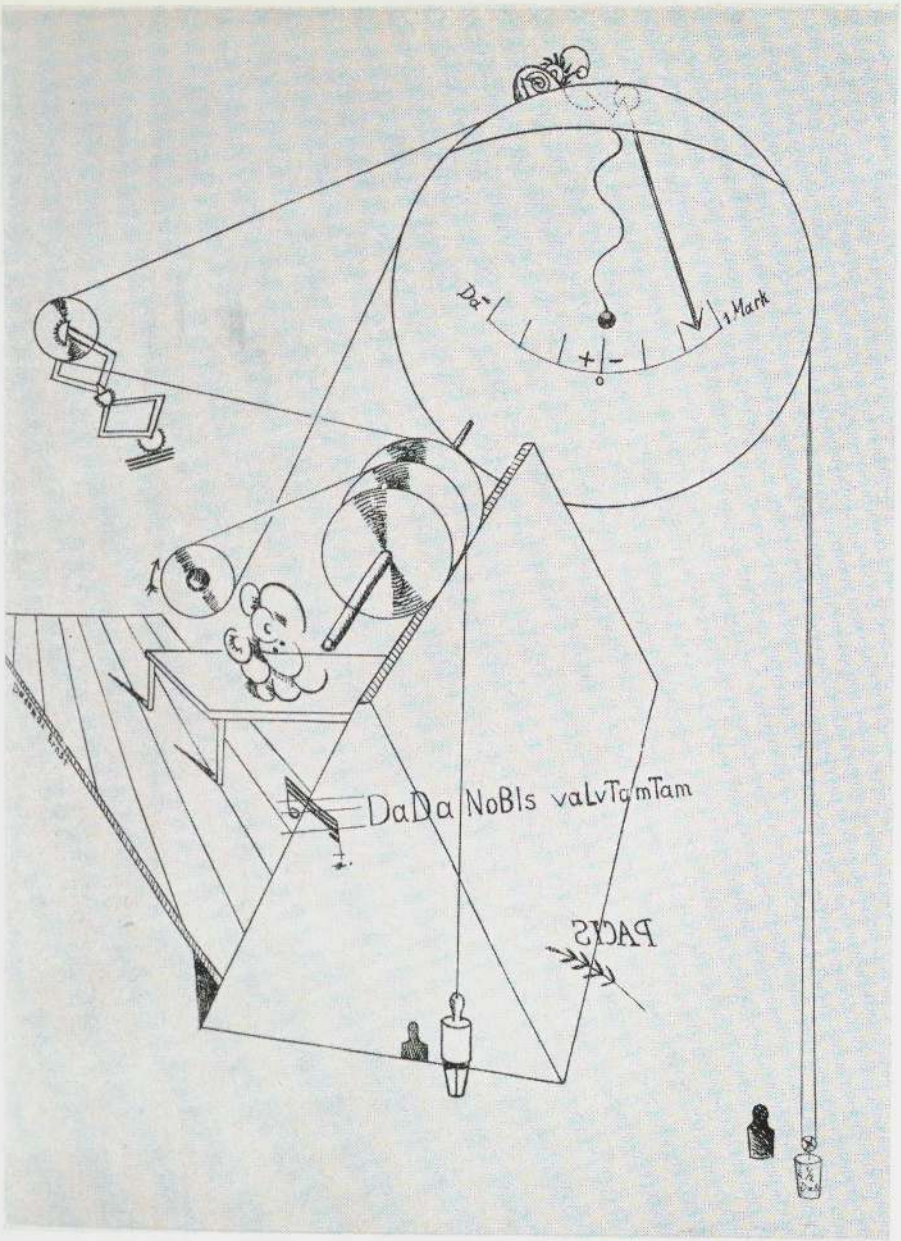


Kurt Schwitters
Untitled (With Machine Part). c. 1923—1924
Cut-and-pasted paper and photo-engravings,
$12^1/_2 \times 9^1/_4''$ (sheet)
Marlborough-Gerson Gallery, Inc., New York

Early in the 'twenties, Schwitters became estranged from those of the Dadaists who were essentially political. After a trip to Holland in 1922—1923, he was increasingly influenced by Theo van Doesburg's neo-plasticism. His work assumed more formalized tendencies, and his interest in typography was intensified.

In some of his collages from this time on, Schwitters seems to be concentrating on the mechanical characteristics of the printed materials he used in them. Much of this material resembles the kind of proofs one might find in a printing shop. Multiple repetitions of the same element, combined with printed images of machines, give collages of this sort a metallic, oily, "modern" look. They are Schwitters' contribution to the Constructivist optimism of that time, which believed so firmly in the potential of efficiency. Yet, in their complete uselessness, they retain Schwitters' characteristic note of skepticism or irony, however discreetly expressed.

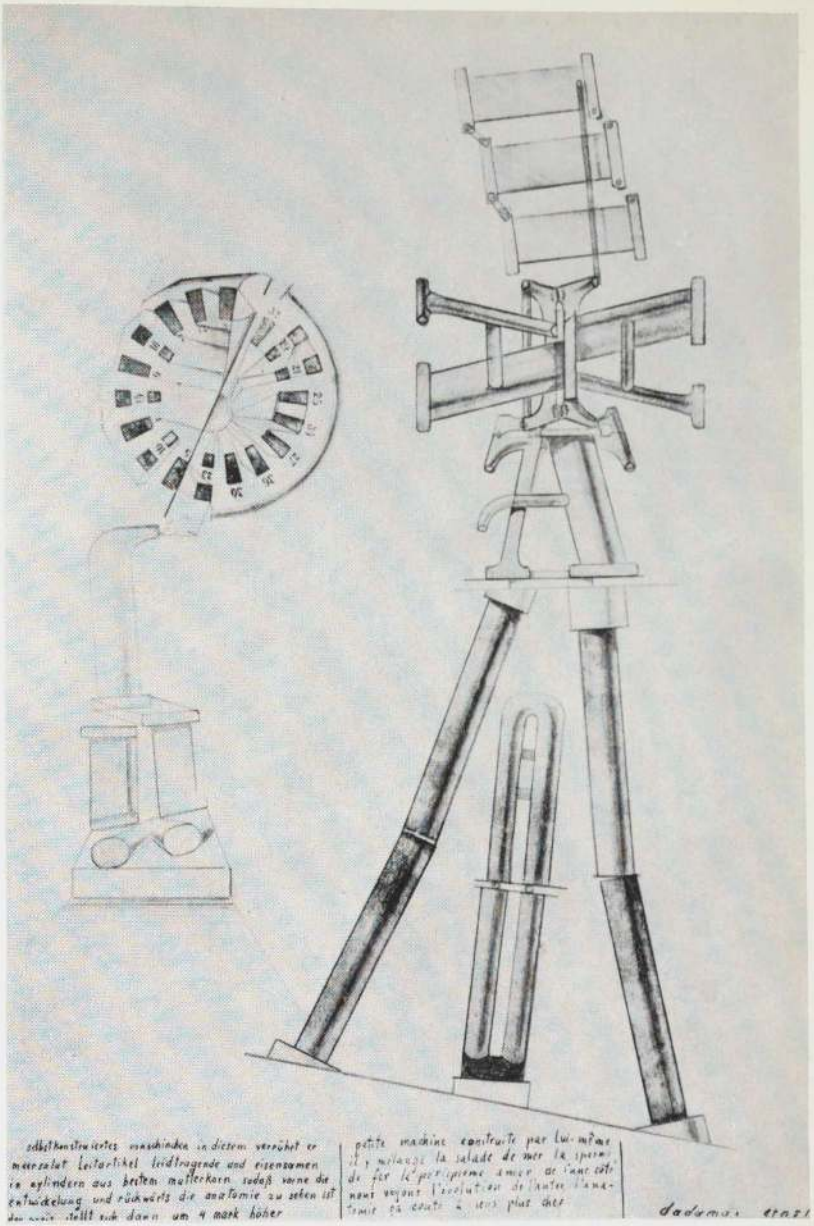
Kurt Schwitters. *Untitled (H. Bahlsens Keks-Fabrik A.G.).* 1930
Cut-and-pasted paper and photo-engravings, $9^{7}/_{8} \times 6^{1}/_{4}''$ (sheet). Private collection, Switzerland



Max Ernst. French, born Germany, 1891
"*Fiat Modes, Pereat Ars*" ("*Let There Be Fashion, Down with Art*"): Plate II,
Da Da NoBis . . . c. 1919. Lithograph, 17 1/8 × 11″ (sheet)
The Museum of Modern Art, New York

Before the war, Max Ernst, the son of a painter, had already decided to follow the same career. He belonged to a circle of avant-garde artists and poets in Cologne and had met others during a visit to Paris. He served four years in the army, was wounded twice, and invalided in 1917. He and Paul Eluard, who became his closest friend, later discovered that in February of that year they had fought on the same front, on opposite sides.

After the war, Ernst could not travel outside Germany, since he lacked a passport. During a trip to Munich in 1919, however, he saw Dada publications from Zurich, and also the Italian magazine *Valori Plastici,* which contained reproductions of works by Giorgio de Chirico. Fascinated by the strange atmosphere and mechanistic elements in de Chirico's interiors with mannequins, Ernst produced an album of eight lithographs, *Fiat Modes, Pereat Ars,* with metallic contours and tiptilted perspective effects. Ernst later destroyed the edition; the album in The Museum of Modern Art is the only one still in existence.

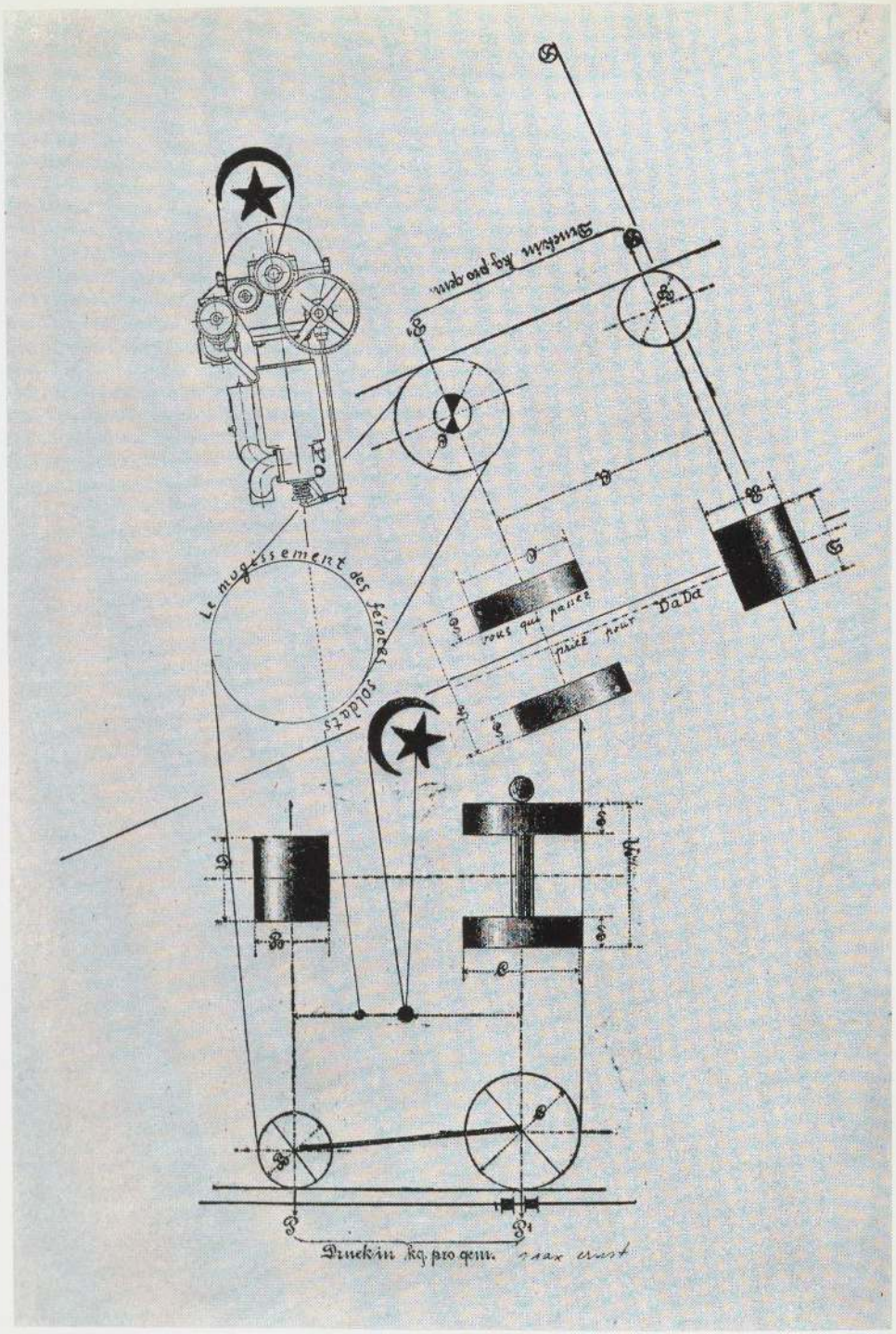


Max Ernst
Self-Constructed Small Machine. 1919
Pencil and rubbing from assembled printer's plates, 18×12″
Collection Mr. and Mrs. E. A. Bergman, Chicago

Ernst soon caught up with the Dada movement as it had developed in Zurich and other European centers. He took the name "Dadamax," and together with Alfred Grünewald, who adopted the pseudonym of Baargeld ("ready money"), and others, founded a Dada movement in the Rhineland. Their art, exhibitions, and publications were planned as a veritable conspiracy to overthrow the stodgy German mentality. Developing the techniques he found in Dada magazines, Ernst used them in a highly personal way. This drawing is inscribed:

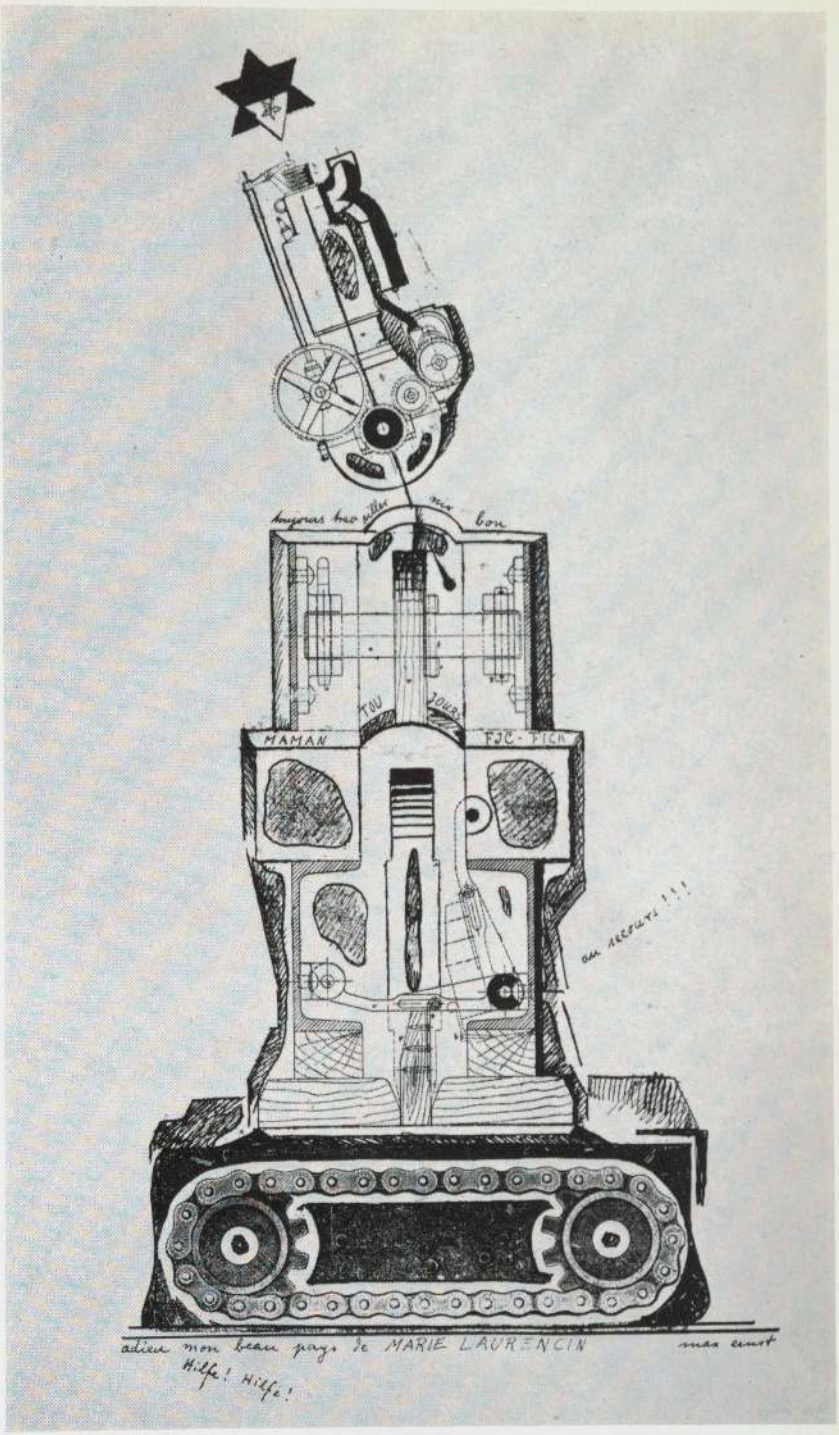
Selbstkonstruiertes maschinchen in diesem verrührt er meersalat leitartikel leidtragende und eisensamen in zylindern aus bestem mutterkorn sodass vorne die entwickelung und rückwärts die anatomie zu sehen ist der preis stellt sich dann um 4 mark höher. / Petite machine construite par lui-même il y mélange la salade de mer la sperme de fer le périsperme amer d'une côté nous voyons l'évolution de l'autre l'anatomie ça coute 2 sous plus cher.

["*Self-constructed small machine in which he mixes sea salad, editorial, mourner, and iron sperm into cylinders of the best ergot so that the development can be seen in front and the anatomy in back. The price is then about 4 marks higher./A little machine constructed by himself, in which he mixes sea salad, iron sperm, bitter perisperm. On one side we see the evolution, on the other, the anatomy. It costs 2 cents more.*"]



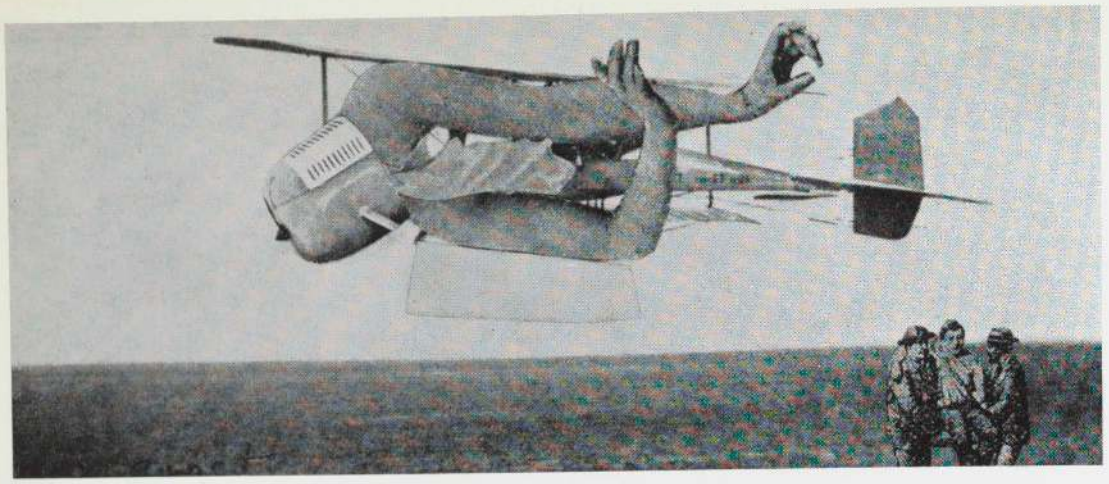
Max Ernst
The Roaring of Ferocious Soldiers. 1919
Rough proof from assembled printer's plates, altered with pen and ink, $13^{3}/_{4} \times 10^{5}/_{8}$″
Galleria Schwarz, Milan

Ernst has said that the use in his drawings and collages of figurative elements dissociated from their normal context "provoked in me a sudden intensification of my powers of sight — a hallucinatory succession of contradictory images . . ."[102] The rough printer's proofs that Ernst added to and altered by drawing on them in ink were very irrational in themselves, since the printer had placed the images with no conscious plan. Ernst's lines impose a second layer of irrationality that somehow makes the whole seem more rational. The well-organized world of German business and industry, however, found such drawings outrageously shocking.



Max Ernst
Farewell My Beautiful Land of Marie Laurencin. 1919
Rough proof from assembled printer's plates, altered with pen and ink, $15^{3}/_{4} \times 11''$ (sheet)
The Museum of Modern Art, New York

According to Ernst's recollection, the title and inscriptions of this work probably refer to Marie Laurencin's efforts to help him obtain a French visa. Together with a similar drawing called *Trophy Hypertrophied* (formerly belonging to Tristan Tzara and given by him to The Museum of Modern Art), it was made while Ernst was waiting one day in a printer's shop for proofs of a Dada publication. The Cubist-oriented Section d'Or group rejected the latter drawing for their show in Paris in 1920, on the grounds that it incorporated fragments of printed material and therefore could not be considered handmade.



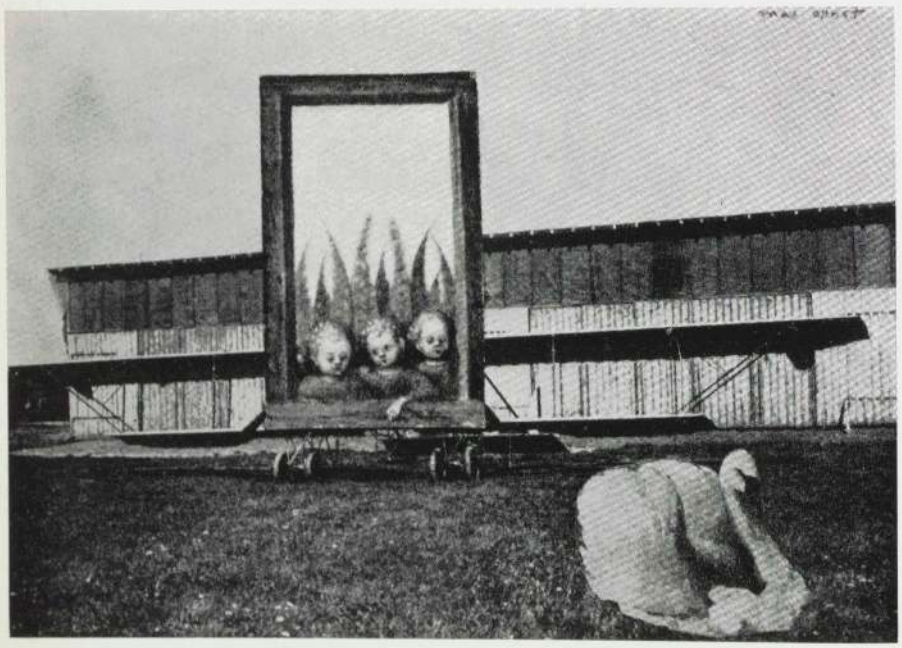
Max Ernst
Untitled (Airplane). 1920
Pasted photo-engravings, $2^{3}/_{8} \times 5^{5}/_{8}''$
Collection D. and J. de Menil

By incorporating photo-engravings into his collages, Ernst seems to have arrived independently at a technique somewhat similar to the photomontages developed by Hausmann and other Berlin Dadaists. In 1921, at the invitation of André Breton, he showed a number of these collages at the Galerie Sans Pareil in Paris.

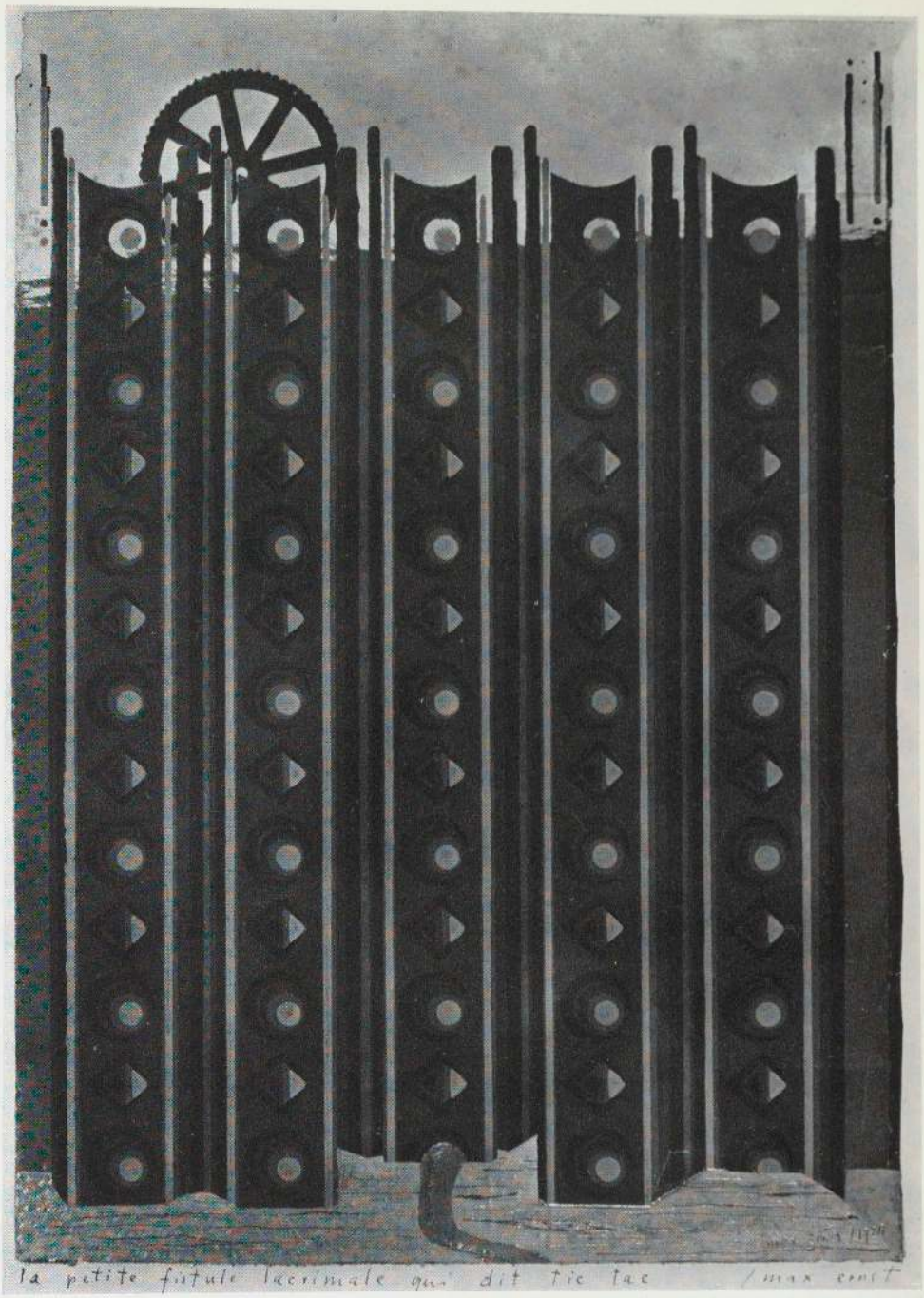
The full title of *The Swan Is Very Peaceful* is:

C'est déjà la vingt-deuxième fois que Lohengrin a abandonné sa fiancée (pour la première fois) / c'est là que la terre a tendu son écorce sur quatre violons / nous ne nous reverrons jamais / nous ne combattrons jamais contre les anges / le cygne est bien paisible / il fait force de rames pour arriver chez Léda.

["It is already the twenty-second time that (for the first time) Lohengrin has left his fiancée. / it is there that the earth has spread its crust on four violins / we will never see each other again / we will never fight against the angels / the swan is very peaceful / he paddles hard to catch Leda."]



Max Ernst
The Swan Is Very Peaceful
1920
Pasted photo-engravings,
$3^{1}/_{4} \times 4^{3}/_{4}''$
Private collection, New York

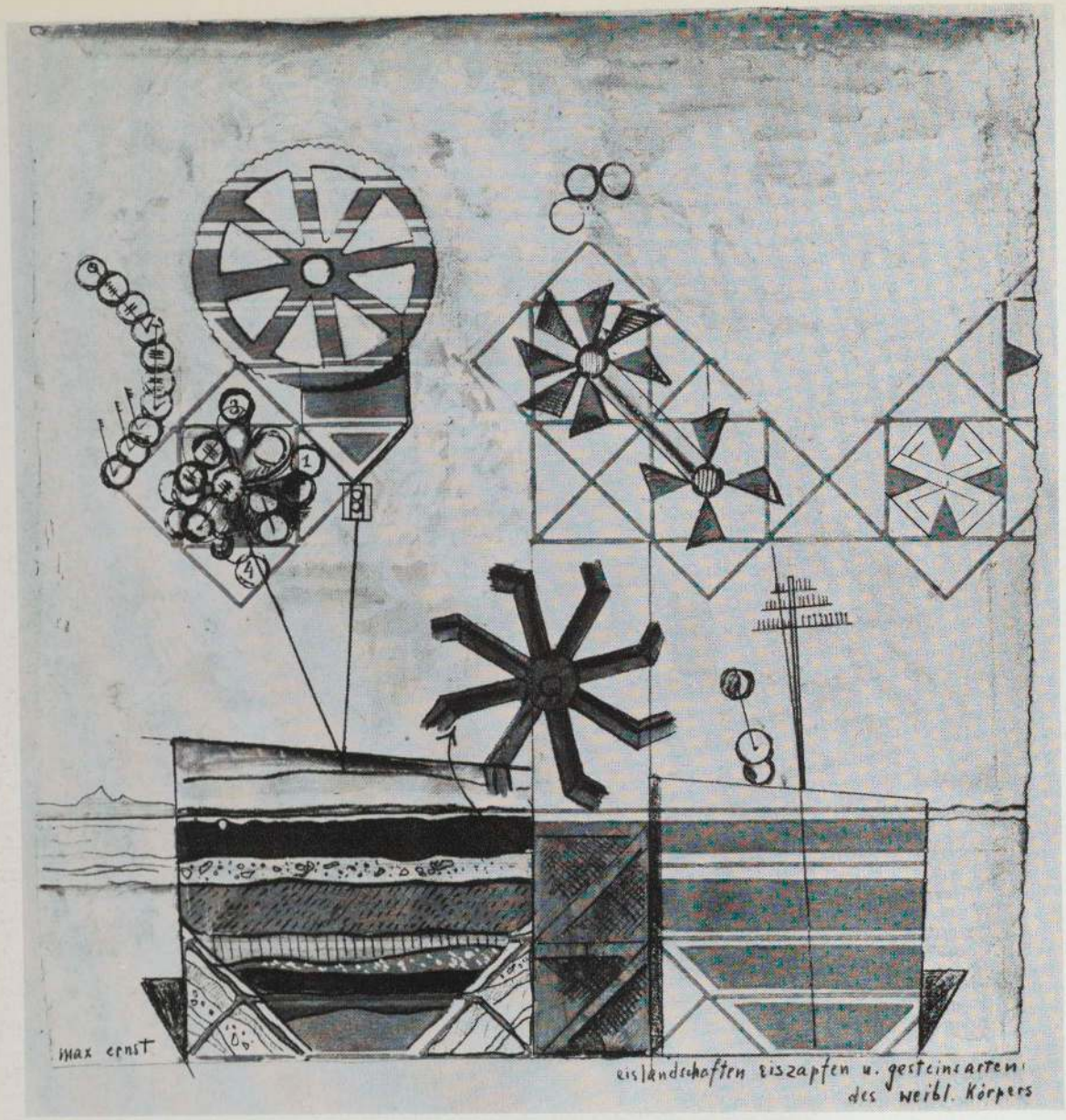


Max Ernst
The Little Tear Gland That Says Tic Tac. 1920
Wallpaper borders altered with gouache,
$14\frac{1}{4} \times 10''$ (sheet)
The Museum of Modern Art, New York

The Little Tear Gland That Says Tic Tac is important as a starting point for the theme of the sun and the forest, which was to recur frequently in Ernst's paintings. Here, what would become the forest in later versions looks more like a screen made of perforated metal strips. The mechanical part, the "sun," is a cogwheel that brings to mind the old-fashioned industries bordering the Rhine, with their mine elevators, always topped by a big wheel, sticking up across the landscape.

Many of the titles that Ernst gave to his Dada pictures have a very irrational relationship to the images. In this case, however, the title is rather direct; it seems to project something within the forest that is either alive or mechanically animated.

Ernst's transformation of one kind of reality into another in this collage already foreshadows Surrealism. In fact, he gave this work to André Breton, who in 1924 was to issue the Surrealist Manifesto.

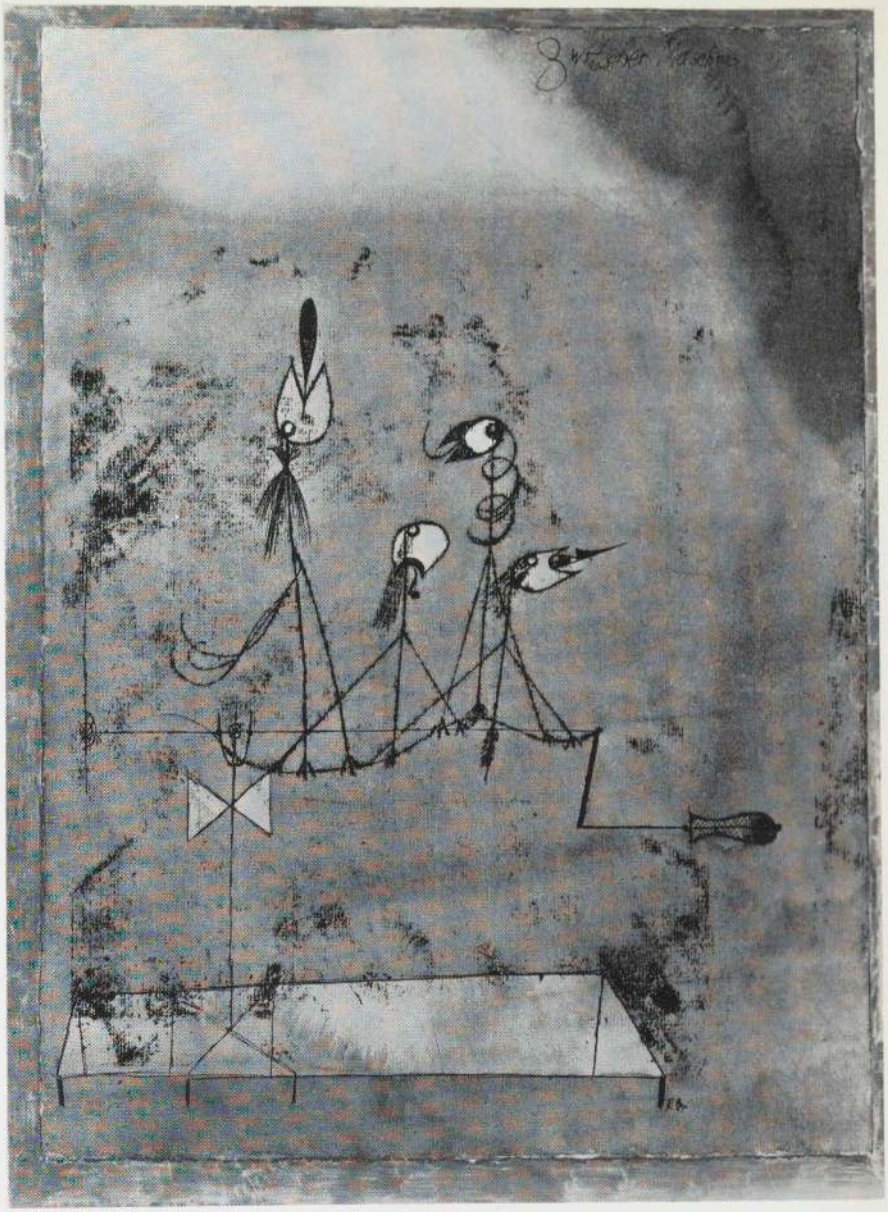


Max Ernst
Glacial Landscapes (*Eislandschaften Eiszapfen u*[*nd*] *Gesteinsarten des Weibl*[*ichen*] *Körpers*). 1920
Watercolor and collage, 10×9½″
Moderna Museet, Stockholm

Ernst has frequently exploited the interplay between printed forms (mechanically manufactured and chosen) and forms drawn by hand (non-mechanical and made by the artist). He does this in at least three different ways: 1) by using printers' signs and symbols in combination with drawn lines; 2) by incorporating into his collages printed materials, often reproductions of mechanical elements; 3) by covering a patterned surface, such as wallpaper, with paint.

Ernst's use of the pattern of the wallpaper on which this collage is painted is so ingenious that it takes quite a while to discover it. In some places, the mechanical parts of the pattern have been allowed to keep their character; elsewhere, a new mechanical but hand-drawn form has been superimposed. The ambiguity is total.

In the *frottage* (rubbing) technique that Ernst developed in 1925, the interplay between what the artist chose and what he fabricated is applied to organic, non-mechanical materials — wood-grain or leaves. This is in line with the Surrealists' concentration on natural forces.

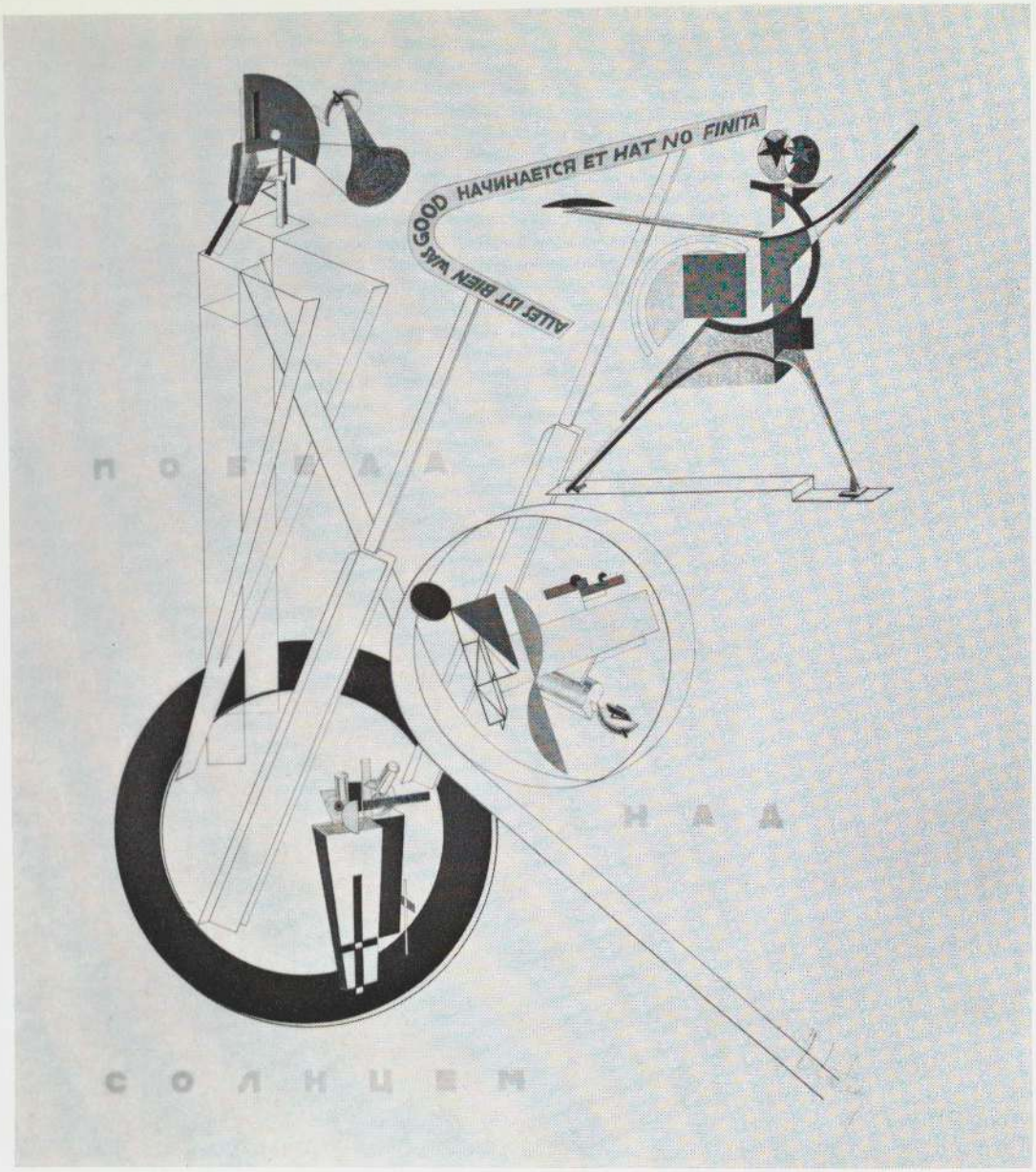


Paul Klee
German, born Switzerland,
1879—1940
Twittering Machine
(*Zwitscher-Maschine*). 1922
Watercolor, pen and ink, $16^1/_2 \times 12''$
(composition)
The Museum of Modern Art,
New York

Although done only a year or two after Picabia's machinist paintings, which are also often ironic in tone, Klee's picture reveals an entirely different concept of the machine. It displays contempt of a mild but incisive kind. Instead of man-as-machine, we have here bird-as-machine (or perhaps vice versa). Klee has taken away all the machine's glorious function and left only a disturbing noise, incarnate in crazed or unhappy birds imprisoned in the image of their mechanically produced, repetitive sound. The sickly violet atmosphere around them heightens the impression of their misery.

This is an early foreshadowing of the estrangement from mechanical things and the fear of machines that were later to predominate in the art of the Surrealists. The core of the Surrealist program was exploration of the inner depths of man's mind, and for that, there was no need for machines — at least, for any known kind of machine. To the Surrealists, the world of technology represented an intrusion, if not an actual menace.

Here we see the beginning of an attitude of rejection of the machine that would culminate in the 'thirties in outright fear or despair, as manifested for example in Giacometti's *Captured Hand* (page 159) or Chaplin's *Modern Times* (page 157). Klee's birds twitter a frightening message that seems like a foreboding of coming events. The hand crank serves to indicate that it is man himself who by his invention and mastery of technology is destroying nature.[103]



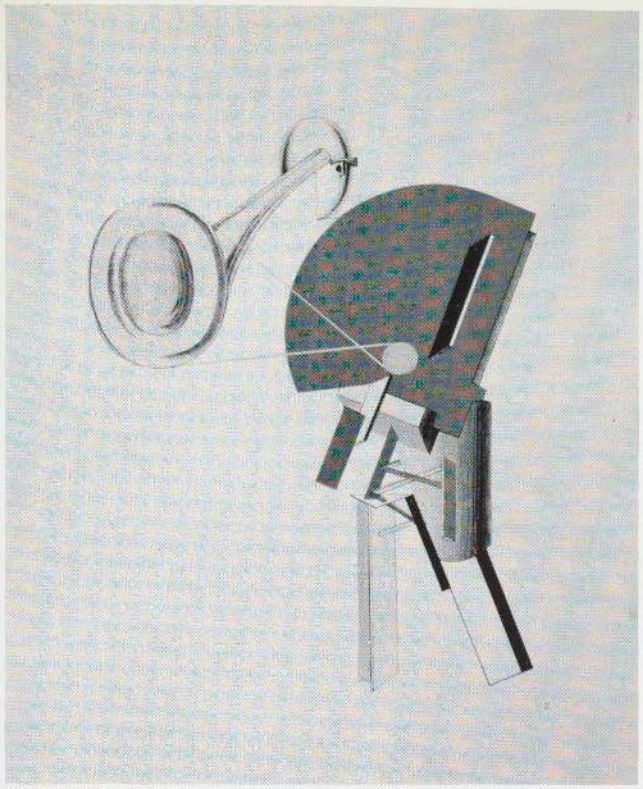
Part of the Spectacle Machinery

El Lissitzky **(Lazar Markovich Lissitzky)**
Russian, 1890—1941

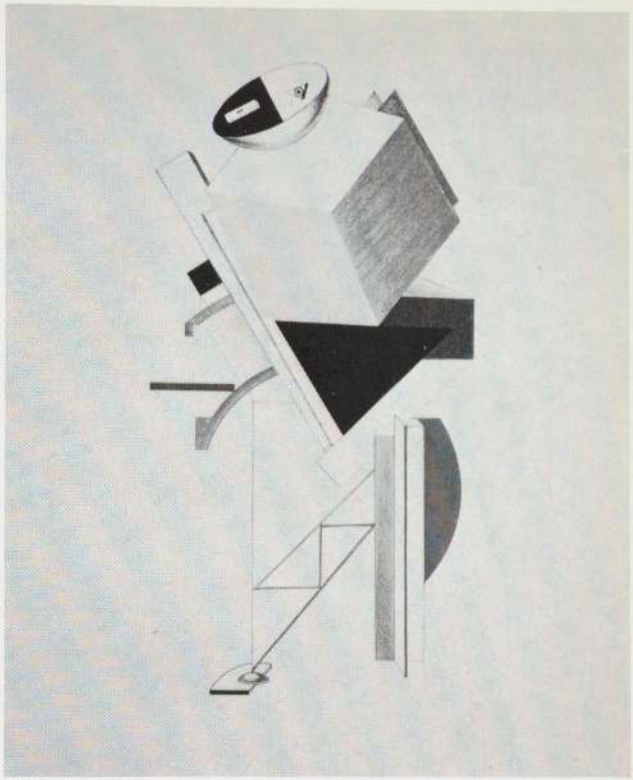
◎ *"Victory over the Sun": Figurines ("Sieg über die Sonne": Figurinen).* Designs 1920—1921; album published by Robert Leunis and Chapman, Hanover, 1923. Suite of 10 lithographs printed in color, each sheet 21 × 17 7/8" The Museum of Modern Art, New York

In Moscow in 1920—1921, El Lissitzky began working on a huge plan for a completely mechanical theatre. It was the most radical attempt to introduce Constructivist ideas into staging. In the text below, originally published as the foreword to his album of ten color lithographs issued in 1923, Lissitzky explained how this "electro-mechanical spectacle" was supposed to work. His conception reveals an excessively romantic attitude toward the machine. The engineer controls the whole set, which seemingly represents the universe; thanks to the machine, man can now take the place of God. Instead of actors *(Schauspieler),* there are mechanically controlled figures *(Spielkörper).*

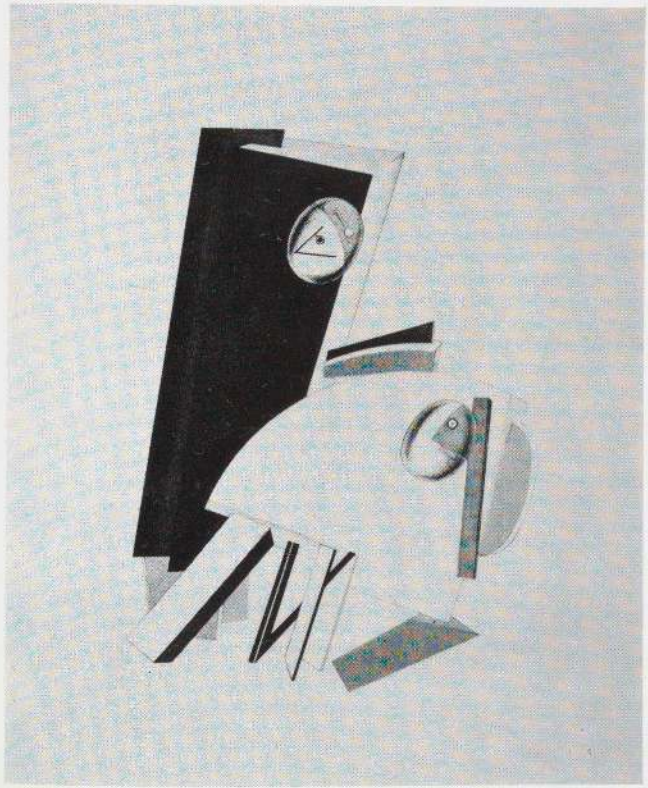
It is significant that Lissitzky should have chosen as the first demonstration of his mechanized stage a play by Alexei Kruchenikh, which had been presented in St. Petersburg in 1913 with a famous decor by Malevich. It was not particularly well suited to the new stage, but what probably impressed Lissitzky was the idea of



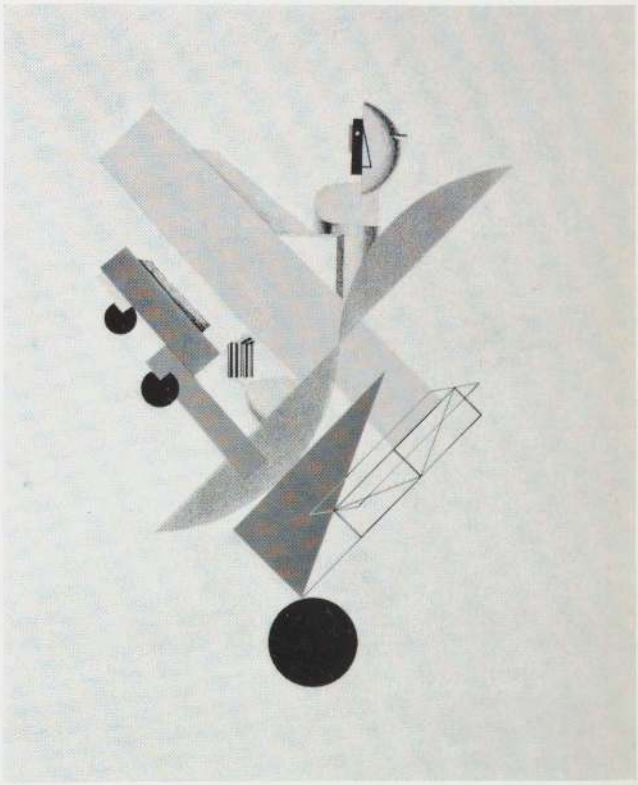
Radio Announcer



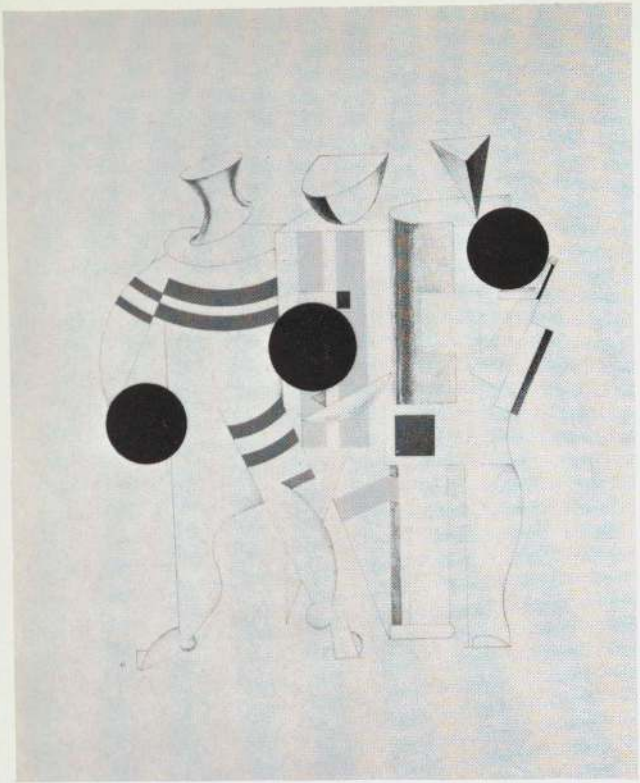
Postman



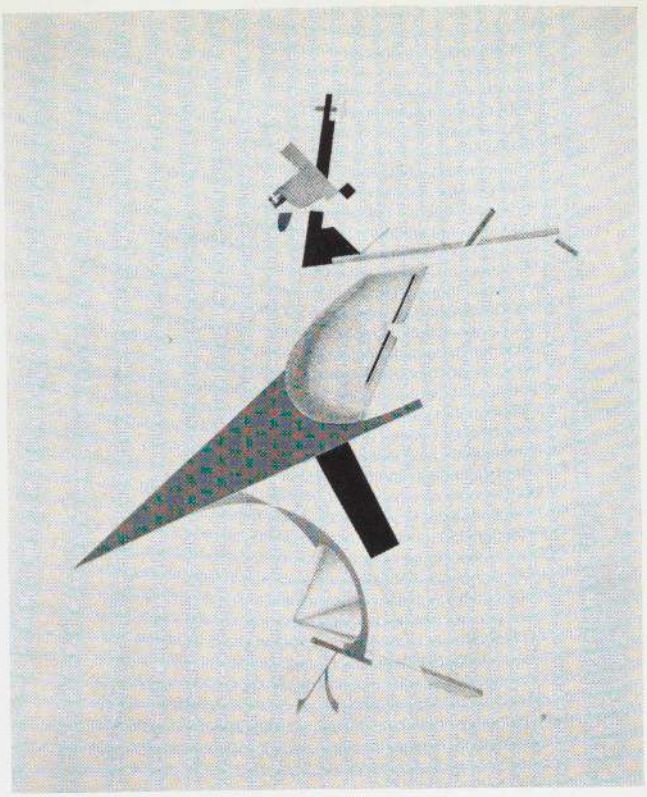
The Anxious



Up-to-date Globetrotter

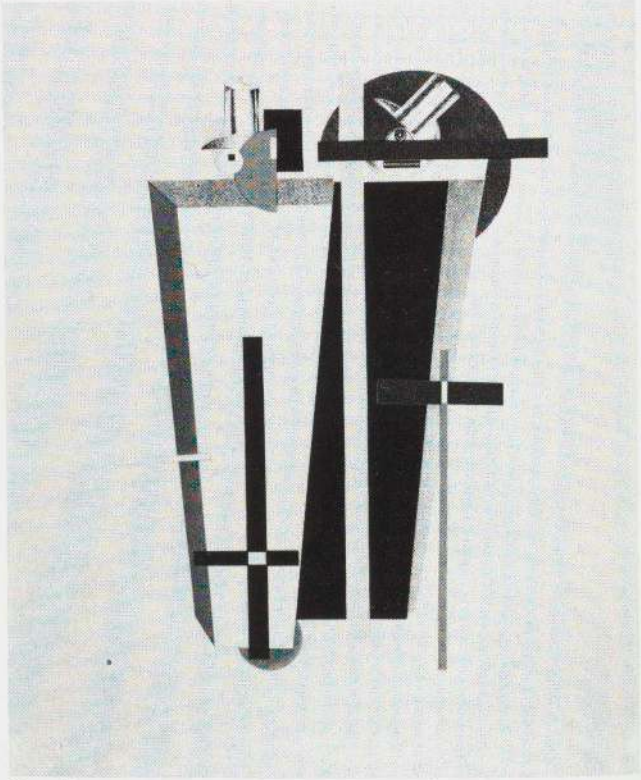


Sportsmen



Troublemaker

Old Man (with His Head Two Steps Behind)



Gravediggers

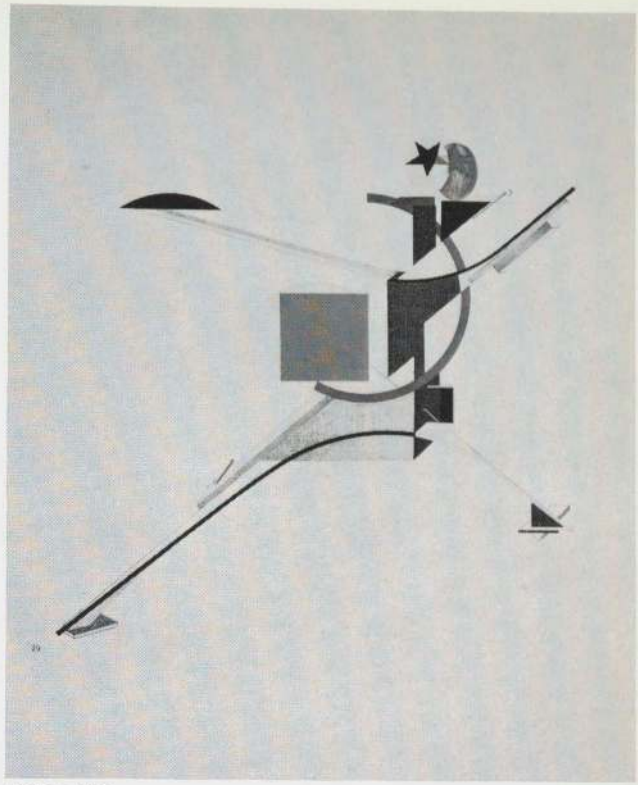
man's ability to dominate the sun by his technical mastery. This view of the development of the technological age was to reach its culmination (and hopefully its terminus) with the dropping of the atom bomb.

The following is the fragment of a work developed in Moscow, 1920—21. Here, as in all my work, my goal is not to reform what has already existed but rather to bring into being another reality.

The magnificent spectacles of our cities are not noticed by anyone, for "anyone" is himself a participant. Each energy is applied solely to its own purpose. The whole remains amorphous. All energies must be organized as a unity, crystallized, and put on display. Thus there comes into being a WORK *— if you wish, call it a work of* ART.

We construct in a public square, open and accessible on every side, a scaffolding, which is the SPECTACLE MACHINERY. *This scaffolding provides the figures every possibility of movement. The individual parts of the scaffolding must therefore be capable of moving in various positions, rotating, extending, and so forth. The different levels must be able to interpenetrate quickly. Everything is of skeleton construction in order not to hide from view the figures running through. They are fashioned according to requirement and intentions. They glide, roll, float, within, around, and over the scaffolding. All parts of the scaffolding system and all the figures are activated by electro-mechanical forces and devices, controlled from a central station by one man. He is the* SHAPER OF THE SPECTACLE. *His place is at the midpoint of the scaffolding, at the switchboards that control all the energy. He directs the movement, sound, and light. He switches on the radio loudspeaker, and over the public square is heard the deafening clamor of railroad stations, the roaring of Niagara Falls, the hammering of a boiler factory. Instead of individual figures, the* SHAPER OF THE SPECTACLE *speaks into a telephone connected to an arc-lamp, or into some other apparatus, which transforms his voice in accordance with the character of the respective figures. Electrical phrases glow and die away. Beams of light, fractured by prisms and mirrors, follow the movements of the figures. In this way, the* SHAPER OF THE SPECTACLE *brings the most elementary action to the highest pitch of intensity. For the first presentation of this electro-mechanical* SPECTACLE, *I have used a modern piece, which was, however, composed for the stage. It is the Futurist opera,* Victory over the Sun, *by A. Kruchenikh, the inventor of sound-poetry and leader of the most modern Russian literature. The opera was first presented in Petersburg in 1913. The music is by Matiuschin (quarter-tonal). Malevich painted the sets (the curtain = a black square).*

The sun as the expression of the old cosmic energy is ripped out of the heavens by modern man, who creates his own source of energy through the power of his technical mastery. This idea of the opera is woven



Modern Man

together in a simultaneity of happenings. The language has no logic. Some singing parts are sound-poems.

The text of the opera obliged me to preserve something of human anatomy in my costume designs. The colors in various parts of these drawings, as in my Proun-works, are to be understood as material equivalents. That is: the parts of the costume designs done in red, yellow, or black do not indicate that those parts are to be executed in those colors, but rather that they are to be made out of corresponding materials — for example, shining copper, dull iron, and so forth.

I leave to others the further development and practical application of the ideas and forms presented here, and I myself go on to my next task.[104]

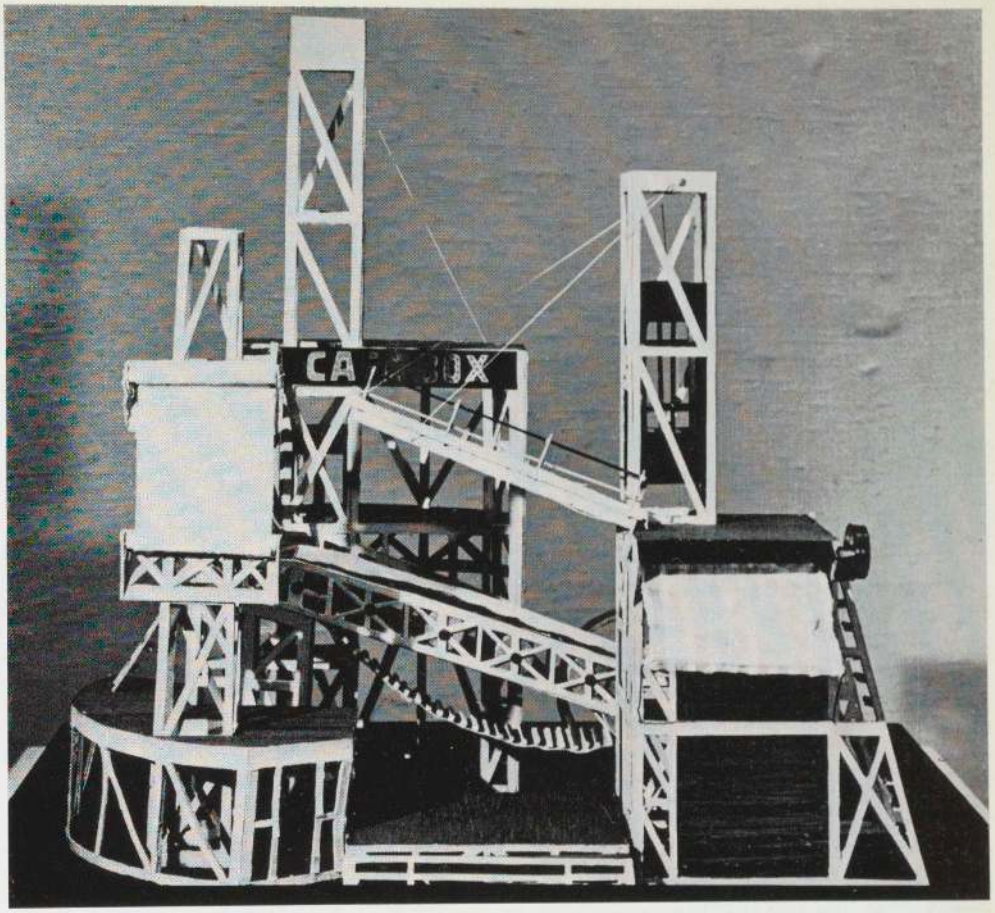
By 1924, however, Lissitzky already seems to have come to realize that over-exaltation of the machine and machine aesthetics had gone too far. While in a sanatorium at Locarno undergoing treatment for tuberculosis, he wrote for Schwitters' publication *Merz* a small manifesto called "Nasci" (Nature). Lissitzky opens with the exhortation: "*Enough* now of the everlasting MACHINE, MACHINE, MACHINE, when speaking of the art production of our time." The machine, he declares, is merely an instrument, and still a highly undeveloped one, for portraying the universe. In a key sentence, he states: "The machine has not separated us from nature. Through the machine we have discovered a new nature, which previously was not envisioned."[105]

Liubov Popova. Russian, 1889—1924
Stage model for "The Magnificent Cuckold." 1922
Wood and metal, 30″ high × 44½ wide × 27½″ deep
Institut für Theaterwissenschaft der Universität Köln, Cologne

In Russia during the 1920s, the theatre became by far the most important outlet for those who wanted to create the new culture for the new society. Films by Eisenstein, such as *Strike* (1924), or by Dziga-Vertov, such as *The Man with the Camera* (1928), were soon to play a major role; but at the outset, the possibilities for experimentation in the theatre appeared even greater, resulting in an impressive number of outstanding plays and settings. Ideas based on Tatlin's new "machine art" predominated. Constructivism in the theatre is most widely known through the productions of Meyerhold, which, like Tatlin's architecture and sculpture, were closely linked to the aims of the Revolution. To quote Ronald Hunt, one of the few Western critics to have written about the art and theatre of those years in Russia: "... Meyerhold repeatedly made it clear that the theatre was a political institution: 'The proletariat must completely fill the ditch that an outworn class has dug between art and life.' For Meyerhold and many others there existed a magical equation: 'proletarization = industrialization of art'."[106]

The highly influential position that those concerned with the Russian theatre occupied during the years after the Revolution has up to now been largely neglected or misunderstood. We shall probably soon see a growth of interest in their contributions, for their efforts to formulate a new kind of expressivity directly relevant to life have much in common with similar attempts today, just as there are contemporary analogies to the efforts of Tatlin and Lissitzky to bring about a collaboration between art and technology.

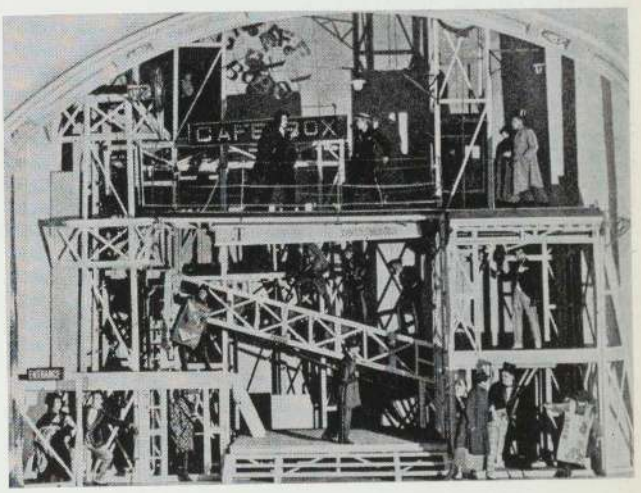
Meyerhold's production of *The Magnificent Cuckold* in 1922 was one of the first to incorporate Constructivist ideas in the theatre. He ignored the script, which was that of a sexy French farce, and turned the whole into a Bolshevik comedy in which young people expressed themselves through physical culture and athleticism. The set and costumes by Liubov Popova were among the most accomplished achievements of machinist decor. Popova designed a construction with a central section about 25 feet high, incorporating several platforms. It had moving elements like a windmill and discs that could be spun. The speed of rotation changed according to the actor's mood — for example, rapid spinning denoted rage.

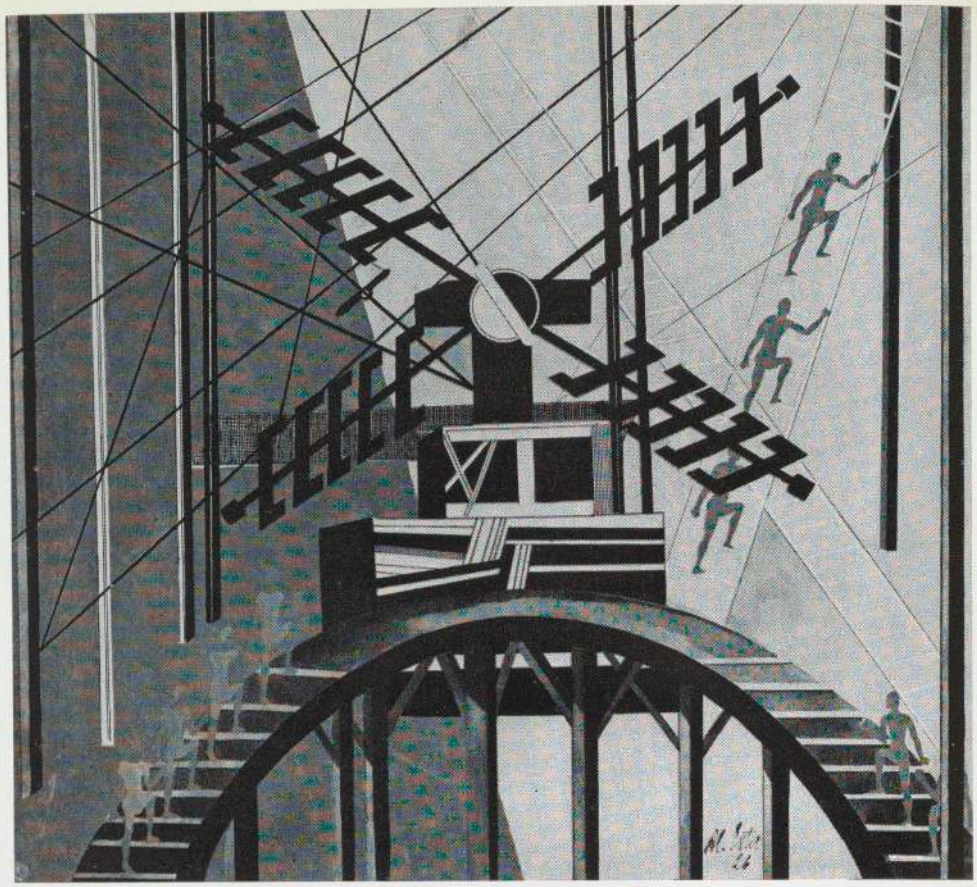


Aleksandr Vesnin
Russian, 1883—1959
Stage model for "The Man Who Was Thursday": Cafeteria. 1923
Wood and metal, 31½″ high × 30″ wide × 20″ deep
Institut für Theaterwissenschaft der Universität Köln, Cologne

Aleksandr Tairov opened the Kamerny (Chamber) Theatre in Moscow in 1914 as a vehicle for his progressive ideas of staging, which he later expressed in a book, *The Liberated Theatre.* Even his early Futurist productions departed from traditional realistic settings by baring the scaffolding and technical apparatus of the stage. After the Revolution, he developed in the Constructivist direction. *The Man Who Was Thursday* was a key example of his style, in which a comedy by G. K. Chesterton, set in the Middle Ages, was transformed into a picture of the new collectivist society. The setting by Aleksandr Vesnin, an architect who was a pupil of Tatlin's, was a skeletal, vertical construction made up of many levels, which fully utilized the new building materials and mechanical apparatus. Moving stairs, elevators, and flashing electric signs kept everything in continuous motion throughout. The actors, who represented various social types, moved and spoke in mechanical rhythms.

Among the other designers for Tairov's theatre were Alexandra Exter, Georgiy Yakulov, and Yuriy Annenkov. The sets that Yakulov designed for Prokofiev's ballet, *The Age of Steel,* probably in part inspired Chaplin's *Modern Times* (see page 157). Annenkov, who was another of Tatlin's pupils, collaborated with Nikolay Evreinov in a restaging of *The Storming of the Winter Palace.* An outdoor, mass spectacle presented in Petrograd two years after the historical event, with a cast of 8,000, it was in part so realistic that a photograph of it has been reproduced as the event itself!



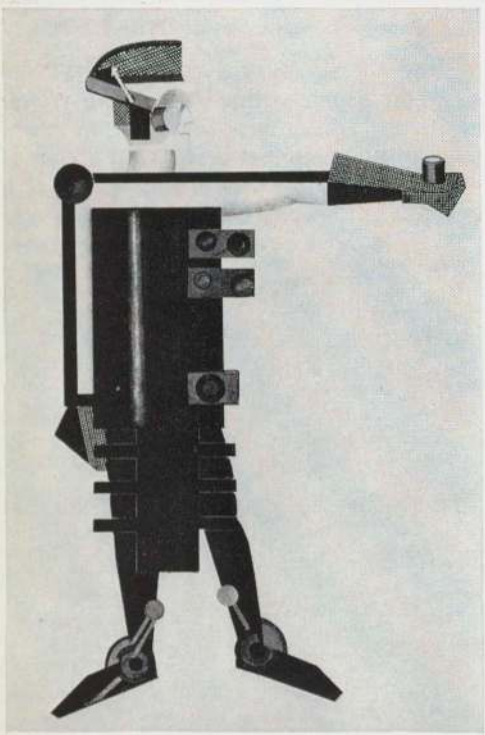


Alexandra Exter
Russian, 1882—1949

Construction for "Scène plastique et gymnastique," 1926
Gouache and pencil,
18×21 3/8″

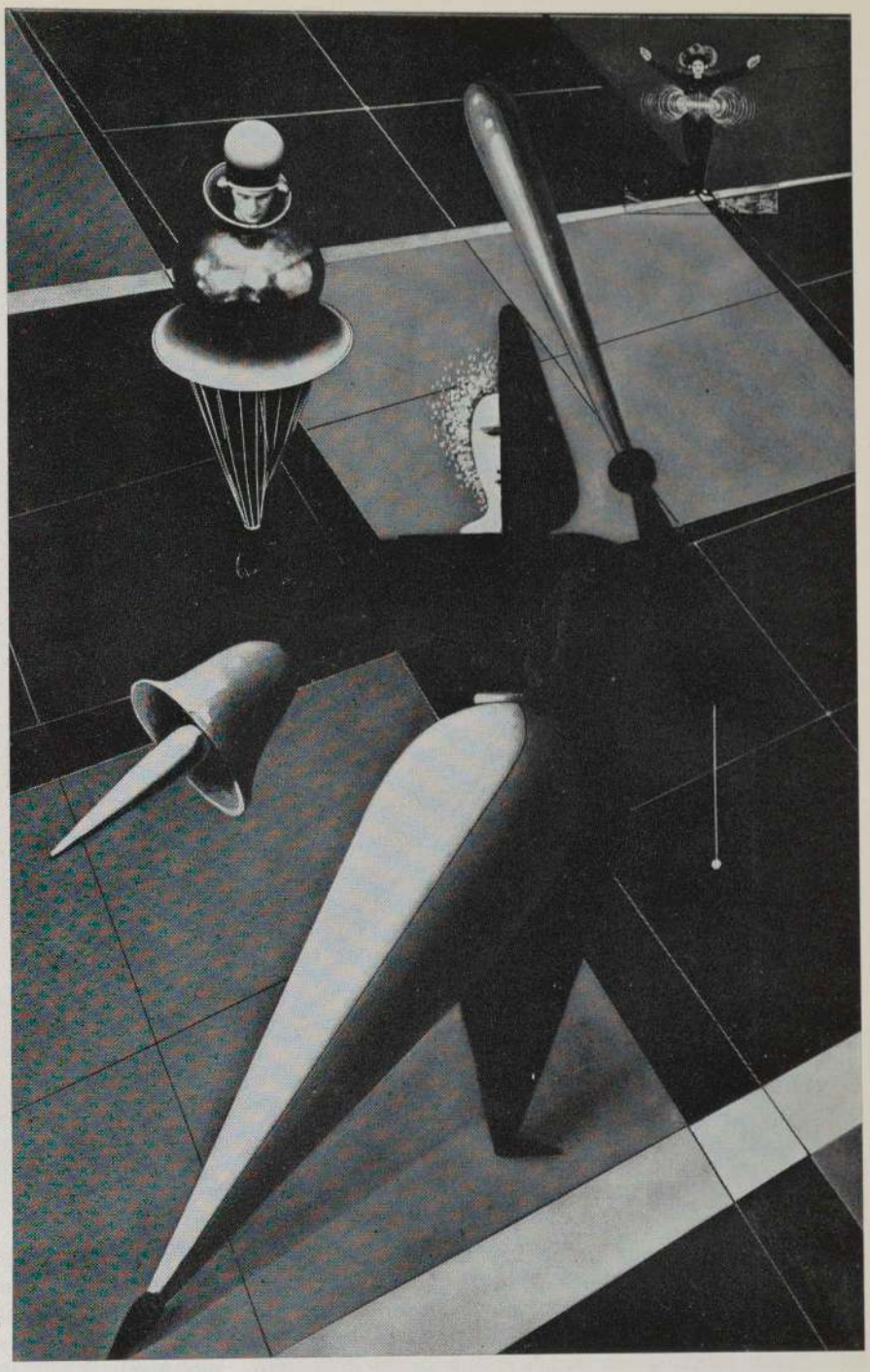
Costume design for the film "Aelita." 1924
Gouache and pencil,
21 1/4×14″

Collection
Mr. and Mrs. Simon Lissim,
Dobbs Ferry, New York



The principal designer for Tairov's theatre was Alexandra Exter, one of the most important Constructivist stage designers of the 'twenties. She traveled extensively abroad, knew many of the leading avant-garde artists in different countries, and from 1925 on conducted a course in theatre arts in Paris. Her dynamic sets, as in the example reproduced here, abandoned the flat stage entirely to make use of verticals and diagonals that required much physical exertion on the part of the actors. Her costumes made the actors resemble machine-like sculpture rather than human beings. Those that she made for the film *Aelita,* a kind of Martian fantasy, show the influence of Cubism and particularly that of Léger's machine paintings.

Many of the machinist plays of this period were enacted by mannequins, very likely inspired to some extent by the figures in de Chirico's metaphysical paintings. One of the most widely known plays using machine-people was Karel Capek's *R.U.R.* The initials stand for "Rossum's Universal Robots"; it is in this play that Capek introduced the word "robot" (from the Czech word meaning "to work") to designate a worker-automaton. In 1923, Friedrich Kiesler created the setting for a production of *R.U.R.* in Berlin, making use of an electrically controlled stage with mechanical flats, films as backdrops, and mirror apparatus.[107]



Oskar Schlemmer

German, 1888—1943

Study for "The Triadic Ballet"
c. 1921—1923
Gouache and photomontage,
$22^5/_8 \times 14^5/_8$" (irregular; sheet)
The Museum of Modern Art,
New York (gift of Mr. and Mrs.
Douglas Auchincloss)

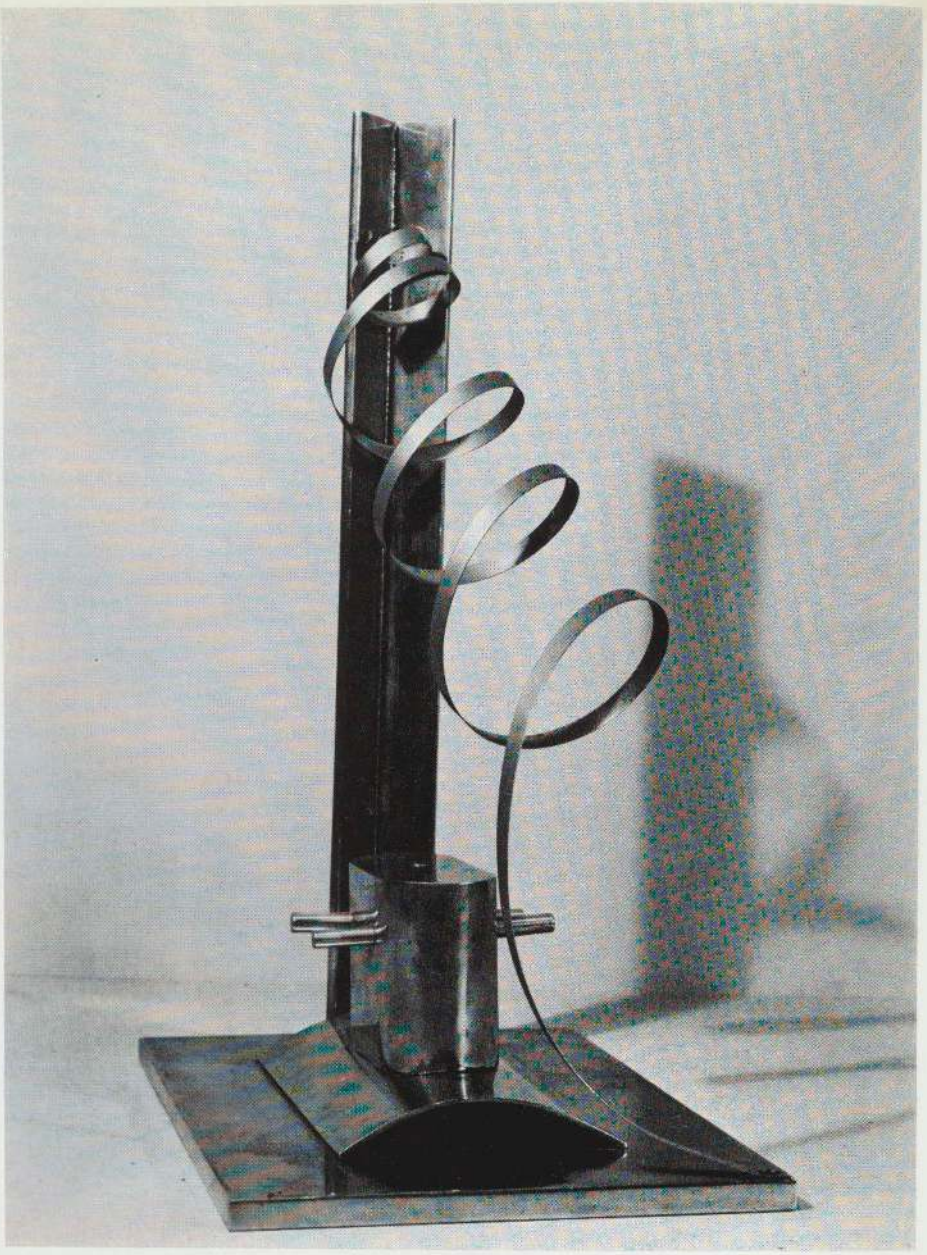
The idea of man as machine recurred frequently in the theatre of the early 'twenties. One of the most ambitious of such projects was *The Triadic Ballet* by Oskar Schlemmer, who had joined the staff of the Bauhaus in 1921 and remained the director of its theatre section until 1929. Adapted from an earlier dance originated in 1912, *The Triadic Ballet* had its first performance at the Landestheater in Stuttgart in 1922, was performed the next year at the Nationaltheater in Weimar during Bauhaus Week, and in 1926 was given at Donaueschingen with music composed by Hindemith for mechanical organ.

The three parts of the ballet have a total of twelve scenes, enacted by three dancers — two male and one female — in eighteen different costumes. It is, in fact, the costumes which have the principal roles. Hidden beneath padded cloth or stiff papier-mâché forms covered with metallic or colored paint, the dancers are reduced to motors for the costumes. They become abstract organisms enacting the laws of motion of the human figure in space. Schlemmer described the dilemma inherent in such a situation:

One of the emblems of our time is abstraction . . . . *A further emblem of our time is* mechanization, *the inexorable process which now lays claim to every sphere of life and art. Everything which can be mechanized* is *mechanized. The result: our recognition of that which can* not *be mechanized. And last, but not least, among the emblems of our time are the new potentials of technology and invention . . .*[108]

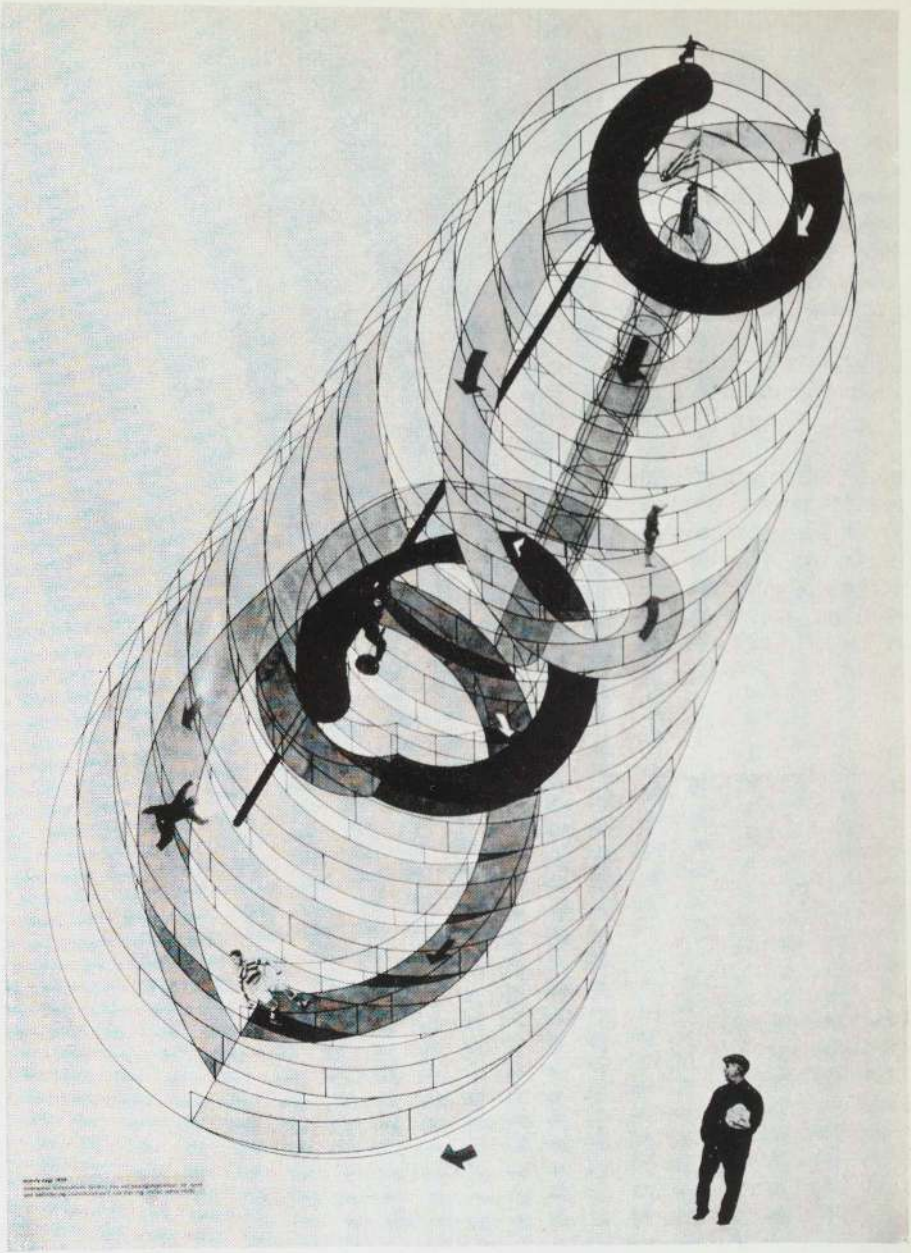
In a lecture given at the Bauhaus in 1927, Schlemmer indicated how these "emblems of our time" might ultimately transform the theatre. He foresaw:

. . . plays whose "plots" consist of nothing more than the pure movement of forms, color, and light . . . . a mechanical process without human involvement of any sort (except for the man at the control panel) . . .[109]



László Moholy-Nagy
American, born Hungary,
1895—1946
Nickel Construction. 1921
Nickel-plated iron, welded,
14 1/8″ high,
including metal base
The Museum of Modern Art,
New York
(gift of Mrs. Sibyl Moholy-Nagy)

In 1920, at the age of twenty-five, László Moholy-Nagy left his native Hungary, and in January of the following year, after a brief stay in Vienna, arrived in Berlin. Born and brought up in a rural countryside, he was fascinated by modern cities, which had fired his imagination from the time he first saw illustrations of them in magazines. He was deeply impressed by the Constructivists, especially Tatlin and Lissitzky. Like the Russians, who also lacked previous experience of a highly developed society and the strength of its institutions, Moholy-Nagy believed that the old ways could be bypassed and that one could immediately begin to construct a new world. He therefore felt no need to participate with the Dadaists in destruction. With new technology and revolutionary politics, nothing was impossible, though he was careful to note that art must lead the way — the new art of Constructivism. For Moholy, as for so many others, Tatlin's tower was the ideal symbol of the new, and he adapted its spirals in several works. His *Nickel Construction* of 1921 is a naive, touching poem composed from elements of this optimism. He later described it as a "... completely perforated, completely broken through, piece of sculpture which demands on the one hand a developed technical knowledge, and on the other hand a mind that works abstractly; a freeing of material from its own weight, a passing beyond expressional ends."[110]



László Moholy-Nagy
Kinetic Constructive System (a structure with paths of motion for sport and recreation). 1922
Pen and brush and ink, $29^{7}/_{8} \times 21^{1}/_{2}''$
Institut für Theaterwissenschaft der Universität Köln, Cologne

The year after his arrival in Berlin, Moholy-Nagy collaborated with Alfred Kemény in writing a manifesto, which in its stress on the importance of kinetic rhythms had much in common which the manifesto that Gabo had published in Moscow in 1920. Kemény and Moholy stated that: "The first projects looking toward the dynamic-constructive system of forces can be only experimental demonstration devices for the testing of the connections between man, material, power, and space. Next comes the utilization of the experimental results for the creation of freely moving (free from mechanical and technical movement) works of art."[111]

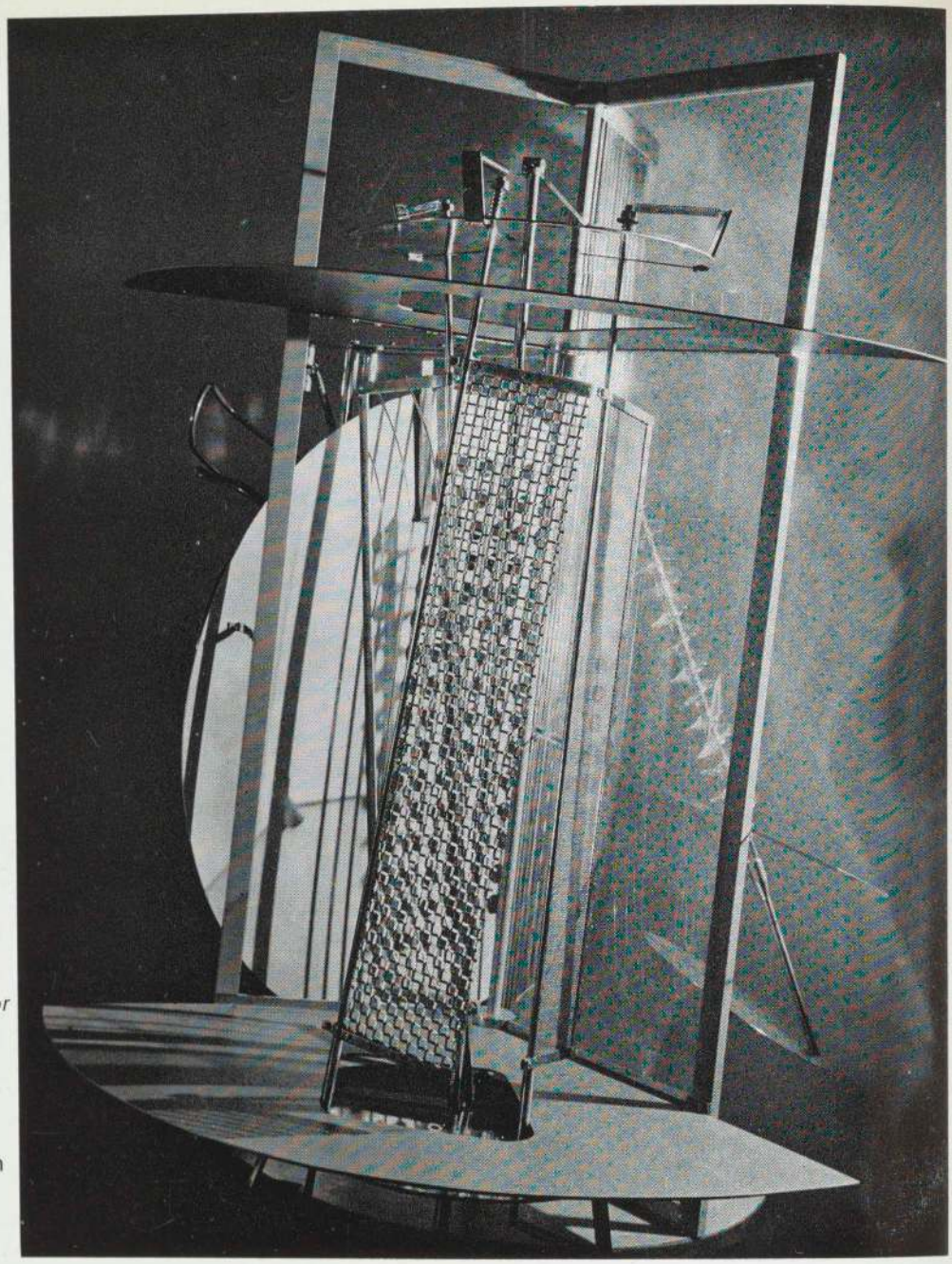
As a demonstration of such a kinetic constructive system, Moholy drew a spiral tower. People are involved in this construction through their own physical movements, as they move about inside it and become part of its function. He later described it in detail:

The structure contains an outer path, mounting spirally, intended for general recreation and therefore equipped with a guard-rail. Instead of steps, it is in the form of a ramp. The path ends at the top in a semi-circular platform, which has access to an elevator shaft. The upper end of the platform is jointed, while the lower end emerges on a horizontal ring-shaped platform which takes the public out by a downward escalator.

The horizontal ring-shaped platform glides downward in respect to the elevator and by means of the turning of the whole structure. The path of motion for it is the inner spiral (intended for general recreation, and hence equipped with a guard-rail). Parallel to the outer path there is a further spiral, with the steepest practicable incline, for the use of more athletic visitors. This, unlike the outer path, has no rail.

Above the upper platform for the public there is a horizontal surface forming three quarters of a ring, which is the terminus of the "athletes' track," and is connected with a slide pole parallel to the elevator shaft. The slide pole, by means of a flexible attachment, can be moved to any point on the upper ring-shaped surface, and can also be swung to any point of the ground level of the whole structure.

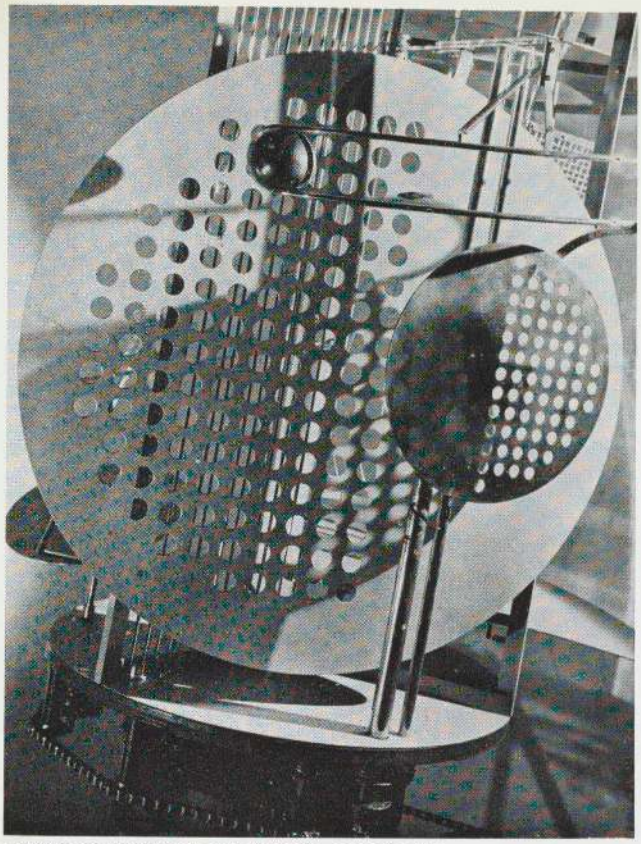
The figures indicate the scale, and the arrows the directions of motion.[112]



László Moholy-Nagy
Light-Space Modulator
1921—1930
Mobile construction:
steel, plastics, and wood,
59½" high,
including base
Busch-Reisinger Museum
of Germanic Culture,
Harvard University,
Cambridge

Moholy-Nagy joined the staff of the Bauhaus in 1923 and remained until 1928. He fulfilled many functions — teaching; planning, designing, and editing the Bauhaus publications; and pursuing his interest in photography.

His light-display machine or *Light-Space Modulator* is the great monument of the Bauhaus Constructivists' enthusiasm for the machine. (He gave it the name *Licht Requisit* — "Light Prop" — because he believed it could be adapted as a stage property.) Moholy-Nagy worked on it for nine years, from 1921, when he was twenty-six, until 1930. An electrically driven, mechanically complicated machine meant to function perfectly, the *Light-Space Modulator* once had a supermachine-like chrome finish. In spite of its striking sculptural presence, it was not meant as an end result in itself. As a true machine, it was productive: it produced a light play.



Light-Space Modulator *seen from the opposite side*

Since about 1920, Moholy-Nagy had been working with cameraless photographs, somewhat similar to Man Ray's Rayographs. He called them photograms, "... a realization of spatial tension in black-white-gray ... a writing with light, self-expressive through the contrasting relationship of deepest black and lightest white with a transitional modulation of the finest grays."[113]

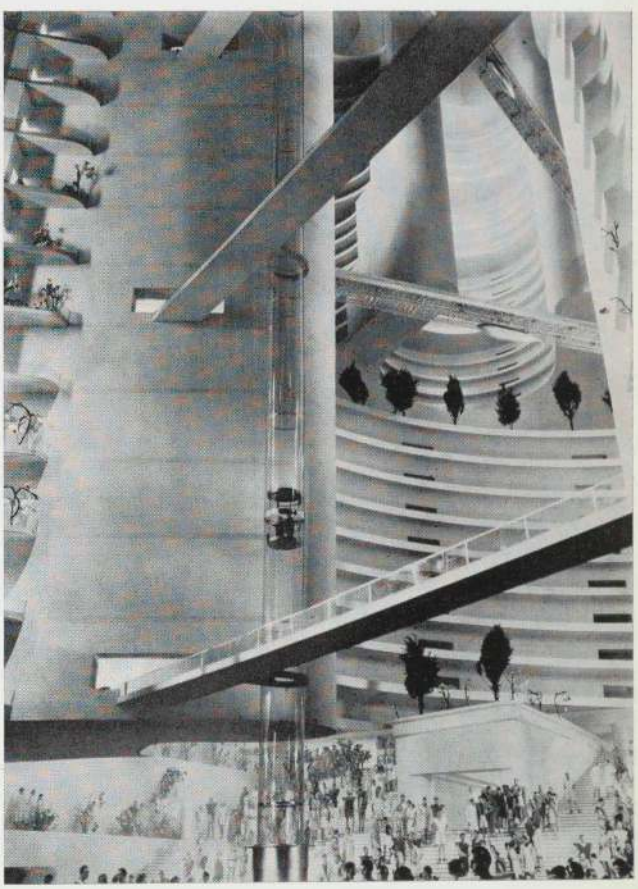
These abstract spaces were made dynamic when lights were projected by the *Modulator* and reflected on surrounding walls. In 1929—1930, Moholy-Nagy made with the *Modulator* his most important film, *Light Display, Black and White and Gray*. The machine was surrounded by 128 bulbs, switched on and off by a drum contact, and turned slowly while projecting on the walls the light play of its three independent sectors. Moholy Nagy wrote of *Light Display* that it employed "... all possible means of the film technique such as superimpositions, ... prisms, mirrorings, and moving light ... it tries to conquer the peculiar dimension of the film, the dimension of space-time."[114]

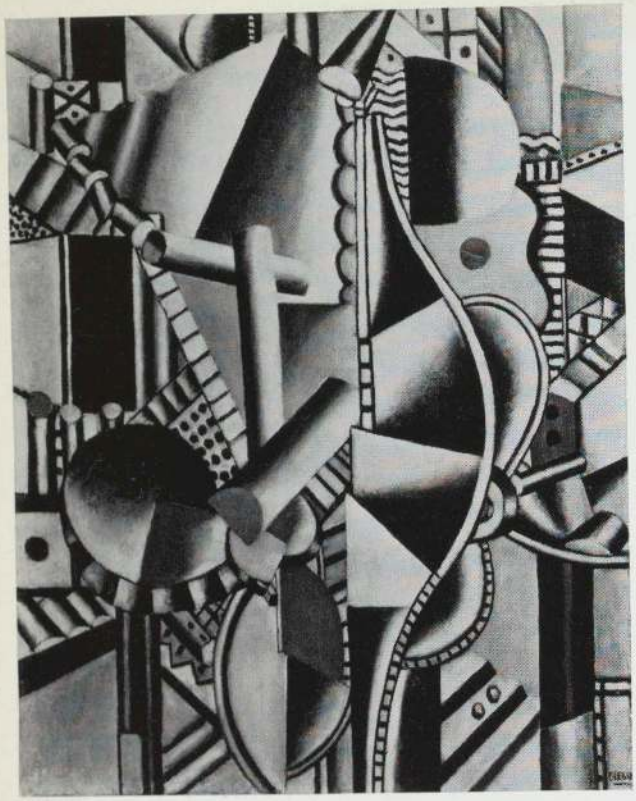
Though Moholy-Nagy may have built the *Modulator* only as a demonstration or an intermediate step to filmmaking, the love with which its parts were conceived was a loud paean to the mechanical world. It was constructed with highly refined craftsmanship at the time when Moholy headed the metal workshop at the Bauhaus.

László Moholy-Nagy
Set for "Things To Come"
Produced by Alexander Korda, London, 1936

After leaving the Bauhaus in 1928, Moholy-Nagy worked for a year or so in Berlin, designing stage sets for the State Opera and the theatre. He traveled for several years in Europe, lived for a while in Amsterdam, and then came to London in 1935. There he engaged in a wide variety of projects, including window displays, posters, book jackets, and so forth. Alexander Korda, who was impressed by his *Light Display*, commissioned him to create special effects for *Things To Come*, a film based on a story by H. G. Wells which told of a future society, half technologists, half robots.

The fantastic technology of the Utopian city of the future would, so Moholy dreamed, eliminate solid form. Houses were no longer obstacles to, but receptacles of, man's natural life force, light. There were no walls, but skeletons of steel, screened with glass and plastic sheets. The accent was on perforation and contour, an indication of a new reality rather than reality itself.[115]





Fernand Léger
French, 1881—1955
Propellers. 1918
Oil on canvas, $31^{7}/_{8} \times 25^{3}/_{4}$″
The Museum of Modern Art, New York
(Katherine S. Dreier Bequest)

Before the World War I went with Marcel Duchamp and Brancusi to an airplane exhibition. Marcel, who was a dry type with something inscrutable about him, walked around among the motors and propellers without saying a word. Suddenly he turned to Brancusi: "Painting has come to an end. Who can do anything better than this propeller? Can you?" He was very strongly attracted to these precise objects; we were also, but not so overwhelmingly as he. I myself felt a preference for the motors, for things made out of metal, rather than the wooden blades .... But I still remember the bearing of those great propellers. Good God, what a miracle![116]

I have used the machine as others have used the nude or the still life .... I was never interested in copying the machine. I invented images of machines ...[117]

Fernand Léger
Frames from "Ballet Mécanique"
1924
Photographed by Dudley Murphy

"The film belongs to the machine age; the theatre belongs to the age of the horse."[118] Léger's *Ballet Mécanique* was made in the same year as René Clair's *Entr'acte* (see page 96), with music by George Antheil, who declared it to be "the first piece of music that has been conceived OUT OF and FOR machines ... the first piece IN THE WORLD conceived in one piece without interruption, like a solid shaft of steel."[119] The visual effects also were made to conform to machinelike precision: "From one end to the other the film is subjected to an arithmetical constraint, as precise as possible (number, speed, time). An object is projected to the rhythm of

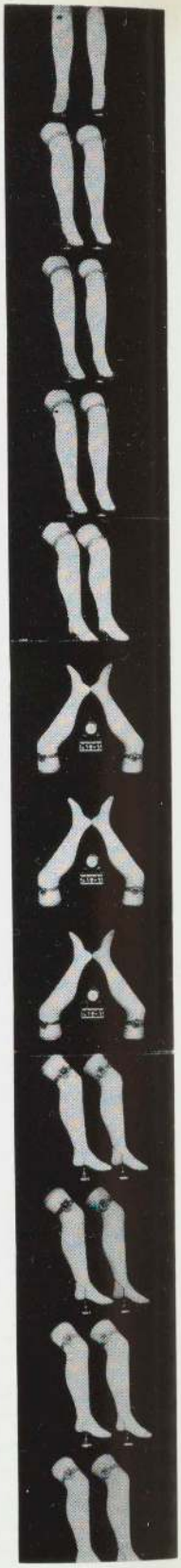
6 images a second for 30 seconds.
3 images a second for 20 seconds.
10 images a second for 15 seconds."

Léger's film, however, was not so much a glorification of the machine as a demonstration of the new ways of seeing opened up by the moving-picture camera:

The technique emphasized is to isolate the object or the fragment of an object and to present it on the screen in close-ups of the largest possible scale. ... I maintain that before the invention of the moving-picture no one knew the possibilities latent in a foot — a hand — a hat.[120]

Leger declared that in the "new realism," parts of the human body were interesting only as fragments and were of no more importance than any other things. His real admiration, in fact, was for the beauty of manufactured objects, as is clear from this sequence in *Ballet Mécanique* that he described:

Take an aluminum saucepan. Let shafts of light play upon it from all angles — penetrating and transforming it. Present it on the screen in a close-up ... The public need never even know that this fairy-like effect of light in many forms, that so delights it, is nothing but an aluminum saucepan.[121]



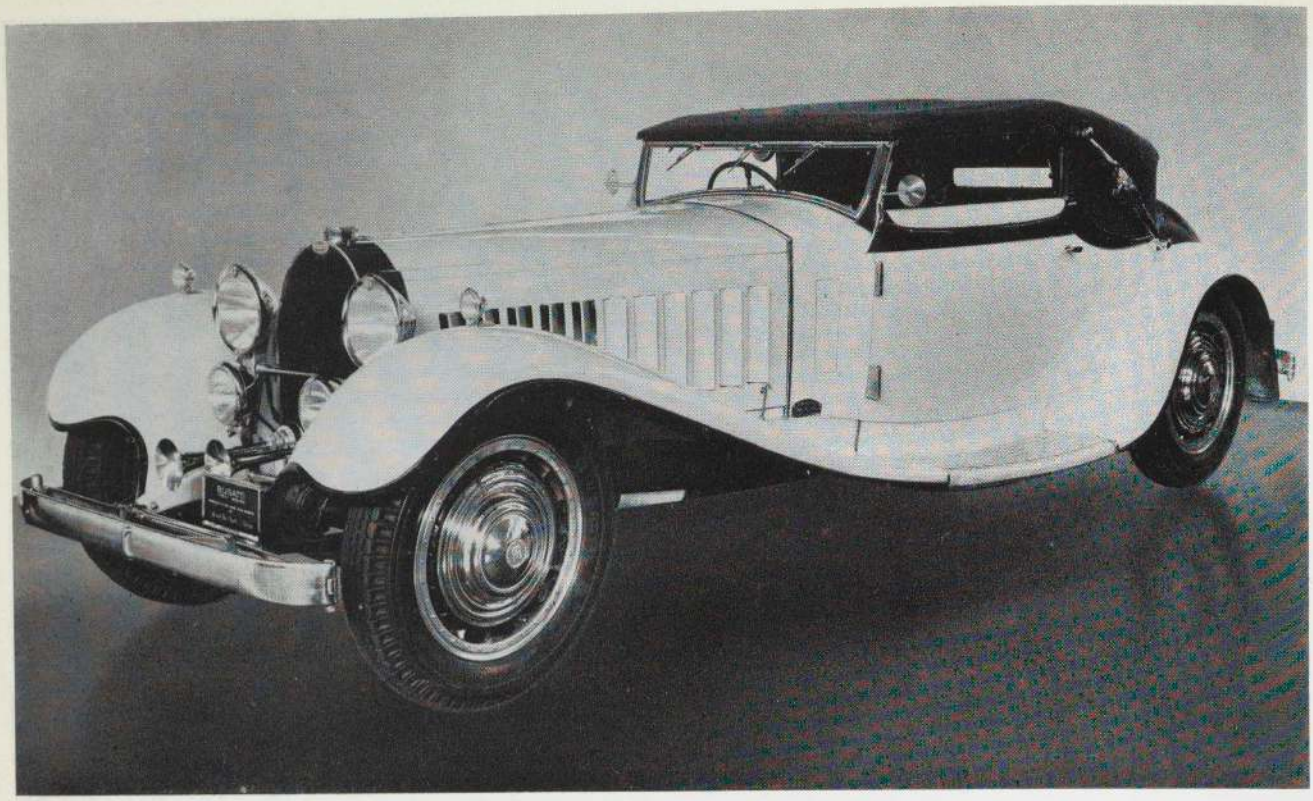
Fernand Léger
The Mechanic. 1920
Oil on canvas, $45^{5}/_{8} \times 35''$
The National Gallery of Canada, Ottawa

The spirit behind Léger's paintings with machine subjects is quite different from the ideas of the Futurists in their paintings of automobiles and trains. The Futurists' position was a kind of literary romanticism; they saw the machine as a symbol of the new, an escape from the corrupt and the antiquated.

Léger's approach was more concerned with plastic form. To him, the machine represented visual clarity and cleanliness. He found in mechanical forms a new pictorial order, an abstraction akin to architecture and geometry but which had nothing to do with nature and the way nature had been imitated by generations of painters ever since the Renaissance. "The beautiful machine is the modern beautiful subject.... Out of a thousand paintings, are two beautiful? Out of a hundred manufactured objects, thirty are beautiful and also resolve that difficulty of Art by being beautiful and useful at the same time," he wrote in 1924.[122]

This, of course, is just another form of romanticism, a reaction against traditional art and the excesses of Art Nouveau. It involved not only placing machine-made objects in a higher category than works of painting and sculpture but also exalting the "world of artisan creators" in contrast to the decadent "professional artists." Léger gave a particularly high rank in the hierarchy to "the electrician in blue smock, emperor-king, chief of us and of all."[123] This new variant of the "noble savage" theme had its historical parallel in the admiration, current at the time, for the supposed virtues of the masses.

As often happens, though Léger's reasoning may have been defective, it could nevertheless produce, as an act of faith, very interesting works of art.



Ettore Bugatti. Italian, 1881—1947
Bugatti Type 41 — "La Royale." 1931
20′ long, wheel base 14′2″
Henry Ford Museum, Dearborn, Michigan
Gift of Charles A. Chayne

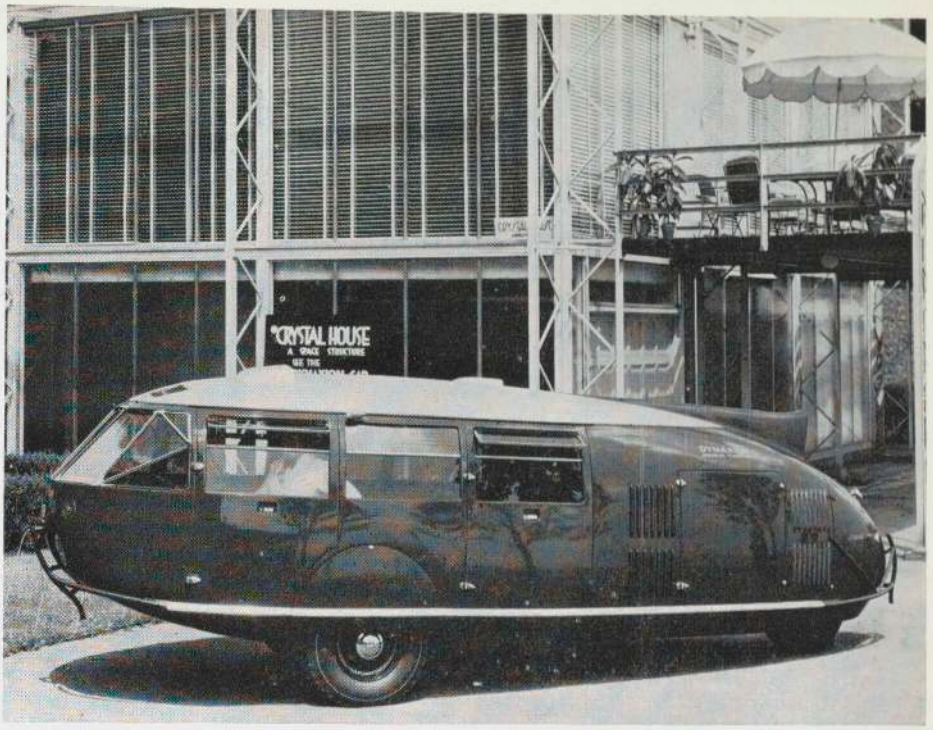
The Bugatti Royale is without doubt the culmination of the heroic period of the automobile, when optimism and confidence in this machine were still unclouded. In the Royale, the car as the supreme effort of mechanics and the symbol of individualism and a dominating ego found its supreme expression. No effort was spared to make it the most perfect automobile ever built. Its parts were fitted with zero tolerances, and Bugatti proudly gave each owner an unlimited lifetime guarantee.

Royale town-car at Bugatti's estate in Molsheim beside sculpture by his brother, Rembrandt Bugatti

Ettore Bugatti was born in Italy in 1881 and began as a painter. His father was an artist, designer, and architect; his brother Rembrandt was a sculptor. When he was about eighteen, Ettore contemplated a work by his brother, a specialist in animal sculpture. Thinking that he could never produce anything of equal perfection in any existing art medium, he made an immediate decision — to give up painting and combine his creative impulses with his interest in mechanics. In this still-unexploited field, he created a new kind of art work, the automobile. By the time he died, he had built over nine thousand cars.

In 1910 he moved to Molsheim in Alsace-Lorraine, where he erected his great estate-factory. He built the prototype Royale, which became his personal car, in 1927 and was so pleased with its performance that he planned to turn out 25 more. Actually, only seven were made, of somewhat reduced dimensions and engine power — probably because Bugatti himself wished to own a uniquely powerful machine. This prototype car was wrecked in an accident five years after it was built.

The Bugatti Royale was already an anachronism when it was put on the market. Ostentatious size had ceased to be fashionable, and the Depression came shortly afterward. There were few people still willing and able to buy a car that cost upwards of $40,000; and those who became rich enough could possess airplanes. Today, many of them do not even own cars, but rent them.



Dymaxion Car No. 3, 1934, photographed outside Chicago World's Fair

R. Buckminster Fuller
American, born 1895
Dymaxion Car. 1933
19′ long

Surprisingly little has been done to reconsider the structure and form that the passenger car took around 1910. The "classic" period of automobile designing in the 'twenties was concerned less with changes in function than with styling. The continued production of the traditional car is a triumph of conventions that have developed around a once new and successful idea.

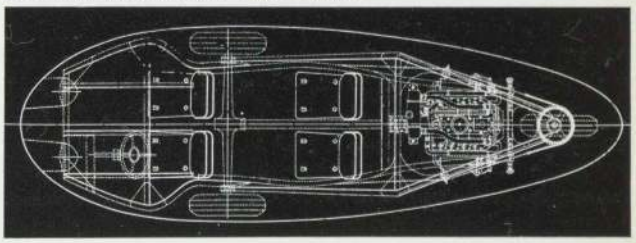
The most original reconsideration of automobile construction has been done by Buckminster Fuller. Probably only a genius who was both artist and engineer would have undertaken such a task. Fuller's airflow Dymaxion car was the outgrowth of concepts that he worked out while trying to solve the problem of providing optimum shelter at minimum cost. The word "Dymaxion" (a fusion of syllables from "dynamism," "maximum," and "ions"), first coined for his model houses, was later applied to all Fuller's enterprises.

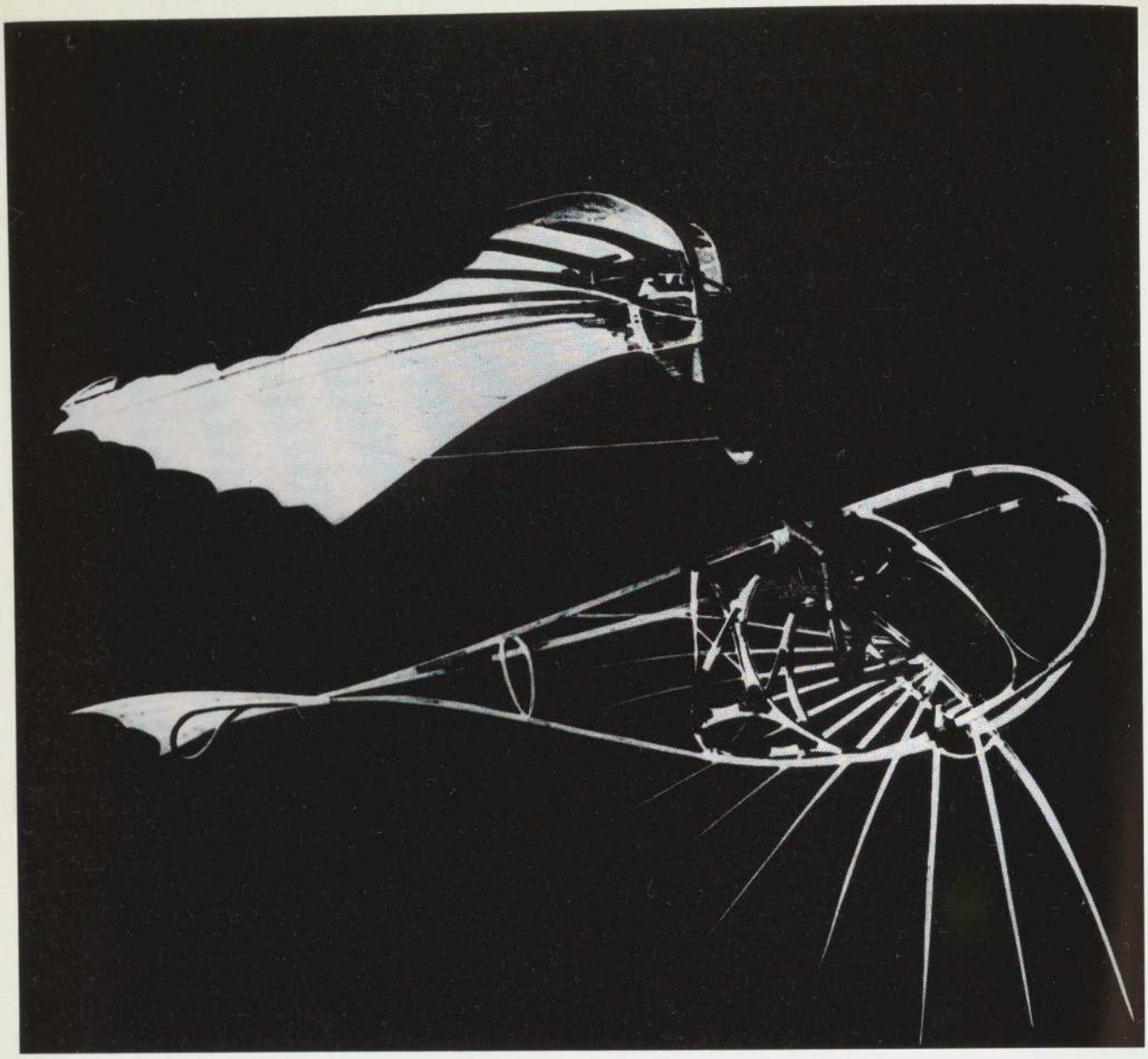
On his thirty-eighth birthday, July 12, 1933, Fuller demonstrated to the public his first Dymaxion car. Among its revolutionary features, it introduced into the automotive field streamlining similar to that used in airplane fuselages, with most of the running gear enclosed. The car had only three wheels, two in front and one behind, which gave it exceptional maneuverability.

While being driven to the Chicago airport to demonstrate its performance to an aviation expert sent on behalf of a group of English automobile enthusiasts who had ordered a second Dymaxion, the car was rammed by an automobile owned by a prominent Chicago politician. The driver of the Dymaxion was killed, and the English aviator severely injured. As the politician had managed to have his machine spirited away before reporters arrived, the accident was blamed on the "freak car." The inquest eventually exonerated the Dymaxion of any fault in design or structure, but the unfavorable publicity led the English buyers to cancel their order. Fuller, nevertheless, had confidence in his principles; he repaired the damaged first car, completed the second one, and used his entire family inheritance to build Dymaxion Car No. 3.

Conventional cars have forced on modern cities a complete change of urban planning and function. There have been reports of a scheme proposed in the Soviet Union to adapt cars to towns. Small, very simple electric automobiles operated by tokens and owned by the state or municipality would be offered to anyone who passed a simple test and paid an annual fee. The fee-payers would receive keys fitting all the cars. Each night, the cars would be delivered to where they would be wanted in the morning, but since most cars would be picked up where they had been left, there would be little need for this nighttime towing. Outside meters would show when batteries were running low, and they would be replaced by service stations.

Scale drawing of Dymaxion Car No. 1, 1933

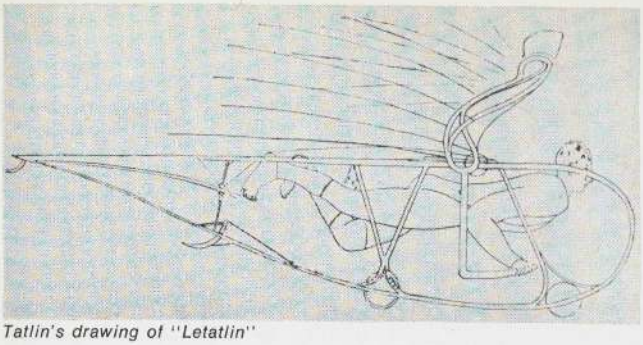




Vladimir Tatlin. Russian, 1885—1953
Letatlin. c. 1930
Ornithopter, wood skeleton
The M. V. Frunze Museum of Aviation and Air Defense, Moscow

Tatlin's experiments in building a flying machine — called "Letatlin" from the Russian *letat,* "to fly," and his own name — represented his boldest efforts to combine art and technology. "Letatlin" was an ornithopter — a glider powered by man's own muscular energy. Gliding was very popular in the 'twenties; what was unique was not that Tatlin should embark on such a project, but that he should do so as an artist. In this work, "the tension between constructive utilitarianism and the artistic aspect reached a maximum."[124]

The conditions of aviation (the mobility of the machines and their relationship to their environment) create gradually a greater variation of forms and construction than static technology. All this excited my attention, and caused me to make the closer acquaintance of flight. . . . An artist with experience of a variety of different materials . . . will inevitably see it as his duty to solve the technical problem with the help of new relationships in the material . . . he will try to discover a new, complicated form, which in its further development will naturally have to be technically refined in more detail. The artist shall in his work, as a counterpart to technology,



Tatlin's drawing of "Letatlin"

present a succession of new relationships between the forms of the material. A series of forms determined by complicated curvatures will demand other plastic, material, and constructive relationships — the artist can and must master these elements, in that his creative method is qualitatively different from that of the engineer.
The further consequences are these:

1. *I have selected the flying machine as an object for artistic composition, since it is the most complicated dynamic form that can become an everyday object for the Soviet masses, an ordinary item of use.*
2. *I have proceeded from material constructions of simple forms to more complicated: clothes, articles of utility in the environment, as far as an architectural work to the honor of the Comintern (the Monument for the Third International). The flying machine is the most complicated form in my present phase of work. It corresponds to the need of the moment for human mastery of space.*
3. *As a result of this work, I have drawn the conclusion that the artists' approach to technology can and will lend new life to their stagnating methods, which are often in contradiction with the functions of the epoch of reconstruction.*
4. *My apparatus is built on the principle of utilizing living, organic forms. The observation of these forms led me to the conclusion that the most aesthetic forms are the most economic. Art is: work with the shaping of material, in this respect.* — Tatlin, 1932.[125]

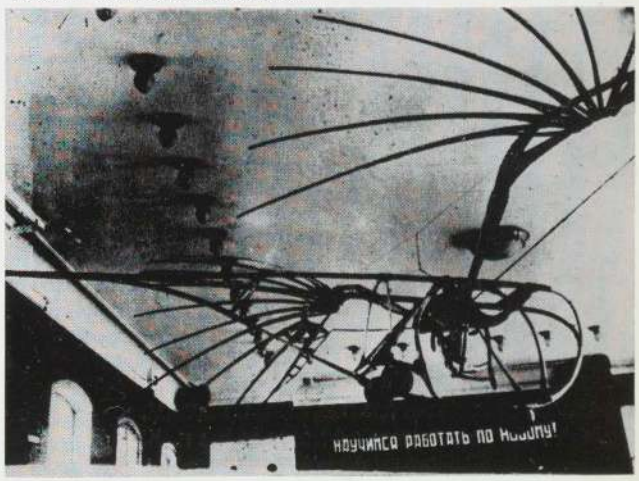
When the glider projects were shown in an exhibition of Tatlin's work in 1932, they excited great controversy — not so much over the feasibility from a scientific point of view as over his ideological approach. An article by Korneliy Zelinsky, based on an interview with Tatlin, questioned his premises:

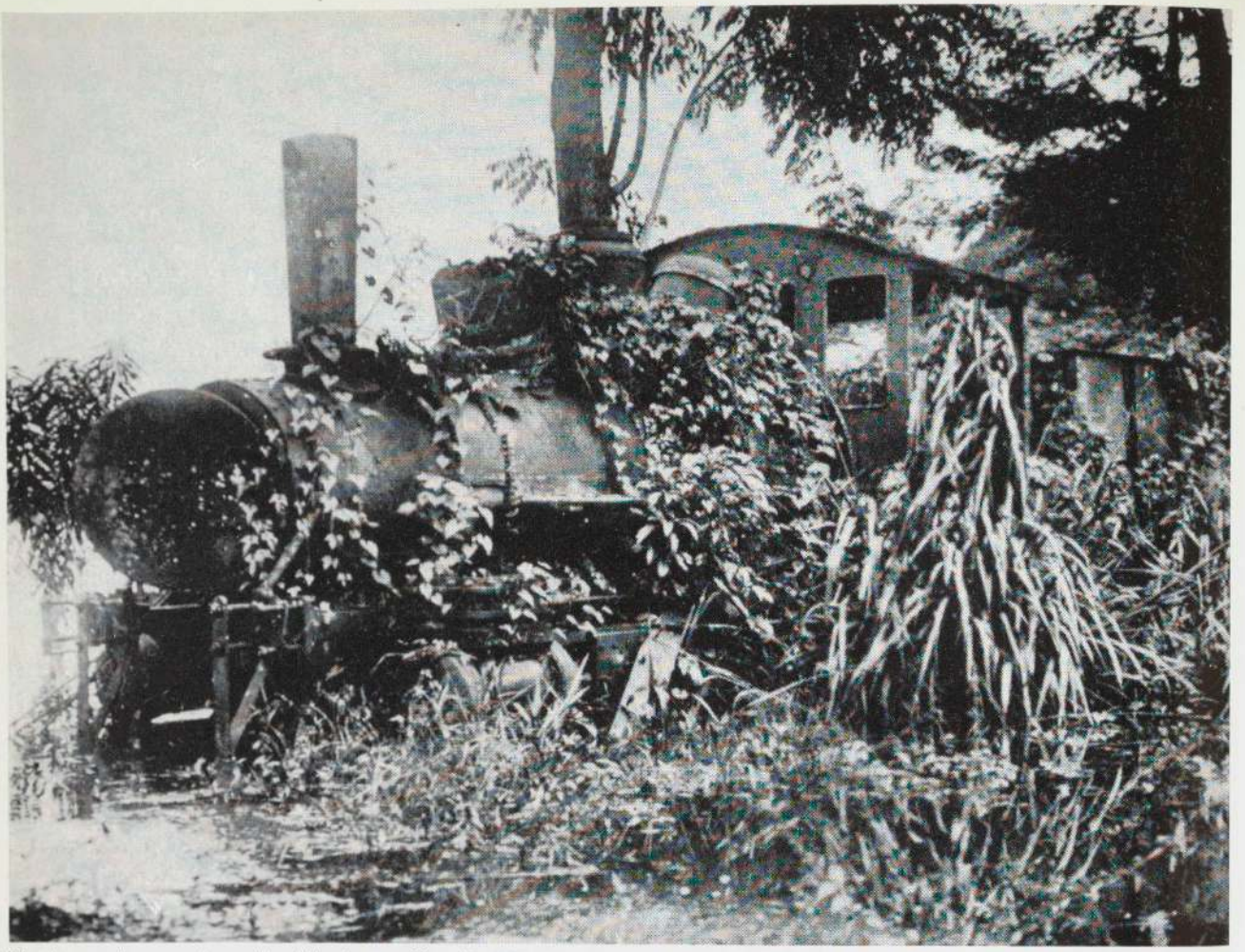
— *Tell me what this is: a work of art or a technological product? . . . I would very much like to know how I should understand your bird or air bicycle: as a demonstration of attractive forms or whether one really can fly with it, as with a glider . . .*
— *I don't want people to take this thing purely as something utilitarian. I have made it as an artist. Look at the bent wings. We believe them to be aesthetically perfect. . . . I count on my apparatus being able to keep a person in the air. I have taken into account the mathematical side, the resistance of the material, the surface of the wings. We have to learn to fly with it in the air, just as we learn to swim in the water, ride a bicycle and so on . . . I want, also, to give back to man the feeling of flight. This we have been robbed of by the mechanical flight of the aeroplane. We cannot feel the movement of our body in the air.*
— *What practical importance does your apparatus have?*
— *The same as a glider. Has the proletariat no use for a glider? . . . But, also, I really want to emphasize the aesthetic side of the thing. Now art is going out into technology.*

Zelinsky took a dim view of this approach. He asked:

Can we really allow the performances of solo inventors to develop? And what about the transference of art to technology? Of course, it just won't do. A new technological creation can give an artistic impression, but it must also serve its direct technical purpose . . . If "Letatlin" is a technical apparatus designed for flight, then it must *fly — and if it cannot, then it is a mere toy . . . The way that has led Tatlin to technology seems to us to be alien, fatiguing and wrong. From the philosophical depths out of which "Letatlin" is to fly, heavy, reactionary prejudices have congealed into a porridge: nature worship, terror of the machine, the adaptation of technology to the feelings of the individual, a naive faith in the "wisdom" of organic forms, and escape from the industrial world. . . . This is a form of technology that is based on artistic "vision," intuition, and not on the scientific vision of mathematics and computation . . . not in haste to draw a cross over the new "Letatlin" glider, we are concerned to purify it from rotten ideological supports, blow through it with the strong winds of proletarian criticism . . . This gifted artist is our camp follower, he came to work with the Revolution in the very first October days. He has acquired not a little experience: he deserves the attention and help of the Soviet public.*[126]

"Letatlin" exhibited in Moscow, 1933





Photograph reproduced in *Minotaure*, No. 10, 1937, to illustrate an article by Benjamin Péret, "La Nature dévore le progrès et le dépasse"

Arthur Rimbaud: *The Sleeper in the Valley* (1870)

It is a green hollow where a river sings
Madly catching on the grasses
Silver rags; where the sun shines from the proud
mountain:
It is a small valley which bubbles over with rays.

A young soldier, his mouth open, his head bare,
And the nape of his neck bathing in the cool blue
watercress,
Sleeps: he is stretched out on the grass, under clouds,
Pale on his green bed where the light rains down.

His feet in the gladiolas, he sleeps. Smiling as
A sick child would smile, he is taking a nap:
Nature, cradle him warmly: he is cold.

Odors do not make his nostrils quiver.
He sleeps in the sun, his hand on his breast,
Quieted. There are two red holes in his right side.

Translation by Wallace Fowlie.[127]

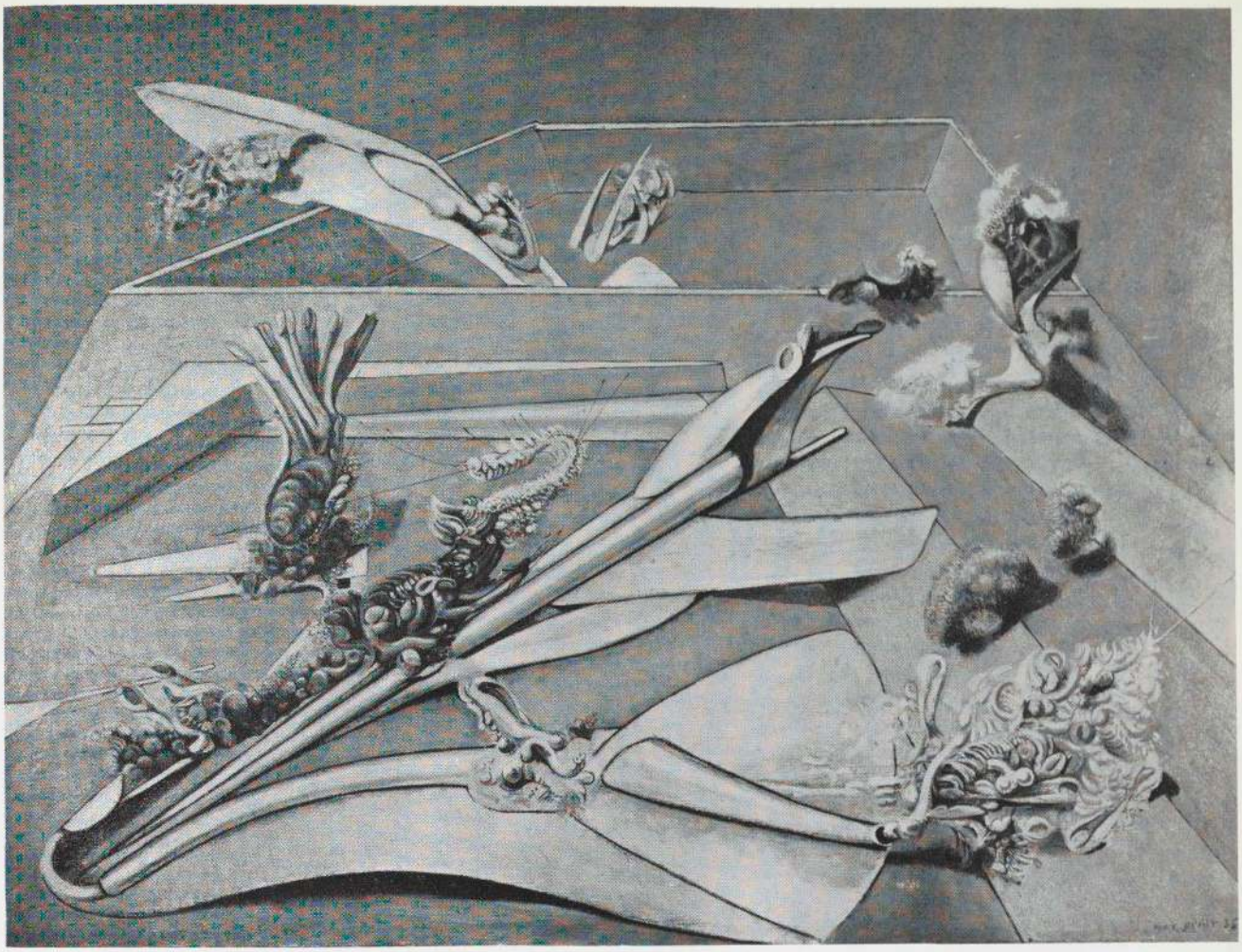
Le Dormeur du val

C'est un trou de verdure où chante une rivière
Accrochant follement aux herbes des haillons
D'argent; où le soleil, de la montagne fière,
Luit: c'est un petit val qui mousse de rayons.

Un soldat jeune, bouche ouverte, tête nue,
Et la nuque baignant dans le frais cresson bleu,
Dort; il est étendu dans l'herbe, sous la nue,
Pâle dans son lit vert où la lumière pleut.

Les pieds dans les glaïeuls, il dort. Souriant comme
Sourirait un enfant malade, il fait une somme:
Nature, berce-le chaudement: il a froid.

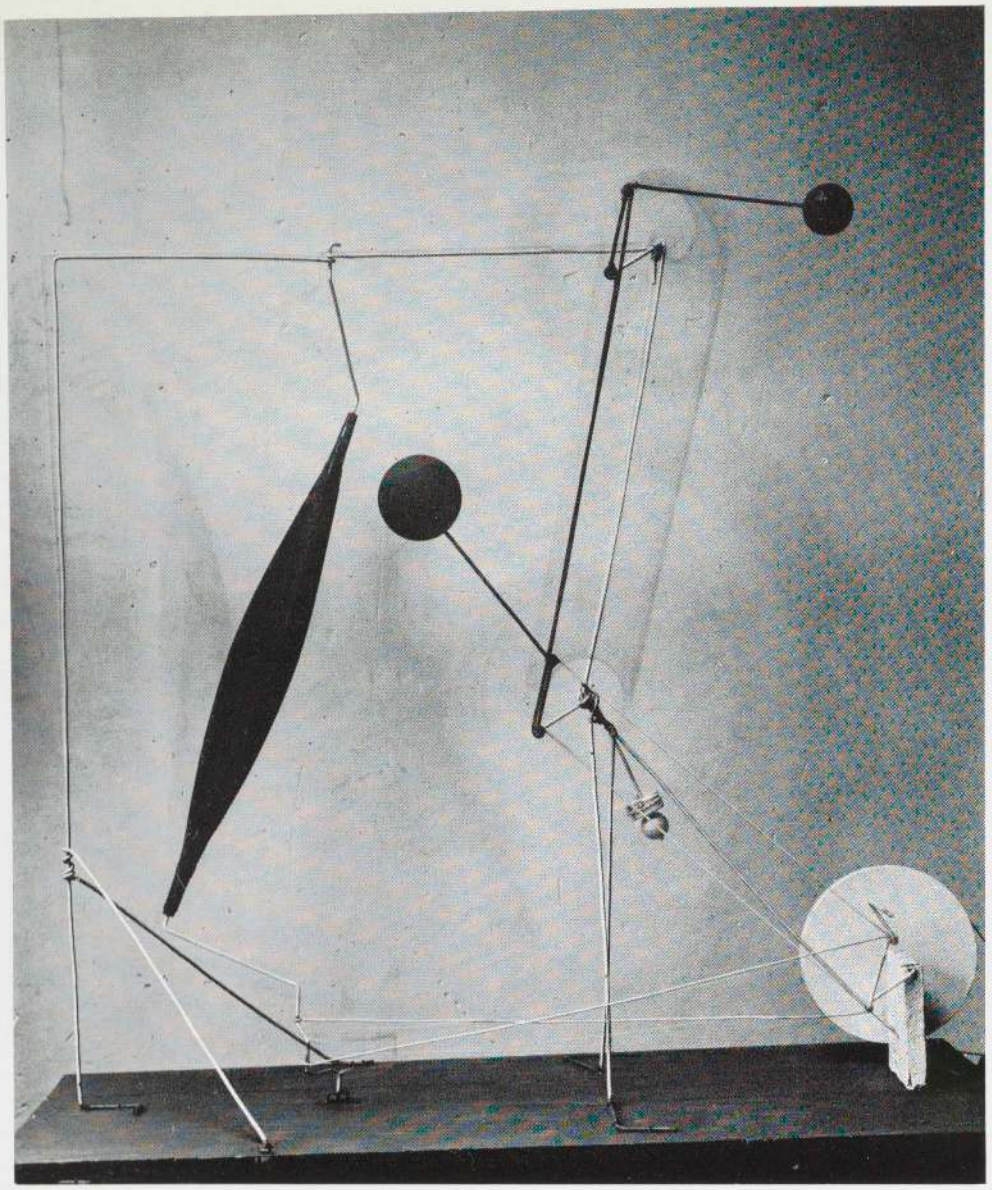
Les parfums ne font pas frisonner sa narine;
Il dort dans le soleil, la main sur sa poitrine
Tranquille. Il a deux trous rouges au côté droit.



Max Ernst. French, born Germany, 1891
Garden Airplane Trap (Jardin gobe-avions)
1935
Oil on canvas, $21\frac{1}{4} \times 29''$
Owned by the artist

Between 1934 and 1936, Max Ernst made a series of paintings that showed a vision of "voracious gardens in turn devoured by a vegetation which springs from the debris of trapped airplanes . . ."[128] In these pictures, ambiguous creatures hide or spy in a desert landscape, or within enclosures rather like the walls of Machu Picchu. Are they airplane-eating dragons, enormously magnified insects, or trapped machines that after falling have somehow taken on animal shapes? Ernst's mechanical forms are often equivocal, without any boundaries between animate beings and inanimate things, as there are none between humans and animals. The world represented in his Surrealist painting and sculpture is animistic, dominated by frightening spirits.

Ernst is obsessed with flight and birds. He has attributed this to an experience he had at the age of fifteen: ". . . one of his closest friends, a most intelligent and affectionate pink cockatoo, died. It was a terrible shock to Max when, in the morning, he discovered the dead body and when, at the same moment, the father announced the birth of a sister. In his imagination Max coupled these two events. . . . A dangerous confusion between birds and humans became fixed in his mind and asserted itself in his drawings and paintings."[129] With the exception of man, birds are the most common creatures in Ernst's work; in Surrealist consequence, it is logical that airplanes should be the most frequently represented machines (see page 124).

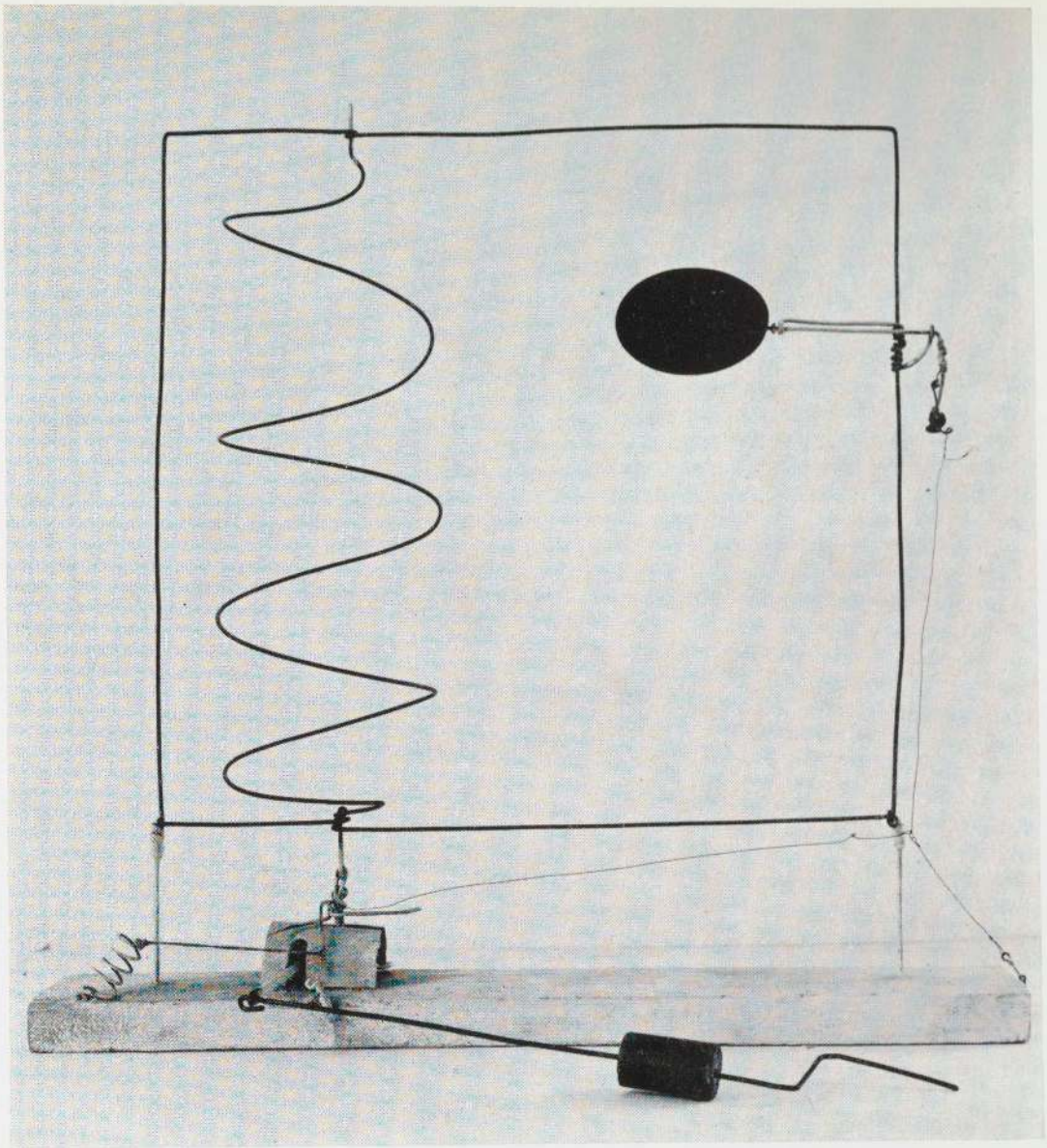


Alexander Calder. American, born 1898

"*The motorized mobile that Duchamp liked.*" 1932; reassembled by the artist, 1968
Wood, wire, cord, and metal, approximately 42″ high
Owned by the artist

Calder's attitude toward the mechanical world is ambiguous, yet relaxed. Born of a family of artists, he took a degree in engineering, but when drafting reawakened his interest in art he abandoned technology as a career. After several years spent studying at the Art Students League and doing free-lance illustration, he went to Paris in 1926. An innate sense for fantasy and love of motion led him to create his miniature circus, in which the animals were characterized chiefly by their movements. The circus made Calder famous throughout the Paris art world. In 1930, he paid a crucial visit to Mondrian:

I was very much moved by Mondrian's studio, large, beautiful and irregular in shape as it was, with the walls painted white and divided by black lines and rectangles of bright colour, like his paintings. It was very lovely, with a cross-light (there were windows on both sides), and I thought at the time how fine it would be if everything there moved; *though Mondrian himself did not approve of this idea at all. I went home and tried to paint. But wire, or something to twist, or tear, or bend, is an easier medium for me to think in.*[130]



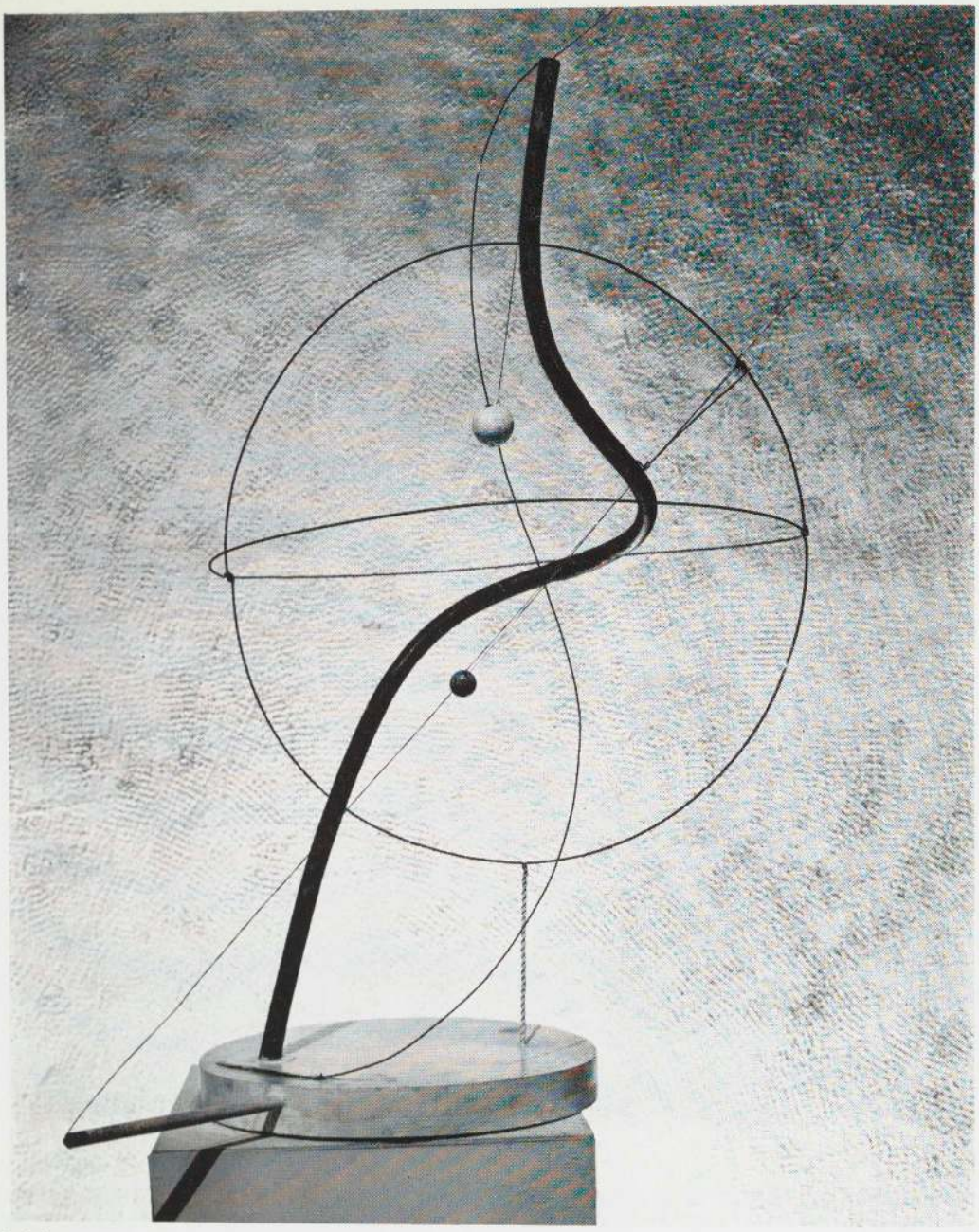
Alexander Calder
Crank-Driven Mobile. c. 1932
Wood, wire, and sheet metal, 23×24½″
Joseph H. Hirshhorn Collection

Calder soon began to carry out his impulse to make objects that moved. In the winter of 1931—1932, as he recalls in his autobiography: ". . . I had been working on things with a little motion, some with more motion. I had quite a number of things that went round and round, driven by a small electric motor — some with no motor — some with a crank."

One day, Marcel Duchamp came to visit Calder and saw his work:

There was one motor-driven thing, with three elements. The thing had just been painted and was not quite dry yet. Marcel said: "Do you mind?" When he put his hands on it, the object seemed to please him. . . I asked him what sort of a name I could give these things and he at once produced "Mobile." In addition to something that moves, in French it also means motive.[131]

Duchamp helped Calder arrange a show of his work, in which "there were fifteen objects with motors and some fifteen others, all of which had moving elements. . . . The journalists did not seem to understand anything I was driving at. There were notes about *'l'art automobile,'* and a photograph of one object, likening it to a gear shift."[132]



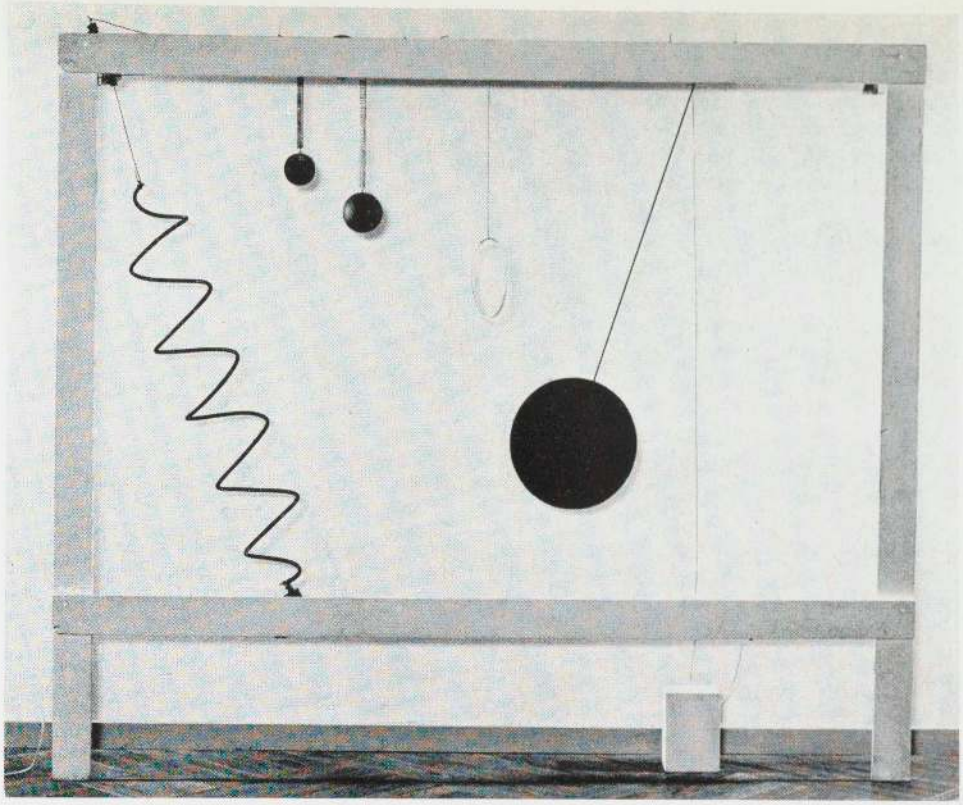
Alexander Calder
A Universe. 1934
Motorized mobile: iron pipe, wire, string, and wood, 40½″ high. The Museum of Modern Art, New York (gift of Abby Aldrich Rockefeller)

. . . the underlying sense of form in my work has been the system of the Universe, or part thereof. For that is a rather large model to work from.

What I mean is that the idea of detached bodies floating in space, of different sizes and densities, perhaps of different colors and temperatures, and surrounded and interlarded with wisps of gaseous condition, and some at rest, while others move in peculiar manners, seems to me the ideal source of form. . . .

When I have used spheres and discs, I have intended that they should represent more than what they just are. . . . A ball of wood or a disc of metal is rather a dull object without this sense of something emanating from it.

When I use two circles of wire intersecting at right angles, this to me is a sphere. . . what I produce is not precisely what I have in mind — but a sort of sketch, a man-made approximation. — Calder, 1951.[133]



Alexander Calder
The White Frame. 1934
Wood, wire, cord, sheet metal, and motor, 7′6″ × 9′
Moderna Museet, Stockholm

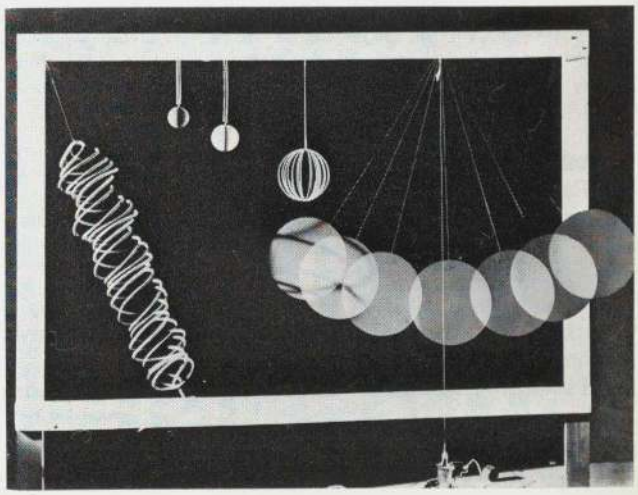
The White Frame is the largest and most ambitious of all Calder's early motorized mobiles. Its composition is based on variations on the circle: within the frame a spiral, two spheres, a ring, and a round disc are suspended and set into different kinds of motion. The emphasis on round forms may perhaps be a kind of declaration of independence from the persistent right-angledness of Mondrian's paintings.

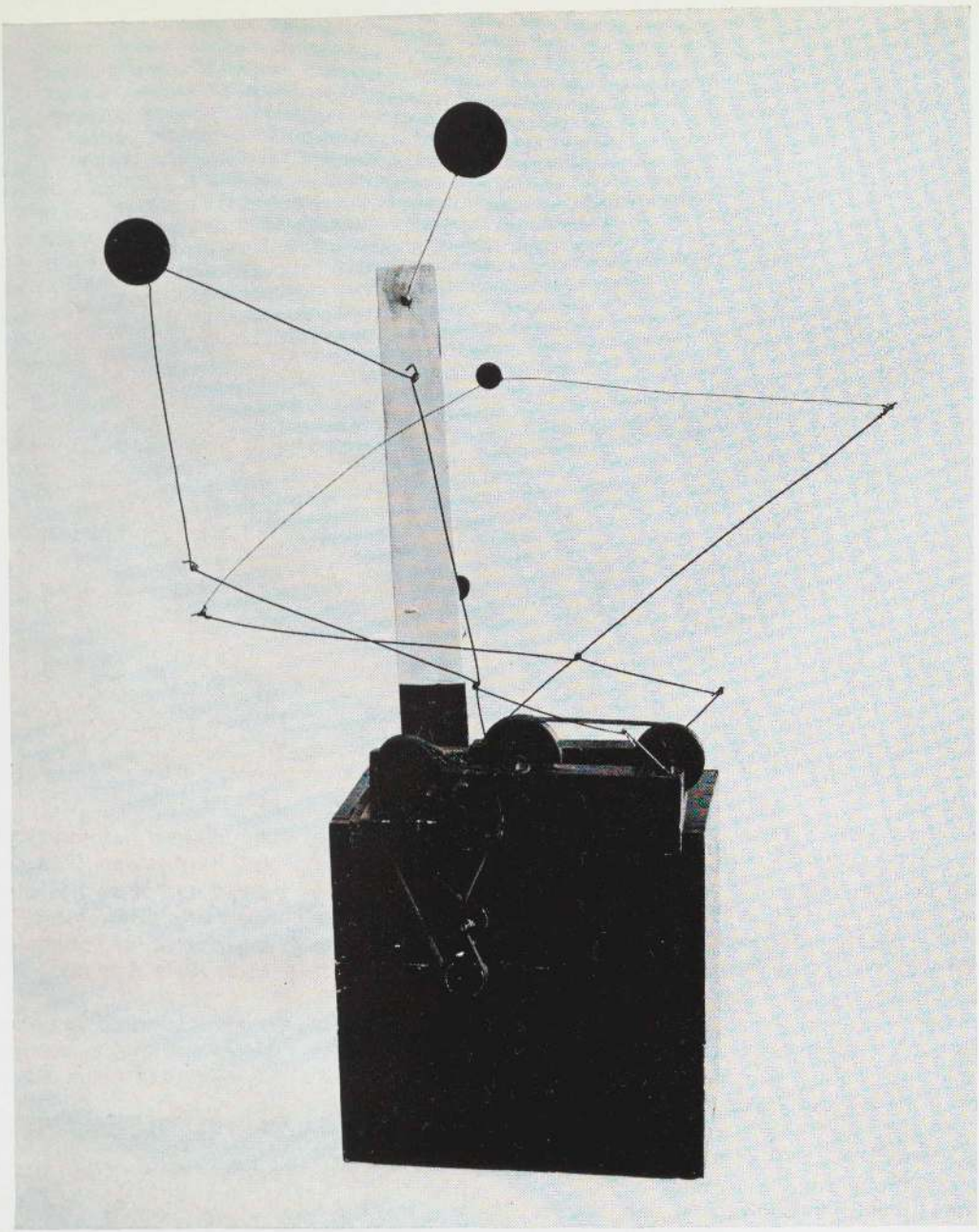
This is the second of Calder's "motorized reliefs." It is obvious that he thought of them as paintings in which forms were put in motion through the agency of motors. The motor served to help solve an aesthetic problem, which Calder clearly posed in his non-figurative paintings but was unable to answer: Why should one position of a form within a composition be better than another?

A year or so later, Calder abandoned motors, because he felt that they produced a too regular and repetitive movement. As he explained in 1937:

I also used to drive some of my mobiles with small electric motors, and though I have abandoned this to some extent now, I still like the idea, because you can produce a positive *instead of a fitful movement — though on occasions I like that too. With a mechanical drive, you can control the thing like the choreography in a ballet and superimpose various movements: a great number, even, by means of cams and other mechanical devices. To combine one or two simple movements with different periods, however, really gives the finest effect, because while simple, they are capable of infinite combinations.*[134]

Although from the mid-'thirties on Calder concentrated increasingly on mobiles powered by natural forces, he has from time to time reverted to motorized mobiles.

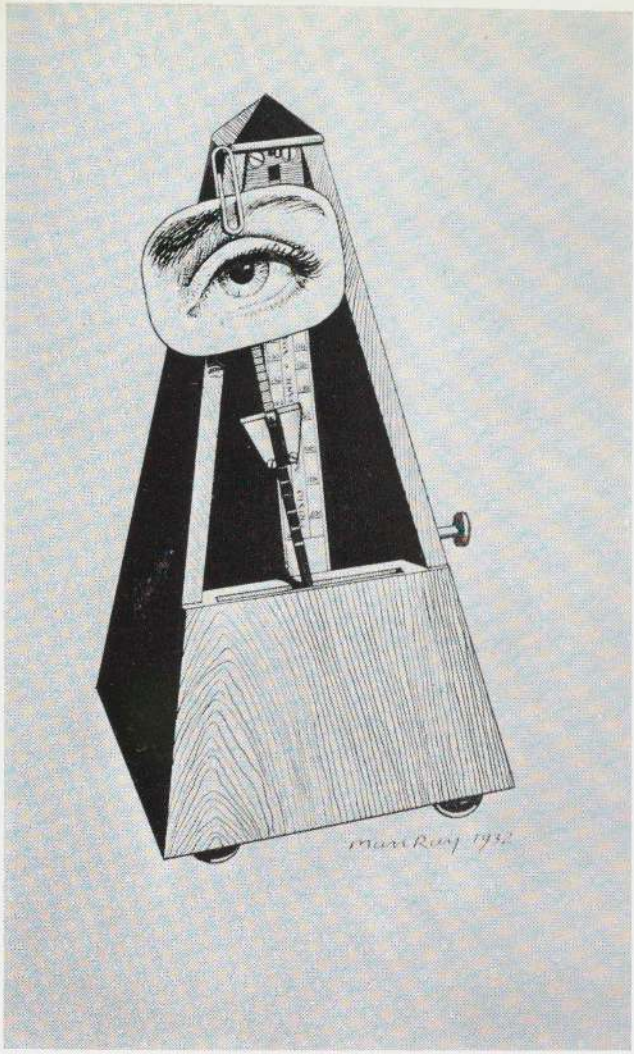




Alexander Calder
Pantograph. c. 1934
Motorized mobile: wood, wire, sheet metal, and motor, 45 3/4" high
Moderna Museet, Stockholm

Calder's rejection of the motor around 1935 in favor of motion produced by natural forces — the wind or a man's hand — was part of a definite trend of those years. The highest point of repudiation of the mechanical world in this century came in the late 'thirties. Art was dominated by Picasso, who has never shown in his work the slightest interest in machines and the mechanical world. In general, interest in the rationality of constructed form was slackening at this time, while interest in the irrational and the unconscious was increasing. The element of chance, so important in the concepts of the Surrealists, could not readily be expressed through the calculated and predictable movements produced by a motor.

Although Calder's hanging mobiles of the late 'thirties seem to abandon geometry and rely on free movement and the inspiration of nature, in their basic approach they remain Constructivist. The "leaves" always float at right angles, with a vertical or horizontal orientation.



A retrospective show of early Dada works was held in Paris. . . I had added another object I had conceived in the early years: simply a metronome to the oscillating stem of which I had attached a photograph of an eye that moved with the ticking as it swung back and forth. The title was, Object To Be Destroyed. I really intended to destroy it one day, but before witnesses or an audience in the course of a lecture.

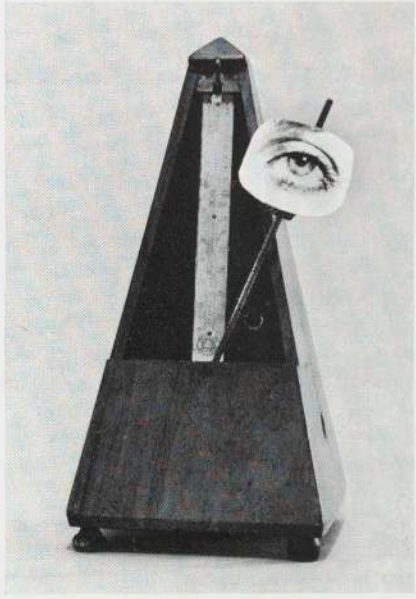
Be that as it may, I was in the gallery one day with my old friend Tzara who had helped organize the show, when a group of youngsters, boys and girls, filed in, some carrying portfolios, evidently coming from the Beaux Arts Academy. Suddenly, handfuls of green handbills filled the air and a voice announced to the other visitors present that this was a protest against the Dadaists and Surrealists. Then the students began taking down the works and laying them carefully on the floor so as not to damage those under glass. After which they filed out in an orderly manner.

But on the way one grabbed the metronome and disappeared with it. . . .

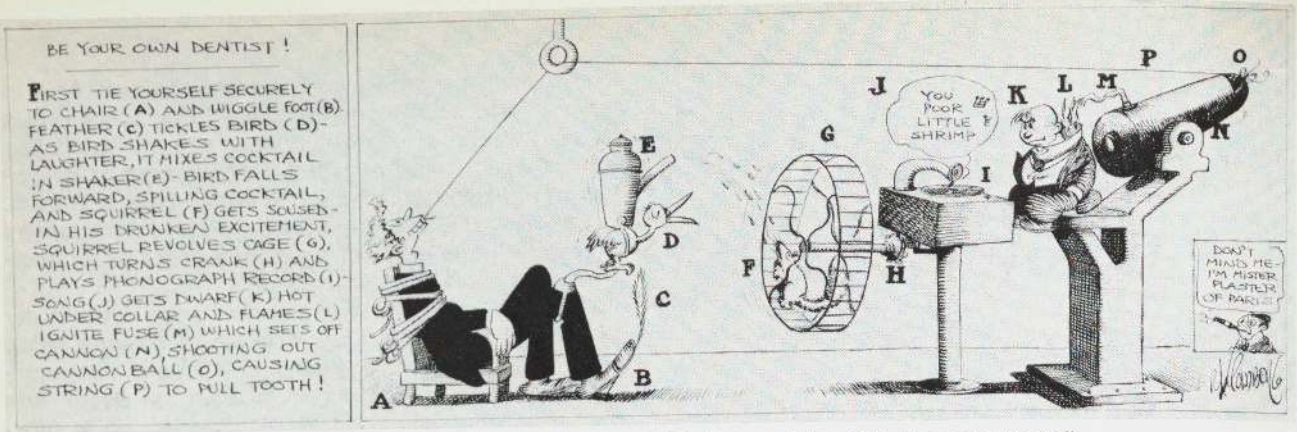
Afterwards I had an interesting session with the insurance expert . . . First he offered to replace the cost of the metronome, a trifle. I pointed out that one did not replace a work of art, a painting, with brushes, paints and canvas. He conceded the point: since I was a well-known artist, he would pay the full value of the insurance. Then, assuming a more intimate tone, he voiced his suspicion that I might, with this money, buy a whole stock of metronomes. That was my intention, I replied; however, I assured him of one thing — I'd change the title — instead of Object To Be Destroyed I'd call it Indestructible Object. — Man Ray, 1963.[135]

Man Ray. American, born 1890
Object To Be Destroyed. 1932
Ink, $11\frac{1}{2} \times 7\frac{3}{4}$″. Collection Mr. and Mrs. Morton G. Neumann, Chicago

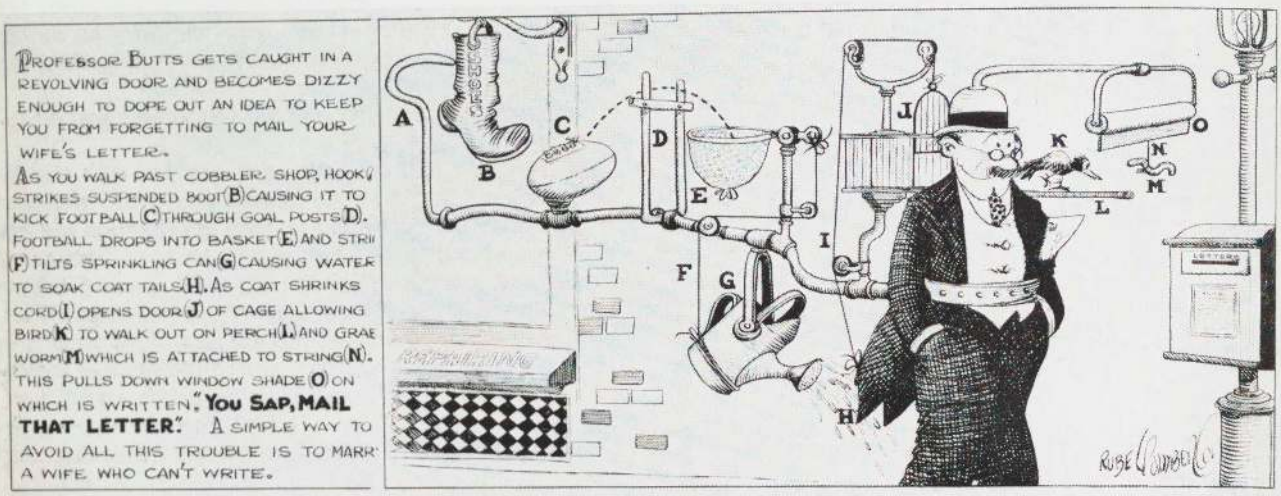
Cut out the eye from a photograph of one who is loved but is not seen any more. Attach the eye to the pendulum of a metronome and regulate the weight to suit the tempo desired. With a hammer well-aimed, try to destroy the whole with a single blow.
— Inscription on back of the drawing



Man Ray
Indestructible Object. Original 1923;
replica of earlier *Object To Be Destroyed,* 1958
Metronome, with cutout photograph of eye on pendulum, $8\frac{3}{4}$″ high.
Collection Mr. and Mrs. Morton G. Neumann, Chicago



Be Your Own Dentist! (Our Simple Home Tooth-Puller). c. 1930. Pen and ink, $6^{7}/_{8}$ (irregular) × 21″



Professor Butts ("You Sap, Mail that Letter"). c. 1930. Pen and ink, $9^{3}/_{8}$ × 19″

Rube Goldberg (Reuben Lucius Goldberg). American, born 1883

Drawings for newspaper cartoons. c. 1930—1936
Owned by the artist

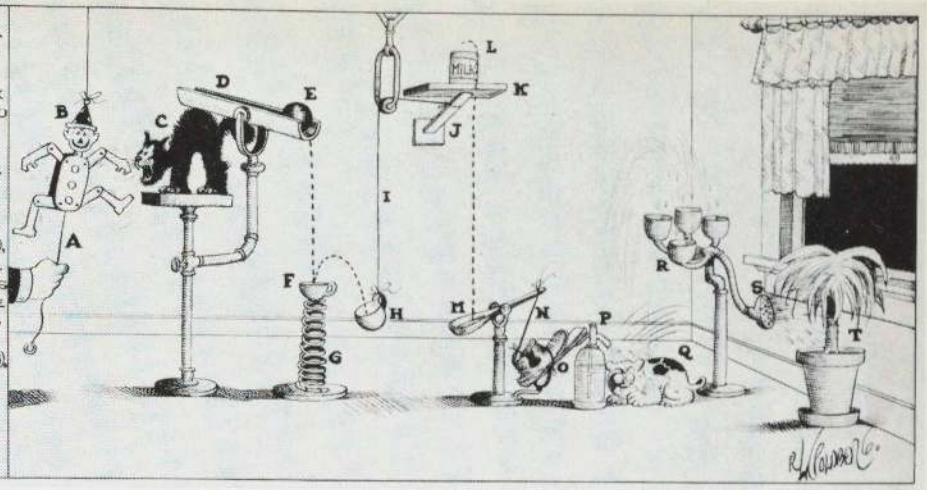
Rube Goldberg is a very American artist — which is not to say that he did not attract European followers; they appeared almost immediately. In April, 1921, Marcel Duchamp published in *New York Dada* a drawing by Goldberg,[136] at a time when his series of comic cartoons, syndicated in newspapers throughout the United States, had already established his reputation, and was soon to make him one of the highest paid artists in the country. Goldberg may perhaps regarded as the first pop artist — if by "pop" one means an interested acceptance of, and not too negative a way of dealing with, the popular or common manifestations of civilization.

Underlying all the complicated contraptions of Professor Lucifer Gorgonzola Butts is the idea that something man can do in a very simple, direct way can also be accomplished, through an elaborate, roundabout, and risky system, by a machine. Goldberg's drawings of Professor Butts's apparatus sabotage our confidence both in man's intelligence and in the machine's efficiency.

Goldberg's relaxed and humorous way of dealing with the intricacies of mechanization could only be born on a continent that regarded technology as the creator of a new culture, rather than the destroyer of an older one. Goldberg himself began as a student of mining engineering at the University of California, where, he has said, "big machines impressed me with their futility." His faith in technology was further undermined when the San Francisco earthquake of 1906 destroyed the city's sewage system and water mains on which he had formerly been engaged as a designer.[137]

PROFESSOR BUTT'S BRAIN TAKES A NOSEDIVE AND OUT COMES HIS SELF-WATERING PALM TREE.

STRING (A) WORKS JUMPING JACK (B), FRIGHTENING CAT (C) WHICH RAISES BACK AND LIFTS TROUGH (D), CAUSING BALL (E) TO FALL INTO TEACUP (F). SPRING (G) MAKES BALL REBOUND INTO CUP (H) PULLING ON STRING (I) WHICH RELEASES STICK (J), CAUSING SHELF (K) TO COLLAPSE. MILK CAN (L) DROPS ON LADLE (M) AND TENSION ON STRING (N) TILTS SHOE (O) AGAINST JIGGER ON SELTZER BOTTLE (P), SQUIRTING SELTZER ON ASH-CAN SPANIEL WHO HASN'T HAD A BATH IN FOUR YEARS. SURPRISE CAUSES HIM TO TURN THREE SOMERSAULTS OVER APPARATUS (R) AND WATER SPLASHES NATURALLY INTO BOWLS, RUNNING THROUGH SPRAY (S), WATERING PALM (T), AND SAVING YOURSELF A TRIP TO HAVANA FOR TROPICAL ATMOSPHERE.



Professor Butts' Brain Takes a Nosedive (Self-Watering Palm Tree). c. 1930. Pen and ink, $7^5/_8 \times 19^5/_8$"

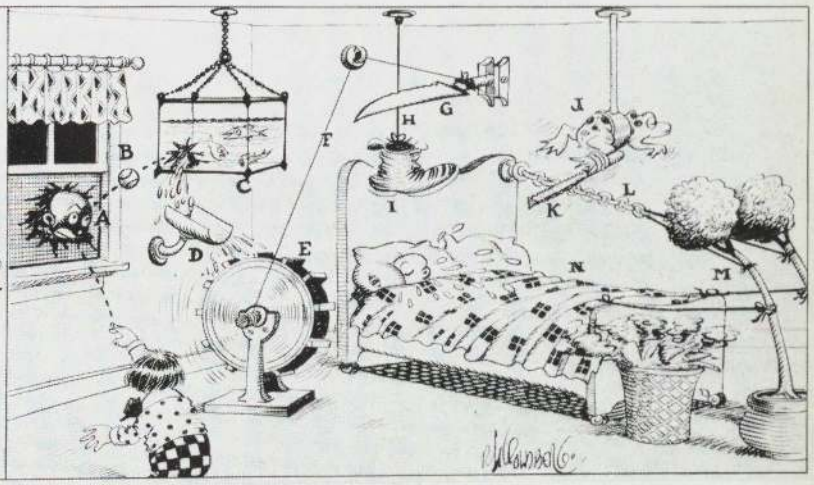
AS FIGHTER IS SOCKED ON CHIN, WATER FROM GLASS (A) FALLS ON SPONGE (B), WEIGHT OF WHICH CAUSES STRING (C) TO PULL TRIGGER OF PISTOL (D). BULLET (E) BOUNCES OFF HEAD OF DUMB SECOND (F) AND HITS WEIGHT (G), KNOCKING IT OFF REST (H) - STRING (I) PULLS TOOTH FROM MOUTH OF RESIN-SPANIEL (J) - DOG JUMPS UP AND DOWN WITH PAIN AND WORKS HANDLE (K) OF JACK (L), THEREBY JACKING FIGHTER OFF THE FLOOR - BOXING RULES SAY THAT A A FIGHTER IS NOT OUT IF HIS BODY IS OFF THE FLOOR - IF YOU WANT TO ARGUE ABOUT THIS GO AHEAD - BUT PLEASE DON'T BOTHER US.

Simple Way for a Fighter to Keep from Getting Knocked Out. c. 1930. Pen and ink, $6^3/_4 \times 21$"

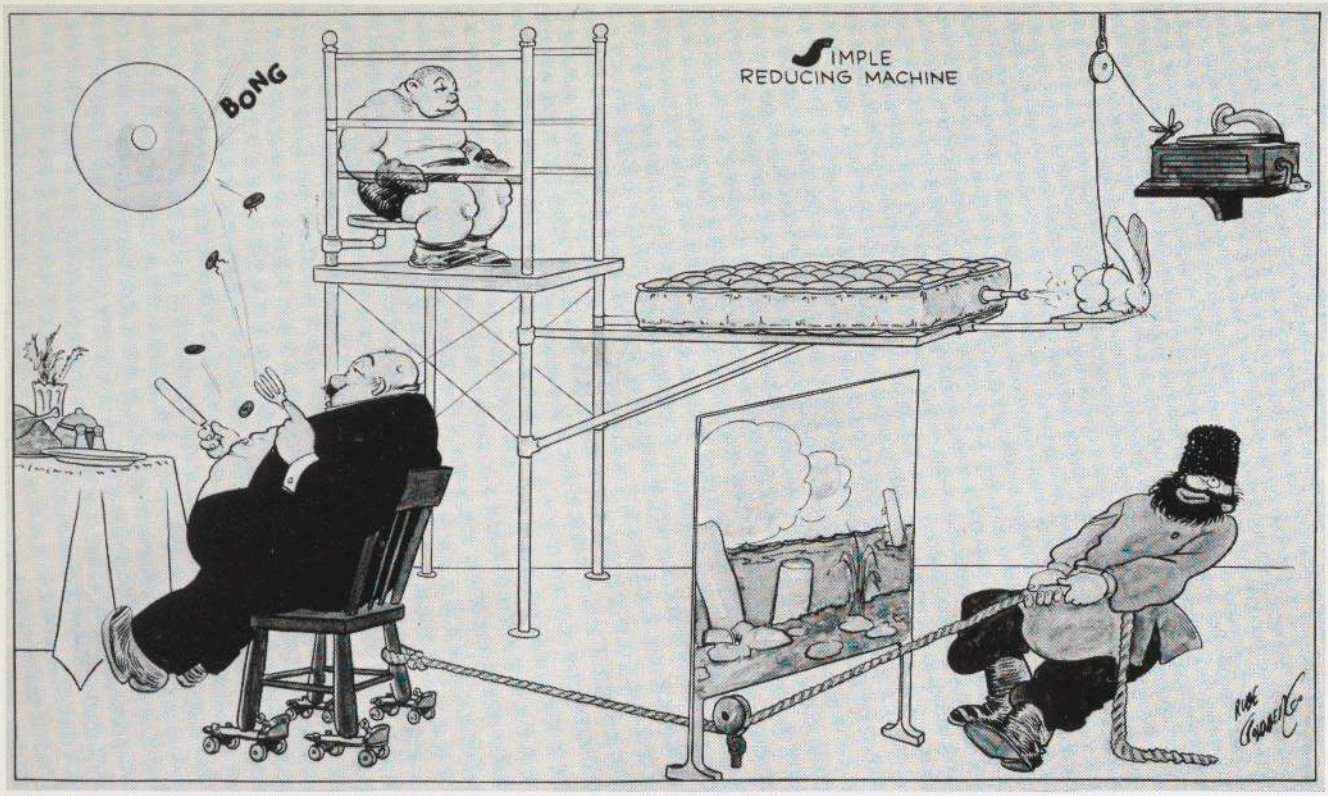
PROFESSOR BUTTS, TRAINING FOR THE OLYMIC GAMES, BROAD JUMPS INTO THE GRAND CANYON BY MISTAKE AND, BEFORE HE REACHES BOTTOM, HAS PLENTY OF TIME TO INVENT A NEAT LITTLE FIRE EXTINGUISHER.

PORTER (A) SMELLS SMOKE COMING FROM ROOM AND IN THE EXCITEMENT STICKS HIS HEAD THROUGH WINDOW SCREEN TO INVESTIGATE. LITTLE BOY REMEMBERING CARNIVAL, THROWS BASEBALL (B) WHICH BOUNCES OFF PORTER'S HEAD AND BREAKS GLASS IN AQUARIUM (C), CAUSING WATER TO RUN INTO TROUGH (D) AND REVOLVE PADDLE WHEEL (E) WHICH WINDS ROPE (F), PULLING KNIFE (G) AND CUTTING CORD (H). SHOE (I) FALLS ON BABY'S FACE, BABY SHEDS COPIOUS TEARS. SPLASHING OF TEARS MAKES BULL FROG (J) THINK OF BABBLING BROOK AND HE STARTS SWIMMING CAUSING FILE (K) TO CUT CHAIN (L) WHICH BREAKS AND ALLOWS TREES (M) TO SNAP UPRIGHT AND PULL WET BLANKET (N) OVER BURNING WASTE BASKET, THEREBY EXTINGUISHING FIRE.

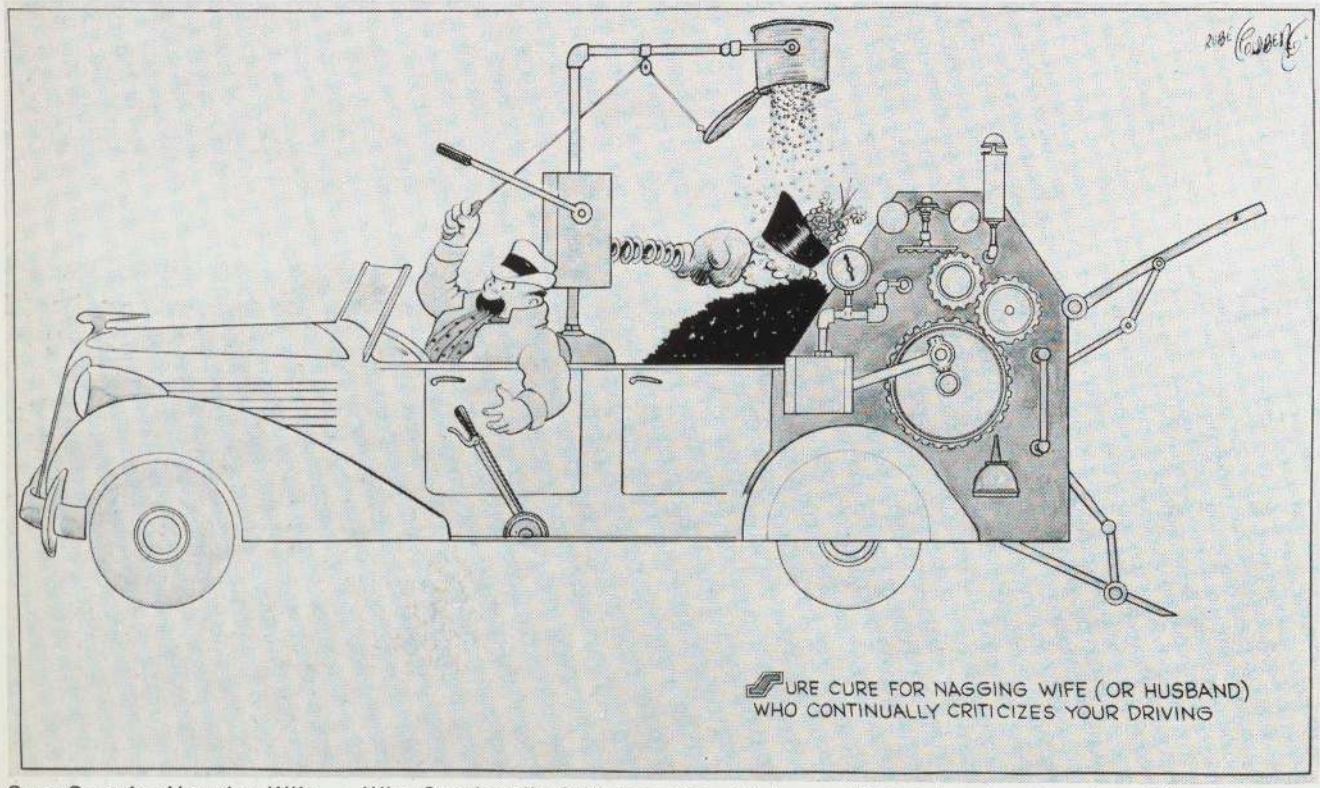
IF THE FIRE DOESN'T HAPPEN TO BE IN THE WASTE BASKET, CALL OUT THE FIRE DEPARTMENT.



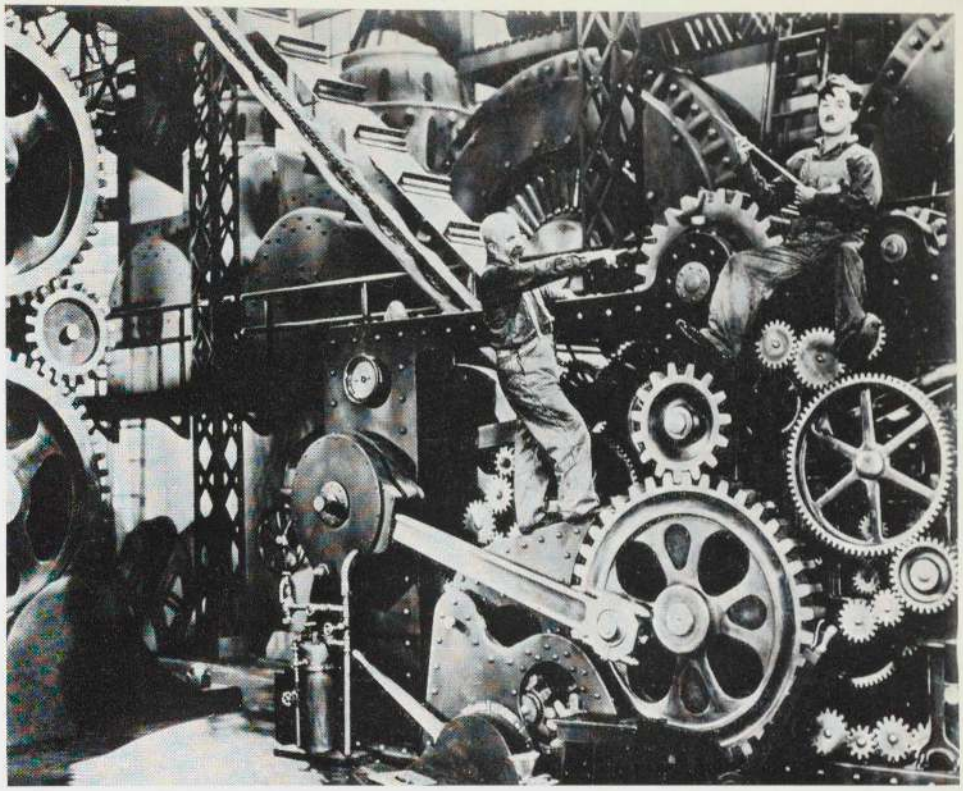
Professor Butts Training for the Olympic Games. c. 1932, Pen and ink, $9^1/_4 \times 20^5/_8$"



Simple Reducing Machine. c. 1936. Ink and watercolor, $14^{3}/_{8} \times 22^{7}/_{8}$″



Sure Cure for Nagging Wife . . . Who Continually Criticizes Your Driving. c. 1936. Ink and watercolor, $14^{3}/_{8} \times 23$″



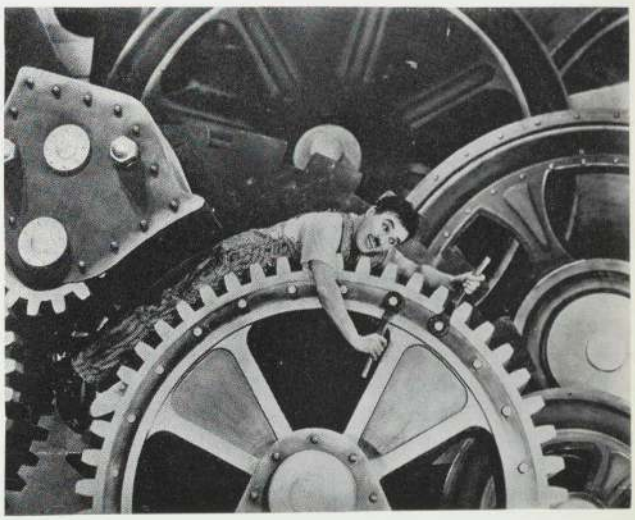
Charles Chaplin
British, born 1889
Stills from "Modern Times." 1936
Written, directed, and produced by Charles Chaplin. Sets by Charles D. Hall. Released by United Artists

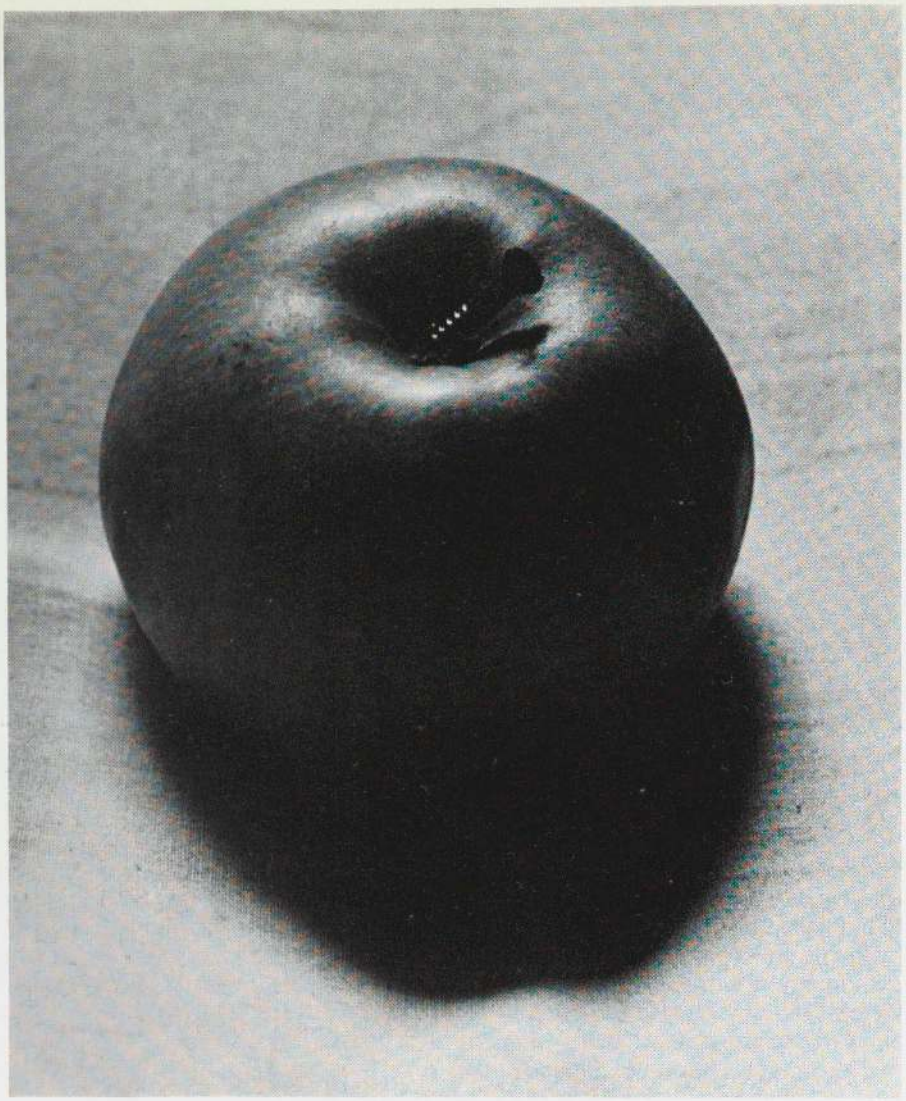
The theme of *Modern Times* is, as so often with Chaplin, the story of an individual who tries to lead his life as a member of society but is constantly rejected by society. The tramp sees the lights of the city and is drawn to them, but in the closing scene he walks away along a country road. In *Modern Times,* society is symbolized by the factory and its machines. In his foreword, Chaplin declared: "*Modern Times* is the story of industry, of individual enterprise — humanity crusading in the pursuit of happiness."[138]

The automatic feeding machine called "Beloved" that is intended to cut down lunch time is a triumph of efficiency and exploitation. The inventor who demonstrates the feeding machine behaves like a robot himself, repeating the same gestures. When the machine goes out of order, he is not at all interested in what happens to Charlie, who is fed steel nuts, has hot soup tipped down his shirt, and pie flung into his face; he is concerned only with the malfunctioning of his machine. When the monotony of endlessly tightening bolts on the conveyor belt makes Charlie go mad, he is drawn into a big machine. (Built of rubber and wood, it cost $50,000 to construct.)

Modern Times is an extremely strong manifestation of the pessimistic attitude toward technology that culminated in the late 'thirties. The point of view is not altogether negative, however. Charlie also knows how to use machines to save himself. The foreman and workers pursuing him after he has gone mad cannot catch him, for whenever he feels in danger of being trapped, he turns on the conveyor, and they have to return to their tasks.

Chaplin said of this film: "It started from an abstract idea, an impulse to say something about the way life is being standardized and channelized, and men turned into machines — and the way I felt about it."[139]





Man Ray. American, born 1890

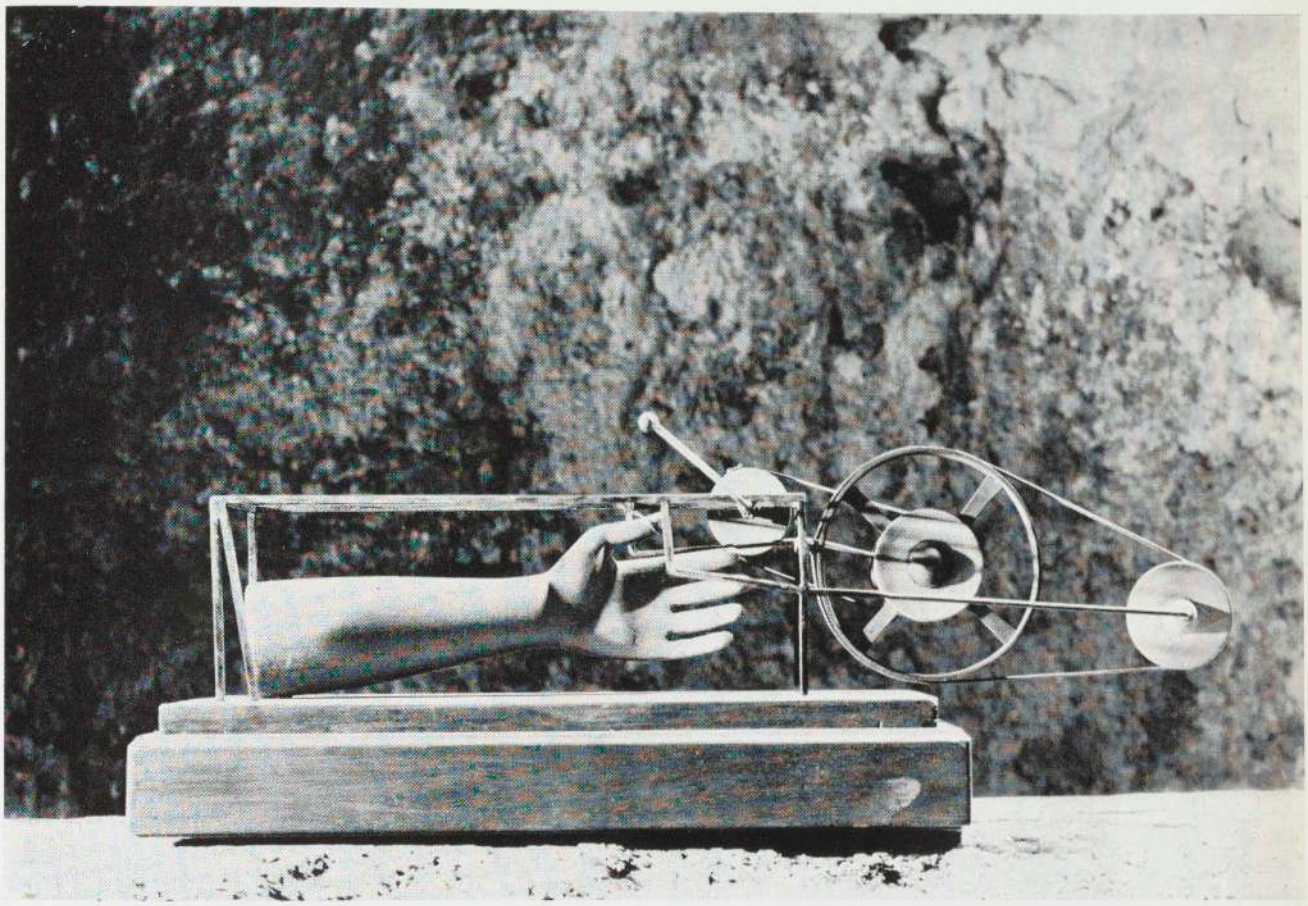
Untitled. 1929

Photograph, $8\frac{1}{2} \times 7''$. The Museum of Modern Art, New York

The Surrealists, like the Dadaists before them, frequently presented their views of the world through the device of juxtaposition — the unexpected pairing of two phenomena that logically cannot be paired. The classic and often quoted example was that given by the nineteenth-century poet Isidore Ducasse, the "comte de Lautréamont": "Beautiful as the chance encounter of a sewing machine and an umbrella on a dissecting table." Two banally normal objects, which in our way of dealing with identities have nothing to do with each other, meet where both are out of place and make love.

The atrocities of this lovemaking must have especially appealed to the Surrealists, who, unlike the Dadaists, had strong feelings of hatred toward machines. They looked upon them as opposed to nature and destroying nature, besides representing stultifying logic at the expense of spontaneity and intuition. Most Surrealist works concerned with the mechanical world show a battle between nature and machines (for example, Ernst's *Garden Airplane Trap*, page 147).

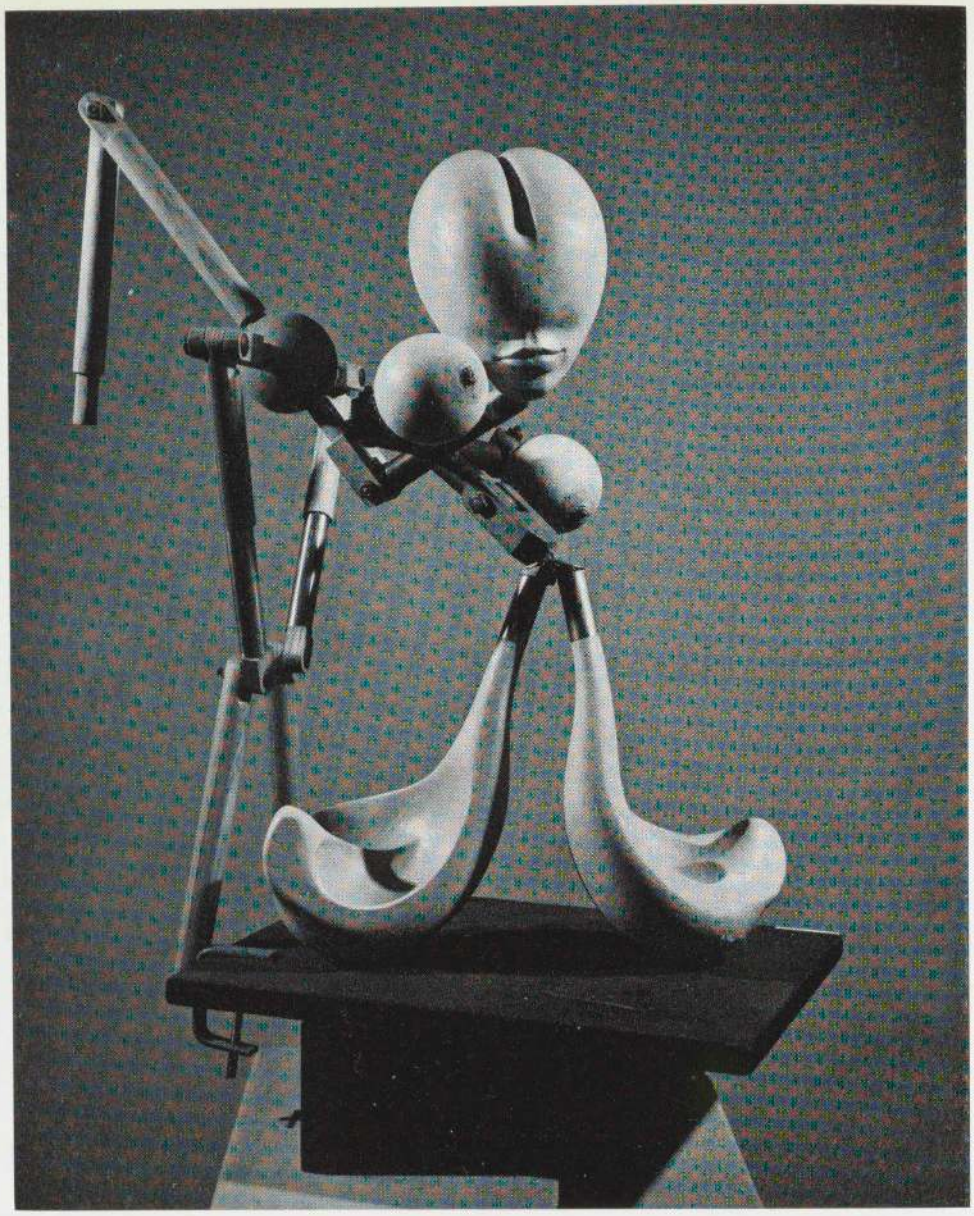
As the first to use the airbrush in painting, however, and as a photographer, Man Ray must have retained some love for machines. In this image of sadistic lovemaking, it is not altogether clear whether he is on the side of the apple or of the screw — though obviously he gives the latter a chance.



Alberto Giacometti. Swiss, 1901—1966
The Captured Hand (Main prise). 1932
Wood and metal, $7^{7}/_{8} \times 23''$. Kunsthaus, Zurich

"I . . . wanted to give the sensation of motion that could be induced."[140] *The Captured Hand* is Giacometti's clearest statement about the mechanical world. It is also one of his most pessimistic works — which is saying a great deal! The image of the hand about to be caught in the machine, and the idea of one's own hand turning the crank, seem to sum up the tragic predicament of our modern world. A crank is made to be turned, and before we are aware of it, without thinking of the consequences, we respond to the invitation. The evolution of technology cannot stop, though its dangers become increasingly obvious. We feel trapped in an inevitable process of escalation, which accelerates at a more and more rapid pace. The anxiety and sense of crisis that Giacometti has here rendered in terms of sculpture is the same as that manifested by Chaplin in Modern Times, or by Friedrich Georg Juenger in his strongly polemic book, *The Failure of Technology.*[141]

What Giacometti expresses with this sculpture could not have been said in a more economical, all-encompassing way. Few works of art so directly enlist the spectator's participation as does *The Captured Hand,* which in a fraction of a second converts his natural reaction to the crank into a shudder down his spine.



Hans Bellmer
German, born Poland, 1902
Machine-Gunneress in a State of Grace. 1937
Articulated object: wood and papier-mâché, 23⅝″ high
The Museum of Modern Art, New York

Many Surrealists of the 'thirties accepted without question the misconceptions about technology incorporated in the theories of machine-aesthetics formulated by such men as Le Corbusier, and ardently embraced by Léger. The qualities of functionalism, standardization, and utility which these theorists attributed to the machine and singled out for praise were, however, rejected in an equally uncritical, emotional way by the Surrealists.

The Surrealists were, nevertheless strongly attracted by the erotic overtones of machines and their movements. Hans Bellmer, a Berlin artist who in the early 'twenties had been associated with Grosz and Heartfield, began constructing his puppet-like figures in 1933, inspired by the doll Olympia in a Max Reinhardt production of *The Tales of Hoffman*. Photographs of Bellmer's doll, a female mannequin that had ball joints which allowed it to be dismantled and reassembled in various erotic positions, were seen by the Paris Surrealists and reproduced in their review *Minotaure* in 1934. The *Machine-Gunneress,* done after Bellmer had visited Paris in 1936 and joined the Surrealists, recalls the often-quoted dialogue:

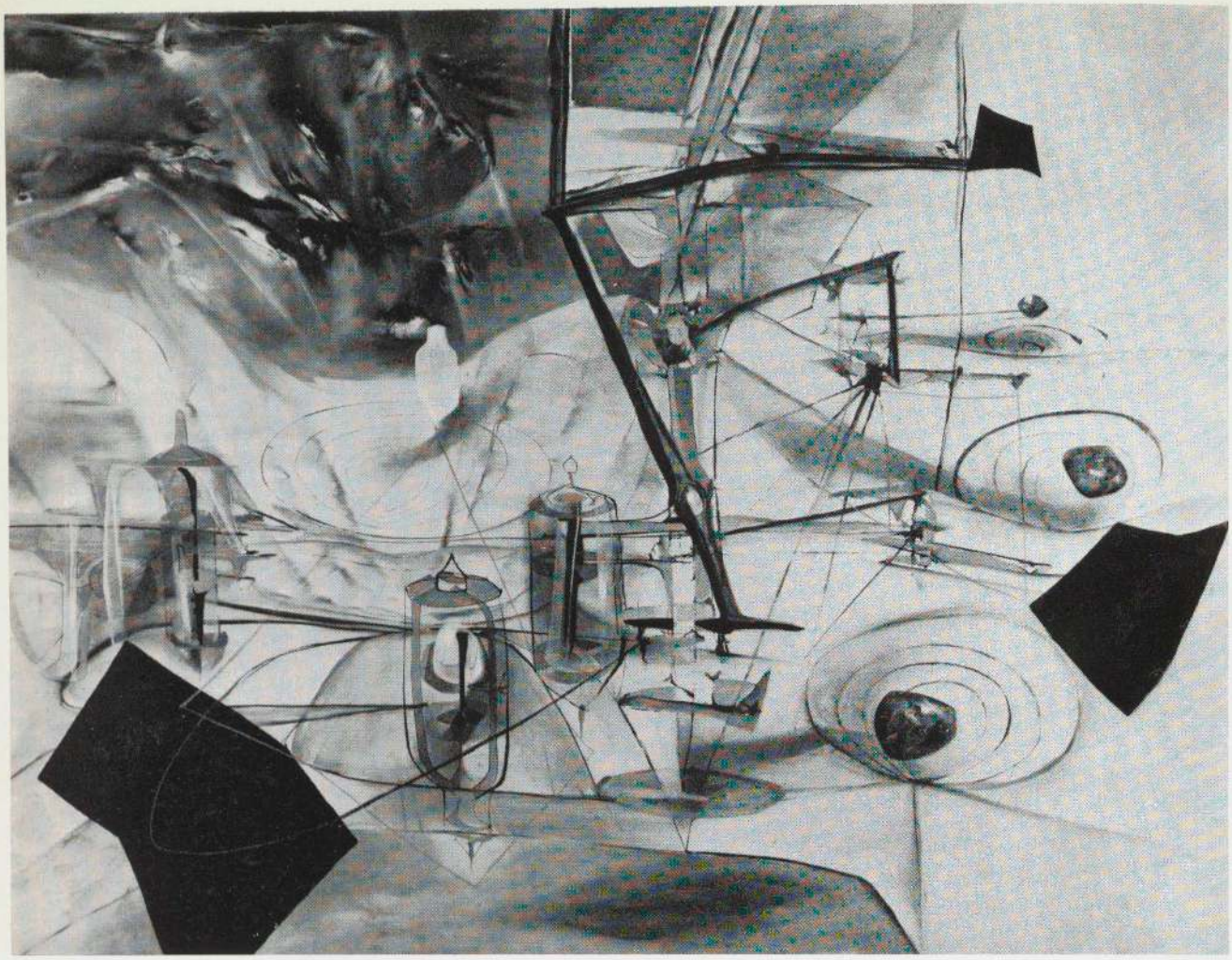
Masochist: "Hurt me."
Sadist: "No."
Masochist: "Thank you."

Besides reflecting the Surrealists' general skepticism toward the machine, this particularly aggressive version of Bellmer's doll alludes to the threat of the heavy war machine that was building up at the time.

Victor Brauner. Rumanian, 1903—1966
The Mechanical Fiancée. 1945
Encaustic on paper, mounted on composition board,
$25^{3}/_{8} \times 19^{5}/_{8}''$
Collection Julien Levy, Bridgewater, Connecticut

The use of the word "mechanical" to describe a human reaction does not imply something rational, logical, and dependent on the intellect. On the contrary, it characterizes an intuitive or "automatic" reaction. The automatism of sexual response has long been observed, from La Mettrie, who in his *L'Homme machine* (1748) allowed it a significant, though discreet, role in his mechanistic interpretation of man, down to the scientific investigations of Dr. Kinsey.

This side of human nature has colored much of our unconscious reactions to machines. The endless allusions that locomotives and the parts of a steam engine, for example, seem to make to human love-making illuminate one aspect of machine eroticism.



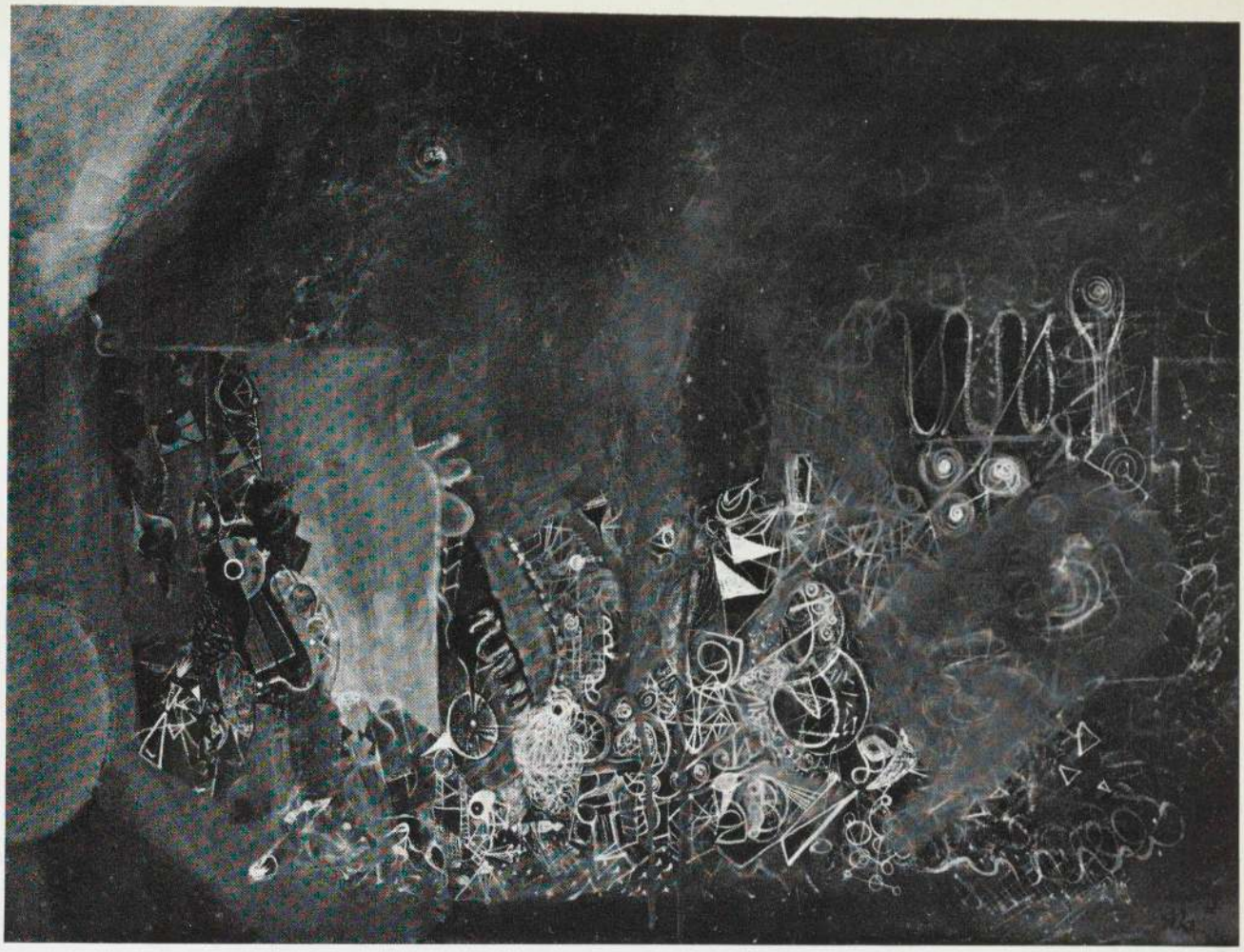
Matta **(Sebastian Antonio Matta Echaurren)**
Chilean, born 1912

The Bachelors Twenty Years After. 1943
Oil on canvas, 38×50″. Collection Mr. and Mrs. George Heard Hamilton, Williamstown, Massachusetts

Matta was the youngest and by far the most speculative of the Surrealists, whom he joined in 1937. He was especially attracted by their emphasis on chance, automatism, and magic relationships, and around 1942 he became particularly interested in magic, cabalistic lore, and the tarot. For obvious reasons, he was drawn to Duchamp.[142] A year after he painted this picture, Matta collaborated with Katherine S. Dreier on a book on the *Large Glass* — one of the first manifestations of the greatly revived interest in Duchamp's work that was to flourish in the 'fifties and 'sixties.

In Matta's painting, the shifting planes and fragmented treatment of space were inspired by Duchamp's machinist works of about 1912. As in the *Large Glass,* the "bachelors" are confined to the lower part of the painting, but they have become more active and involved. They have been brought out of the age of the mechanical and old-fashioned chemistry into the dawning era of nuclear science and projects for the conquest of space. Here, space has been given an undefined, apocalyptic quality.

Matta was the first artist of the postwar generation to understand the complexity and power of cybernetics. His attitude toward the mechanical world, however, was basically the same as that of the traditional Surrealists; it was one of fear and refusal. Many of his paintings of the 'forties express a sense of frustration and alienation. On the one hand, Matta finds deeply shocking the use of the term "the human factor" to explain an accident or a mistake; on the other hand, he is haunted by the realization that human destiny is often the victim of forces beyond man's individual control — forces described by Breton in the *Prolegomena to a Third Surrealist Manifesto* (1942), which Matta illustrated, as "perturbations like the cyclone, in the face of which man is powerless to be anything but a witness, or like war . . ."[143]



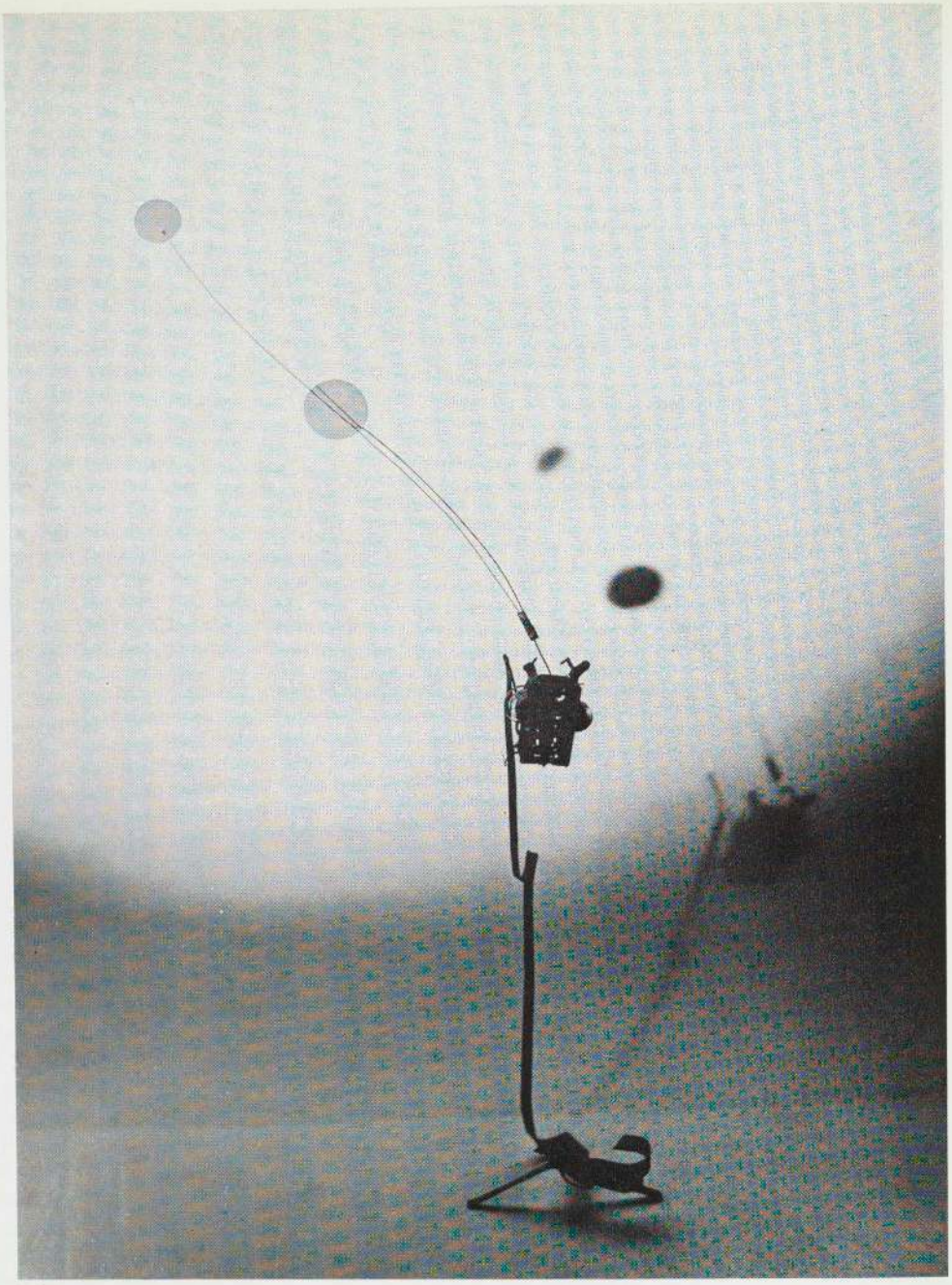
Mark Tobey. American, born 1890
The Void Devouring the Gadget Era. 1942
Tempera on cardboard, $21^{7}/_{8} \times 30''$. The Museum of Modern Art, New York (gift of the artist)

Political conditions in Europe from the mid-'thirties on, even before the outbreak of the war, made it difficult to concentrate on anything but the problems of survival and defense of the most elementary values. Such a climate did not favor the birth of new ideas in art, and in the 'forties the initiative passed to the United States.

Tobey's picture, painted a year before Matta's reinterpretation of Duchamp's *Large Glass,* presents a new conception of space, which was to be a main preoccupation for a generation of painters. In post-Renaissance painting, space has generally been measurable by the objects it contains. As Tobey's title indicates, a void implies a space so vast and limitless that it tends to swallow up everything in it. Figures and objects lose their dimensions, and with them, their identity. In this painting, the lines and figures sometimes seem familiar and recognizable, yet they finally elude our interpretation. Are they parts of machines? vessels? microbes? malevolent animals? This elusiveness of identity gives rise to a sense of great uncertainty. Before we have time to recognize the elements of our gadget civilization, it is shrouded in haze. We can no longer see clearly; chaos descends.

"... if we remain fettered and restricted by human inventions and dogmas, day by day the world of mankind will be degraded, day by day warfare and strife will increase and satanic forces converge toward the destruction of the human race."[144] 'Abdu'l-Bahá, a leader of the Bahá'í faith to which Tobey has adhered since 1918, gave this admonition in 1912 in the course of a visit to America.

In 1965, asked to interpret this work, Tobey replied that its genesis was "the realization of many people and myself that gadgets were filling up the space in which we lived ... It could be possible that there is a warning in this picture. Those who look carefully will in any age decipher it, I am sure."[145] In retrospect, Tobey's painting and its title, dating from just three years before the dropping of the bomb, seem uncannily prophetic.

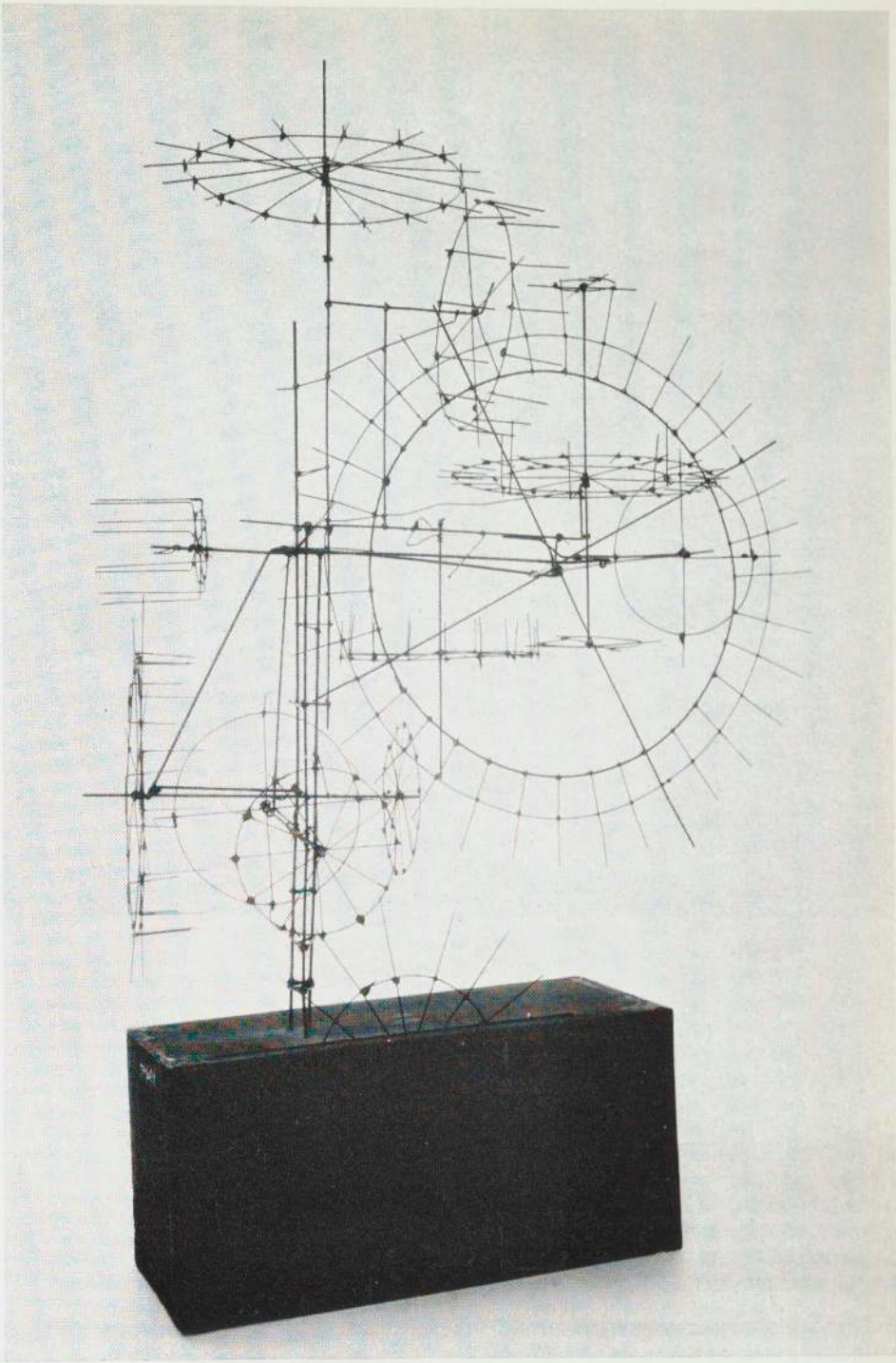


Bruno Munari
Italian, born 1917
Mobile. 1952
Sheet iron and clockworks,
30 3/4" high
Kaiser Wilhelm Museum,
Krefeld

The spring, as in a clock, is the most temperamental reservoir of mechanical energy. When wound up, it has great force; when run down, it performs most erratically. The balance wheel in a clock regulates and distributes the energy in equal parts.

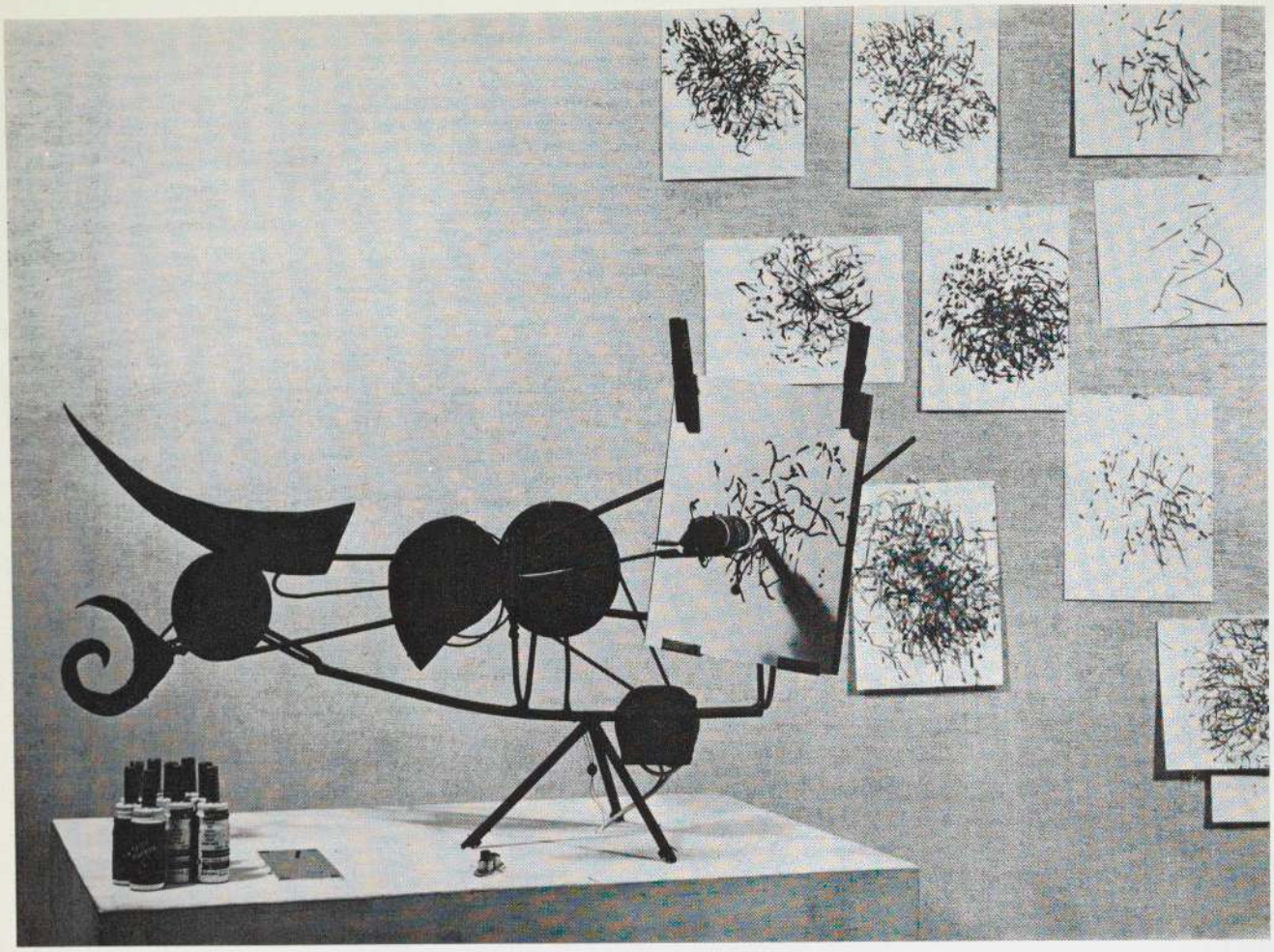
Munari gave back to the spring its own unregulated behavior, and by adding two more springs in the form of thin rods that support discs, he created a wriggling dance that goes on while the force of the spring is running down; then it has to be rewound. The motor is glorified, not heroically but poetically.

Munari had his first exhibition of "useless machines" in Milan in 1935, and in 1945 began "the creation of kinetic objects, whose make-up could be varied, driven by small clockwork motors."[146] Since the early 'fifties, he has been a strong proponent of the use of technology to achieve poetic results. In 1952, the year in which he made this object, he wrote a Manifesto of Machinism that ends: "The machine must become a work of art. We shall discover the art of machines!"[147] His ideas have probably helped inspire the optimistic, anarchic machine art that was developed in the mid-'fifties by Tinguely and others.



Jean Tinguely
Swiss, born 1925
Meta-matic. 1953
Wire, 26 3/4″ high × 30 3/8″ wide × 11″ deep
Collection Harry Kramer, Paris

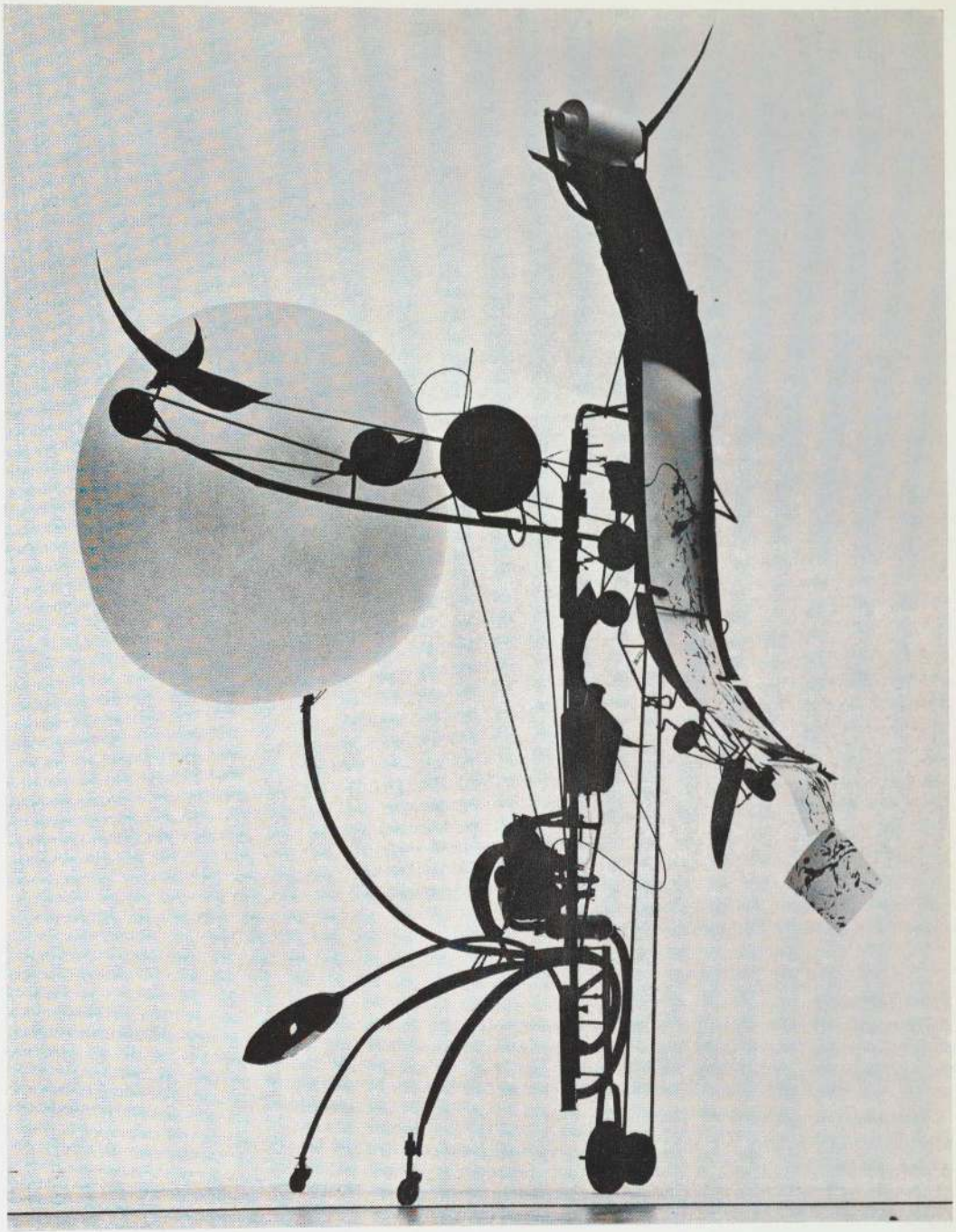
Tinguely's form of mechanics is "meta-mechanics," which suggests an analogy with physics and metaphysics. Most of his early machines are ironic, sometimes feverish; they carelessly ignore the disciplines of the conventional machines of this world. From a machine one demands order and precision, reliability and regularity. Tinguely's point of departure is mechanical disorder. In his early works, change and movement obey only the laws of chance. He pits the emancipated machine against the functional one and gives his creations a glorious life of improvisation, happy inefficiency, and shabbiness, expressing an enviable freedom.



Jean Tinguely
Meta-matic No. 8. 1958
Sheet metal, wood, wire, and motor, 15½″ high × 26″ long
Moderna Museet, Stockholm

Tinguely's auto-destructive and auto-creative art machines are among the most engaging ideas of a machine society. The self-destroying machines (of which Tinguely has so far made three) shed a harsh light on our present situation and the complexity of its structure. If art is a reflection of the fundamental ideas of a civilization, one can think of few more pertinent images or symbols. These machines have the richness and beauty of all very simple and therefore very great inventions.

The "meta-matics," the art-making machines, also stretch a tentacle into the heart of our civilization. In this century, art has come to represent faith in the individual, the ultimate liberty; it typifies the fullest expression of the creative process. By contrast, the machine is used for mass production; the entire basis of its existence is standardization. We require it to be rational, efficient, and serviceable; at the same time, we are frightened of it because it has now become so clever

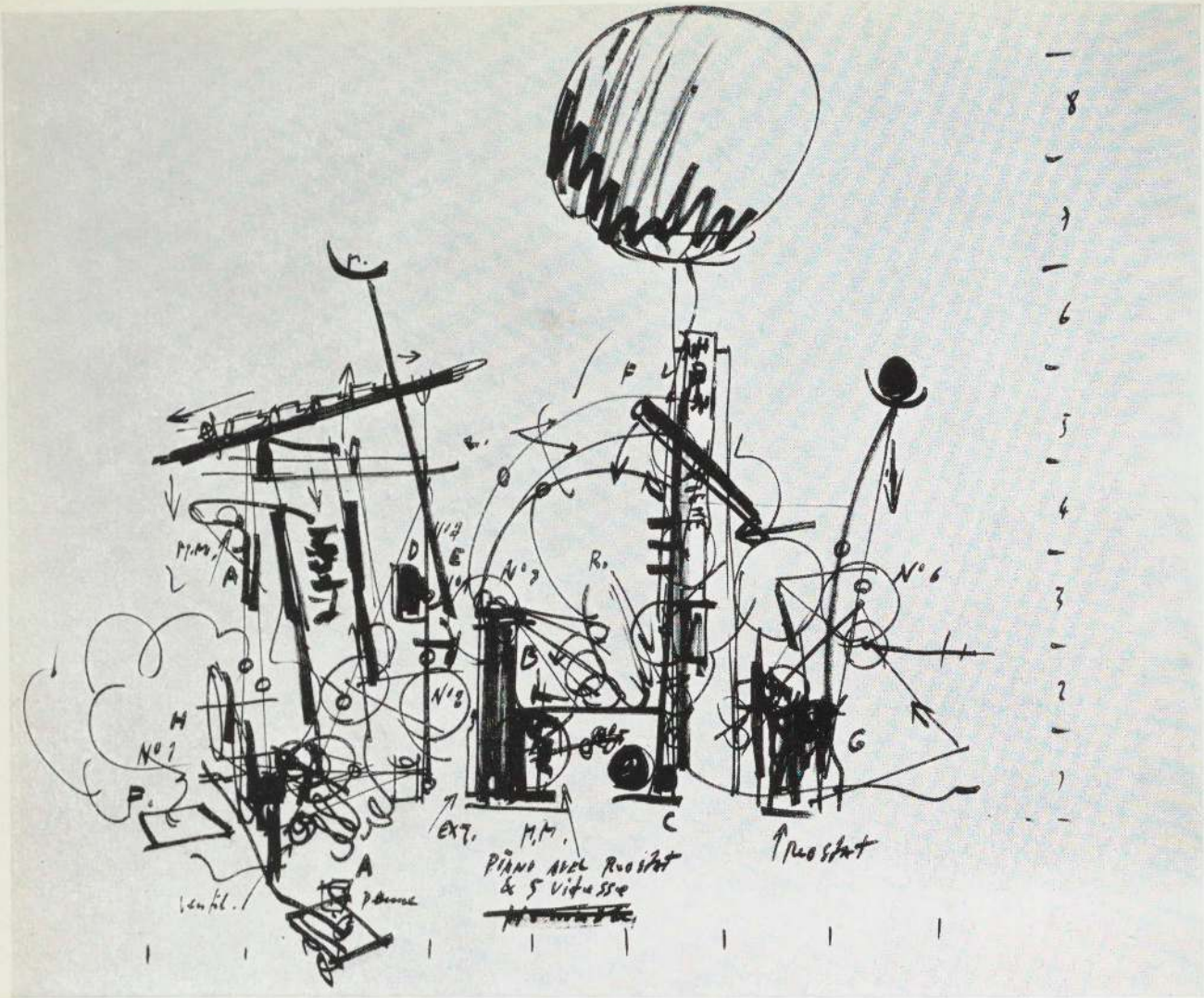


Jean Tinguely
Meta-matic No. 17
1959
Iron, 9′10″ high
Moderna Museet, Stockholm

and powerful. There is little dignity in our present relations with machines.

When one thinks in these terms about Tinguely's painting machines, it becomes evident that the basic idea is the *collaboration.* Together, man and machine produce an irrational product. Tinguely seems to hint that if we were to get on better emotional terms with machines, there could be great times. He gives us an appetite for explorations. "For me," he says, "the machine is above all an instrument that permits me to be poetic. If you respect the machine, if you enter into a game with the machine, then perhaps you can make a truly joyous machine—by joyous, I mean free. That's a marvellous thing, don't you think?"[148]

One should not overlook the fact that the meta-matics may also constitute a rather devastating critique of some of the *art informel* of the late 1950s, the date of Tinguely's invention.



Jean Tinguely
Homage to New York (preliminary drawing). 1960
Felt pen and ink on bristol board, 22 1/8 × 28″ (sheet)
The Museum of Modern Art, New York (gift of Peter Selz)

The most important of Tinguely's self-destroying machines was probably his first one, *Homage to New York*, which destroyed itself in the Sculpture Garden of The Museum of Modern Art on March 17, 1960 (see illustrations, inner covers).

si la scie scie la scie
et si la scie qui scie la scie
est la scie que scie la scie
il y a Suisscide métallique.

marcel Duchamp
1960

The best description and analysis is that written shortly after the event by Billy Klüver, a Swedish-born research scientist at the Bell Telephone Laboratories in New Jersey, who was closely involved in the work.

"The Garden Party" — 8 Years Later

I wrote *The Garden Party* two days after it happened, as a kind of personal note. Now, eight years later, on rereading it, I am struck by the many aspects of the collaboration between Jean, Harold Hodges, and myself that are still pertinent. Even though such collaboration is bound to become less naive, it seems that the same excitement is essential for it to become effective. Harold Hodges, an engineer at Beil Labs, has since made several contributions to works by Rauschenberg, Fahlström, and others.

The title of my essay comes from a review in *The Nation*.[149] — B.K.

Billy Klüver: THE GARDEN PARTY

Jean Tinguely's destructive construction No. 1 was built in the Buckminster Fuller dome at The Museum of Modern Art over a period of three weeks. When, on March 17, 1960, his machine was put into action, the spectacle was one of beautiful humor, poetry, and confusion. Jean's machine performed for half an hour and exists no more.

When Jean first told me about his idea for a self-destructive machine, he wanted a large assembly hall on Manhattan. The machine would do all kinds of wild things and finally destroy itself. A chicken-wire netting would save the audience from a similar fate. But The Museum of Modern Art came into the picture and offered Jean its Sculpture Garden as the site, and the dome to work in.

The first drawings of the machine show little resemblance to the final result. A meta-matic painting machine was there. It would create a continuously changing painting that would disappear as the paper was rolled up again into a tight roll. A text of dirty words would unfold. A Virgin Mary was to be sawed in half. Parts of the machine would tip over, others would finally collapse as dozens of saws attacked the steel construction. The noise would be terrific.

The beginning was slow. Jean bought old motors in the bizarre Canal Street shops. A weather balloon and smoke signals (that did not work) were found in a surplus store. He collected steel tubing for the structure and tools to work with. Pulleys were expensive. He wanted old bicycle wheels from junk yards. But no junk yard in the U.S. deals in such trivialities. I stumbled onto a dealer in Plainfield who was clearing out his basement and carried away 35 old rusty wheels. Jean was as excited as a child when we brought the wheels through the empty museum that evening. The dome was unheated, and the temperature was below freezing, but things began to move. "I want more wheels," he said.

The next day my wife and I raided the Summit dump. This was a gold mine. We loaded the car and parked it behind the fence on 54th Street. A child's potty and bassinet, the drum from a washing machine, and 25 more baby carriages and bicycle wheels were thrown over the fence. The Saturday-afternoon passers-by raised the inevitable question: "What's going on here?" On the other side of the fence, Jean was laughing.

The following day the first structure was almost finished. It contained a large meta-matic with the pot, the bassinet, and the drum as percussion elements. A nut beat on the pot, a clamp jumped up and down in the bassinet, and a fan motor attacked the drum. The paper would unfold from a horizontal roll at the top and be guided down on a sheet-metal trough. Here it would be painted on by an elaborate arm that Jean later worked on for two days until it was perfect. At the bottom of the structure, the continuously moving paper would be blown toward the audience by a fan. The machine was taking form.

Jean and I made another trip to the dump. This time it was the Newark city dump, which is as much a reflection of the general neighborhood as is the Summit dump. This large dump was Jean's world. He kept finding the oddest objects and formations. Spilled-out paint would make a painting to be exhibited in some fashionable gallery. Someone had left a complete bedroom suite. If he could find a willing girl (which he admitted would be difficult), this would be a place where he would like to live. "I could, you know," he said. He would spend his days in the dump as a completely free man. Out of the debris he would build large, involved constructions. Slowly he would convince the bums, living in small shacks on the dump, that what he was making was important. Eventually they would join him and help him build. Of course, art was never to be mentioned, and his constructions would never be anything else but part of the dump. It is against the background of the anarchy and chaos of the Newark city dump that I see the growth of his machine.

The bums did indeed help us, and we walked away with a cable drum, American flags, a rusty oil can, and more baby-carriage wheels, of which for some reason there were plenty. Jean kept saying constantly: "We can put anything into the machine." In the final analysis, this of course was not true. As we were going back to the museum over the Jersey flats with our load, Jean behaved like a tourist seeing the Grand Canyon for the first time. To him the landscape was extremely beautiful.

Jean was now going at a fantastic rate. But the dome was cold, and he became ill with fever. This did not stop him, however, and he called anxiously for the insides of an old piano and a radio. I was lucky. A piano dealer in the neighborhood of the museum had an old piano. "Ten dollars if you come and get it." For two dollars, Jean bought an old Addressograph machine from the museum. Now he had everything that he wanted.

On the piano he mounted about ten arms made up of old bicycle parts. These arms hit the keys of the piano like the players of a player piano. Attached to the piano was another meta-matic, a smaller one with a sponge on the painting arm. The paper came down and was again rolled into a tight roll. L'art éphémère. *There were two texts that would roll by like the news bulletins on Times Square. One was vertical, and one was horizontal. "Je fais l'angle droit, tu sais," he boasted. Rising above the structure was a 25-foot-high steel tube that would support the weather balloon at the top. An old wooden radio was attached to the side of the piano and was sawed in half by a large handsaw. The whole section with the piano and the second meta-matic had dozens of wheels in it for the various operations.*

The Addressograph machine was transformed into a percussion machine with cans and a big bell. It made a fantastic noise. As the big motor of the machine worked, a lever stuck under the machine would be pulled in, and the machine would fall over. This system was never tried out.

During the last days, he made two small carriages powered by their own motors. One had a giant motor and a two-foot Klaxon sitting on two baby-carriage wheels and a small pulley. This was to be placed under the piano and would at a certain moment escape, dragging odd objects behind it. The second moving contraption was a very odd thing. Jean's idea was that it would move to the side and fall into the pool of the garden. It would commit suicide. The carriage was made up of a cable drum, more wheels, and an oil can. Sticking above it was a rod to which a corner of an American flag was attached. Two nights before the set evening, we tried it out in the museum. It was a strange sight to see this wonderful creation move laboriously in the empty museum halls. As it moved, an arm tapped a march rhythm on the empty can, and the red and white piece of the flag waved back and forth furiously. Stunned spectators looked through the windows on 53rd Street at the weird and beautiful spectacle.

Destruction seemed less and less an element of the machine. The saws were replaced by joints that would break as the metal of which they were made was melted by the heat from overheated resistors. Thus the original steel tubing was sawed through, and these joints were attached to support the structure. Jean seemed happy not to have to worry about the saws, but the joints never became quite a real part of his structure. As the first meta-matic collapsed, it would fall backward. The piano, placed on a frame two feet above ground, would itself fall backward into the fallen meta-matic. The second meta-matic and the support for the balloon would be dragged along in the fall of the piano. Behind the piano, Jean mounted a carbon-dioxide fire extinguisher, concealed by wooden boards. As a lever was pulled, the extinguisher would empty itself with a big swoosh. At the same time, the bell on the Adressograph would begin to ring.

Nothing was to be touched during the operation of the machine. The various functions and elements were to be started by pre-set time-delay relays. Everything was elaborately wired mechanically and electrically. Even a flame that would burn on the piano was to be lighted electrically. All over the structure were smoke flashes and yellow smoke signals, which would be started without direct interference. This combination of electrical and mechanical control gave Jean a great freedom to develop his machine.

An involved gear system would slowly turn the piano on. After a few minutes, a bucket of gasoline would be overturned onto the flame, a burning candle, so that the piano would catch fire. Another mechanical arrangement in the first meta-matic turned three beer cans filled with paint onto the paper rolling down toward the audience. On the very top of the first structure was a trough in which gallon-sized bottles would slide down as they were pushed by a lever. When they crashed to the ground, nauseating smells would spread. A child's go-cart would be pushed back and forth in front of the structure. There must have been about a hundred different operations in the machine.

Not until the last days did Jean decide to paint his machine all white. He seemed fascinated with this color but was a little worried that the machine would look too beautiful. The only counterpoint seemed to be the balloon that would explode and hang disgustingly over the piano. The two texts were composed the night before the event on the first floor of the museum. The night-watchmen, late museum employees — everybody helped.

On the day of destruction, the temperature rose above freezing for the first time. It was slushy, and the St. Patrick's Day parade was braving the rain on Fifth Avenue. When I arrived in the morning, the museum workmen, usually accustomed to hanging delicate paintings, were struggling to get the machine out of the dome and down to the Sculpture Garden. It was slippery, and things broke. The Addressograph was damaged, and Jean became tense. At one moment I thought he was going to quit it all. But nothing could break his resources of energy, and toward the afternoon his excitement transmitted itself to everyone. The workmen were now breaking their backs to get things in order. The museum had given him carte blanche, and everything Jean wanted he got. The rain stopped.

Robert Rauschenberg, who had promised a mascot for the machine, showed up with an object called a money-thrower. When some powder in an open box was lighted, the thrust would release two springs in which he had stuck a dozen silver dollars. Rauschenberg waited for hours to have his money-thrower connected.

Earlier in the morning, I had finally got hold of various stinking liquids, which I put in the bottles. Jean had already rejected the use of nitrogen butyl mercaptan or the stink of a skunk, in spite of the fact that he had demanded the strongest stenches I could find. I had also found out how to make a thick white smoke. Since several other methods had failed us, I did not emphasize to Jean what I had found, but simply asked him if I could put it in the bassinet. He said O.K.

The Klaxon did not work. Robert Breer went for a wild last-minute chase for a 6-volt Klaxon and found one that he actually tore off an old car. No new one would do. By then he was so wet and dirty that no taxi would take him back to the museum.

The public arrived, but nobody noticed it. Jean was fixing the meta-matics, putting on the smoke flashes, and directing everybody else. Not until 6 o'clock did I get a power line to the machine. All the circuits were connected. By accident, Robert Breer turned on the fire extinguisher in the piano. The secret had been revealed, but nobody understood what had happened. I discovered that one leg on the first structure was not sawed through. It was a real irony that the last thing we did was to saw this leg off. If it had been left, the structure would presumably not have collapsed and fallen over.

At 7:30 I was finished. "On va?" "On va," said Jean. He looked as calm as if he were about to take a bus. Not once did we go over and check everything. The construction and the beginning of the destruction were indistinguishable. Bob Breer put the titanium tetrachloride in the bassinet, a friend who had helped me with the circuits put in the plug, and I set the relays. The machine was off. It was launched as it was constructed. Jean was in complete charge of his work.

The piano was to begin playing slowly as the flame on the keyboard was lighted. But the step-up transformer had broken in transport, so the motor had to be started directly at full speed. The result was that the driving sling jumped the wheel on the piano as the motor started. I went cold. No piano! Nervously, I tried to put on the sling. "Laisse-moi faire, Billy," I heard Jean's voice say calmly. A fuse had blown. It was fixed. The piano was working again, but only three notes were playing — three sad notes. Some slings had been lost. I saw nothing but the machine. The audience was invisible.

After three minutes, the first meta-matic went on. But Jean had reversed the sling so the paper was rolling up instead of down. It was a bizarre effect. Earlier he had with great care put the paper in order and fixed the arm. The audience must have expected a lot from this machine. To make the situation more incredible, the motor driving the arm had not been reconnected. Thus, even if Jean had put the sling on correctly, the meta-matic would not have worked, and the empty paper would have rolled down the trough. Jean was laughing as he always did when something exciting happened. Meta-matic No. 21 *produced a three-foot-long painting as the beer cans emptied on to the paper rolling in the wrong direction. And the arm he had worked on to perfection did not function. But the fan at the bottom of the structure was not without use. The smoke was coming out thick and white from the bassinet, and the fan blew it toward the audience. Ladies with mink coats who were sitting in the cafeteria could not see because of the smoke. The percussion elements were working fine.*

In the sixth minute, the radio went on. Nobody could hear it because of the noise. The gasoline bucket was turned over the flame, and the piano started burning. Rauschenberg's money-thrower went off in a big flash. The silver dollars were never seen again. The fan motor started to beat on the drum from the washing machine. But the bottles did not fall. Jean had put in too weak a string. Why? After all our haggle over the stinks! But the only thing that annoyed Jean was that the balloon did not burst. The compressed air bottle was empty. The little two-wheeled cart in front of the meta-matic started to move back and forth.

In the tenth minute, the second meta-matic started and worked beautifully. It made a black painting streak with the sponge on its arm. The horizontal text went on. Something was wrong with it. It was winding up too slowly. Jean came by: "Do you remember the little ring you picked up and asked what it was for? It was to hold the paper roll up." Meanwhile, the vertical text was finished and the end of the paper was flying over the burning piano.

Jean was walking around calmly. He stopped in front of the machine and let the photographers take pictures, posing like an actor. As he was standing there, the text "Ying is Yang" appeared on the horizontal text roll. On the photographs of him with his self-destroying machine in the background, this sentence can be read above his head.

In the eighteenth minute, the fire extinguisher in the piano was supposed to go off. It didn't. The simple reason was that the piano was now burning all the way through, and the rubber hose had burnt up and clogged the extinguisher. But the suicide carriage rolled off some ten feet. The motor was so weak that Jean had to help it along. It would never have made it to the pool anyway, and Jean knew this all along. But he never exchanged the weak motor for a stronger one, which would have been a simple operation. As a functional object, the suicide carriage was supposed to move; as a work of art, it wasn't. This was typical of Jean's relation to the motor. On other places in the machine, there were big motors that did practically nothing; and in one place, he used a motor as a counterweight! The motor was for Jean part of the sculpture.

The Addressograph machine began to work. The yellow smoke signal was lighted, and the arms banged on the empty oil cans. The bell had never been put into operation. It turned out to be a gong that strikes only once. The whole machine was somewhat sick after the bad handling in transport, and it fell over after only a few minutes.

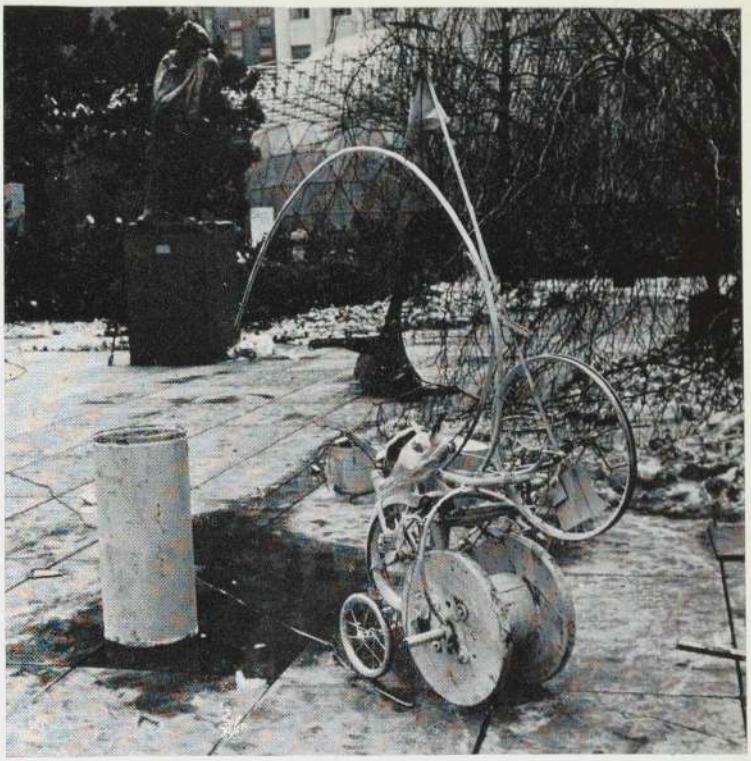
In the twentieth minute, the resistors in the first structure were connected. After a few minutes the metal had melted, and the whole structure sagged, but it never collapsed completely and fell over. The reason was that the crossbars that held up the wheels were strong enough to keep the structure together. But the smoke flashes were lighted by the heat from the resistors.

In the twenty-third minute, the little carriage shot out from under the piano with terrific speed. Its Klaxon was working fine, and it ended up in a ladder on which the Paris-Match *correspondent was standing. He turned it around, and it continued into the NBC sound equipment. Smoke and flames were coming out of its end.*

The fire in the piano was rapidly spreading. At one point, Jean had tried to damp it with an extinguisher. Now the flames had eaten their way through the piano, and Jean suddenly became afraid that the extinguisher on the back of the piano might explode from the heat. He told me to get the fireman to put out the fire.

The fireman had been there all afternoon. When the fire on the piano started, I was standing next to him. He did not react, and maybe he was enjoying the spectacle. He later called up the fire department. My wife overheard him trying to explain what was going on: "You see, Joe, there is this fire . . ." It was evidently decided that the fire in the piano was not a fire. Jean called him a "théoriticien de feu."

When I realized what Jean was saying, I tried to explain the situation to the fireman. He did not understand me when I talked about an extinguisher in the piano. The first fire extinguisher from the museum arrived. The fireman was very calm, as if nothing were happening. After three minutes, the longest in my life, they finally began to put out the fire. Even then the fireman was reluctant to do so because of the electrical wiring. At this point, both Jean and I were almost desperate, but the audience apparently got the wrong impression of what was happening. They thought the fireman was the one who wanted to put out the fire, and that we were trying to prevent him. They almost lynched the poor man who brought the extinguisher. A giant misunderstanding had developed, in which only the fireman seemed to be untouched by the confusion. He told me later that, of course, fire extinguishers are not made so that they blow up from heat. There had been no danger whatsoever. The fireman liked the show, he said.



Jean Tinguely
Homage to New York, remnant. 1960
Painted metal,
6′8¼″ high × 2′5⅝″ long × 7′3⅞″ deep
The Museum of Modern Art, New York
(gift of the artist)

The fire was damped and Bob Breer courageously knocked the supporting pieces of wood from under the piano. Jean had not dared to use the automatic system because of the bad effects from the transport. The piano collapsed backward but did not fall over.

I separated the fire extinguisher from the piano, and the public descended on the remains for souvenirs. They walked away with the radio, the saw, the meta-matic drawings, and lots of other things. Later the structure was dragged down into a pile of scrap that looked incredible. The bottles broke, so that the garden stank for two days. The junk was carried back to the dump the next day. Only a few mementos survived. The battered Addressograph machine was given to a photographer from the museum, who hauled it away at great expense. It will stand and rust in his garden. The suicide carriage was given to the museum, Bob Breer got a funny wheel construction that had early been put out of operation by the eager audience, and the small carriage with the big motor and the Klaxon stands under my table. All the rest was memory and pictures.

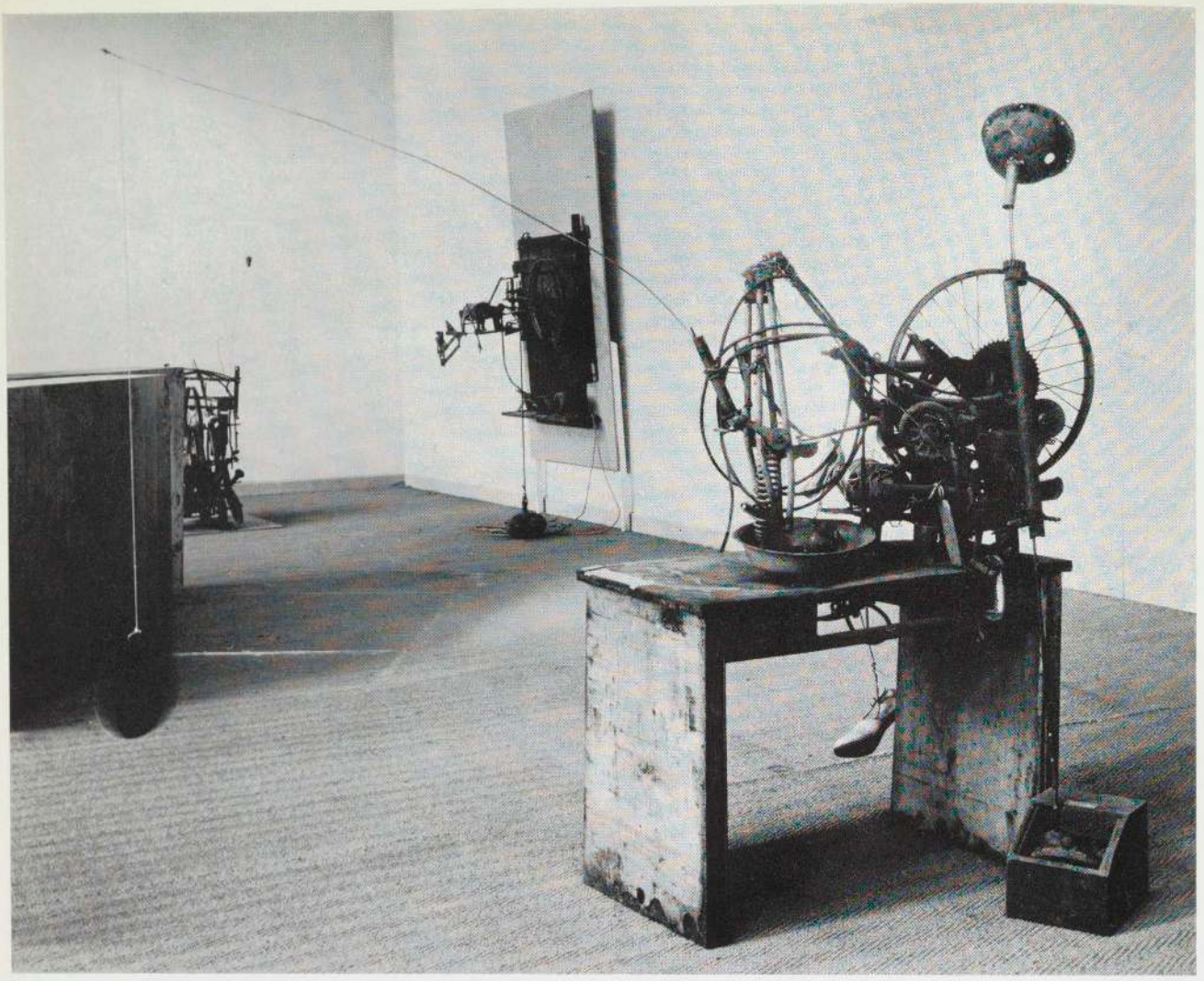
In the same way as a scientific experiment can never fail, this experiment in art could never fail. The machine was not a functional object and was never treated like one. The spectacle can therefore not be judged in terms of whether this or that thing did or did not work. During the construction of the machine, I was constantly amazed at Jean's disregard for the simplest rules of engineering. In one instant he would demand that something should function, and in the next he would violate his demand by the most trivial of actions. Jean worked as an artist. He chose his motors and put on his slings as an artist. He was interested only in functional operations that he could understand, so that he could reject or accept them as he pleased. But he was also inspired by the possibilities of engineering and realized that he could use them as long as he was in complete control of what he was doing. As an engineer, working with him, I was part of the machine. This new availability was largely responsible for the size and complexity of the machine.

Jean's machine was conceived out of "total anarchy and freedom," as he put it. The free and chaotic circumstances under which it was built were a necessity and, in a way, a tremendous luxury. Jean supplied the energy to create the freedom and was the ruler over the chaos. When the energy was released, everything that happened was related to some of Jean's decisions. No distinction can be made between the "random" elements, the accidents, or the controlled parts of the spectacle. It was created in its totality out of freedom and innocence. The bottles that did not fall, the paper roll that rotated in the wrong direction, the fireman, and the audience were all part of the same spectacle. There could exist no paradox, no question, no "nonsense," no a priori, and no chaos in this spectacle. It was a definite demonstration, made with love and humor, and not a philosophical problem.

I do not interpret the self-destruction of Jean's machine as an act of protest against the machine, or an expression of nihilism and despair, as some critics have suggested. The self-destruction or self-elimination of the machine is the ideal of good machine behavior. For anyone concerned with the relations between machines and human beings, this is an obvious truth. This idea has already been expressed by Claude Shannon in the "Little Black Box," in which, when you pull a switch, a lid opens and a hand emerges that throws the switch in the off position, whereupon the lid closes again over the hand.

Just as in every moment we see and experience a new and changing world, Jean's machine created and destroyed itself as a representation of a moment in our lives. The art of the museum is related to a past time that we cannot see and feel again. The artist has already left his canvas behind. This art then becomes part of our inherited language, and thus has a relation to our world different from the reality of the immediate now. L'art éphémère, *on the other hand, creates a direct connection between the creative act of the artist and the receptive act of the audience, between the construction and the destruction. It forces us out of the inherited image and into contact with ever-changing reality. In one of Jean's "manifestos," he says that we shall "be static with movement." We must be the creative masters of changing reality — which we are, by the definition of Man. The parts from which Jean's machine were built came from the chaos of the dump and were returned to the dump.*

Jean kept saying that he was constantly thinking about New York as his machine took form. There are probably many connections, the most obvious one being a machine that has rejected itself and become humor and poetry. New York has humor and poetry, in spite of the presence of the machine, whereas in a purely technocratic society the machine must always be a functional object. Failures of the machine can therefore never be allowed, because control is the necessary element of that society. It is when the machine must function at any cost that there can be no "Homage to New York."

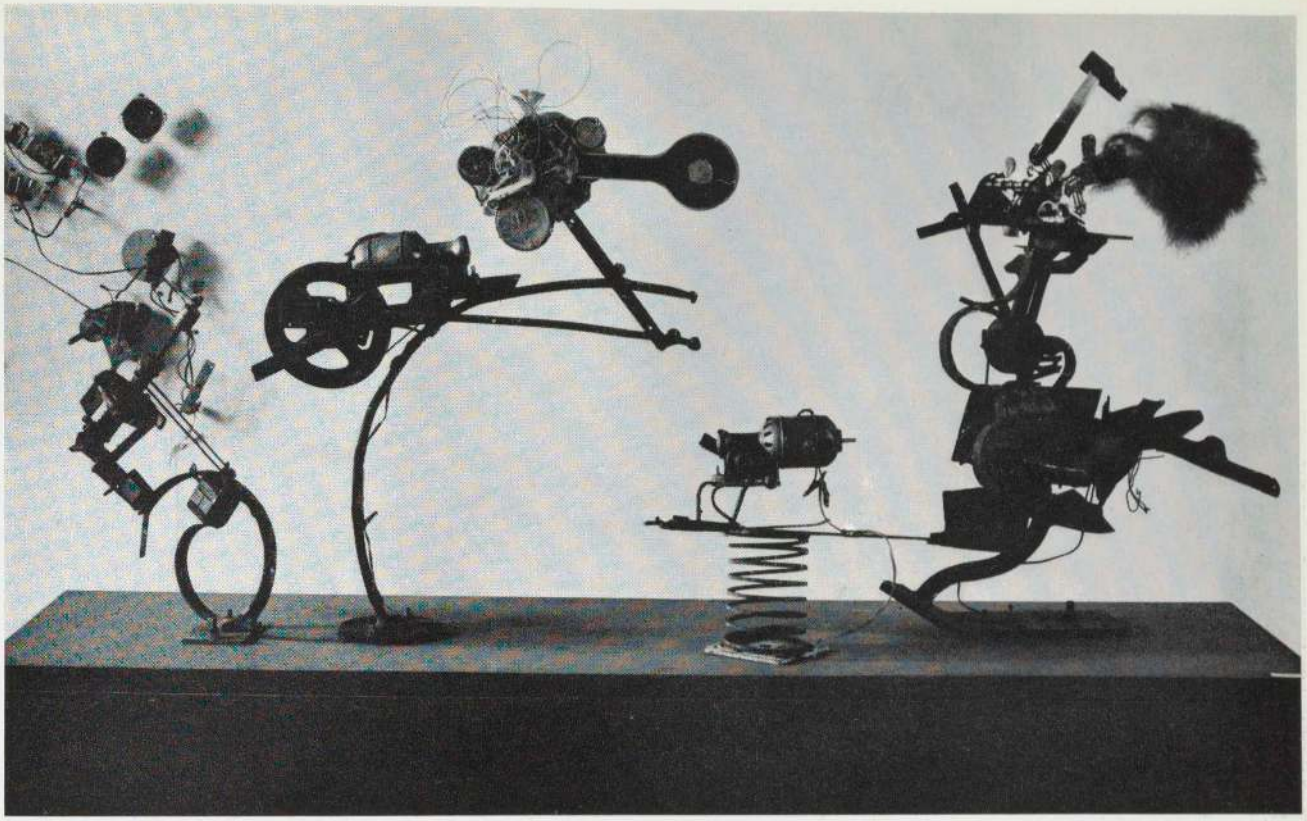


Jean Tinguely
Madame Lacasse's Shoe. 1960
Junk with motor, approximately 60″ high
Owned by the artist

This paroxysm of junk in motion is one of the most extreme of Tinguely's constructions from the early 'sixties. It is a ballet of poor, discarded scraps that have belonged to people's lives. The motion makes the pieces even more pathetic; they refuse to die, to lie still. The beautiful veneer of our civilization is penetrated, and the depths of destitution hidden beneath make gestures at us. It is somehow obscene. The junk seems more real than the new and shiny, partly because it is so marked by life. Even the mechanical parts are old and worn out.

The disc that dangles from the string is a ruined monochrome by Yves Klein, with whom Tinguely had collaborated in an exhibition held in Paris in 1958.[150] Obviously the disc is there to serve as a reminder of the way of all things.

At the time when Tinguely began to build machines of this kind, he was living on Walker Street in New York, close to Canal Street, the former headquarters and main outlet of the great American mechanical industry from the eighteenth century on. There were still many old shops with a glorious past dealing in machines and accessories. It would be a mistake to believe that Tinguely scorned them; it would be more correct to say that he loved them.



Jean Tinguely
Pop, Hop and Op & Co. 1965
Painted steel, toys, feathers, etc., with motor,
3′7¼″ high × 6′10⅝″ long
Owned by the artist

The industrialization of the New York art scene, where the journalists who write about culture expect movements in art to succeed one another like each season's fashions, is a phenomenon we have witnessed in recent years. Such mechanization of art history is all the more unnecessary, because it is totally unproductive and arises out of laziness and lack of imagination. Free expressions that have been created through individuals, reactions and inventiveness are forced into an artificial pattern of development, because it is easier to present them in that way. This mechanization is also part of the rapidly accelerated commercialization of art that has occurred in New York and elsewhere in the past few years. Art is viewed as a consumer product and sold on that basis; therefore, at the opening of every season a new model must be unveiled. Ultimately, these standards will lead to the destruction of art as the independent expression of an individual, for a society based on standardized values will not long tolerate the existence of an individualistic kind of art.

It is interesting to realize that an extensive flow of information, dissociated from any emotional involvement with art, can be as destructive as the lack of interest in it or the fear of free expression in a totalitarian state.

As a convinced individualist, Tinguely has observed this situation. The title of this work indicates his feelings about a kinetic art movement launched with the same fanfare as op art (whose title was the brainchild of *Time* magazine). "Hop" art, "mec" art, or as Hans Richter has called it, the "movement movement," would be a disaster for everyone who loves the possibilities of machines and has dedicated himself to the task of trying to understand them. As he does so often, Tinguely here uses the machine to express his opinion in an hilarious way.

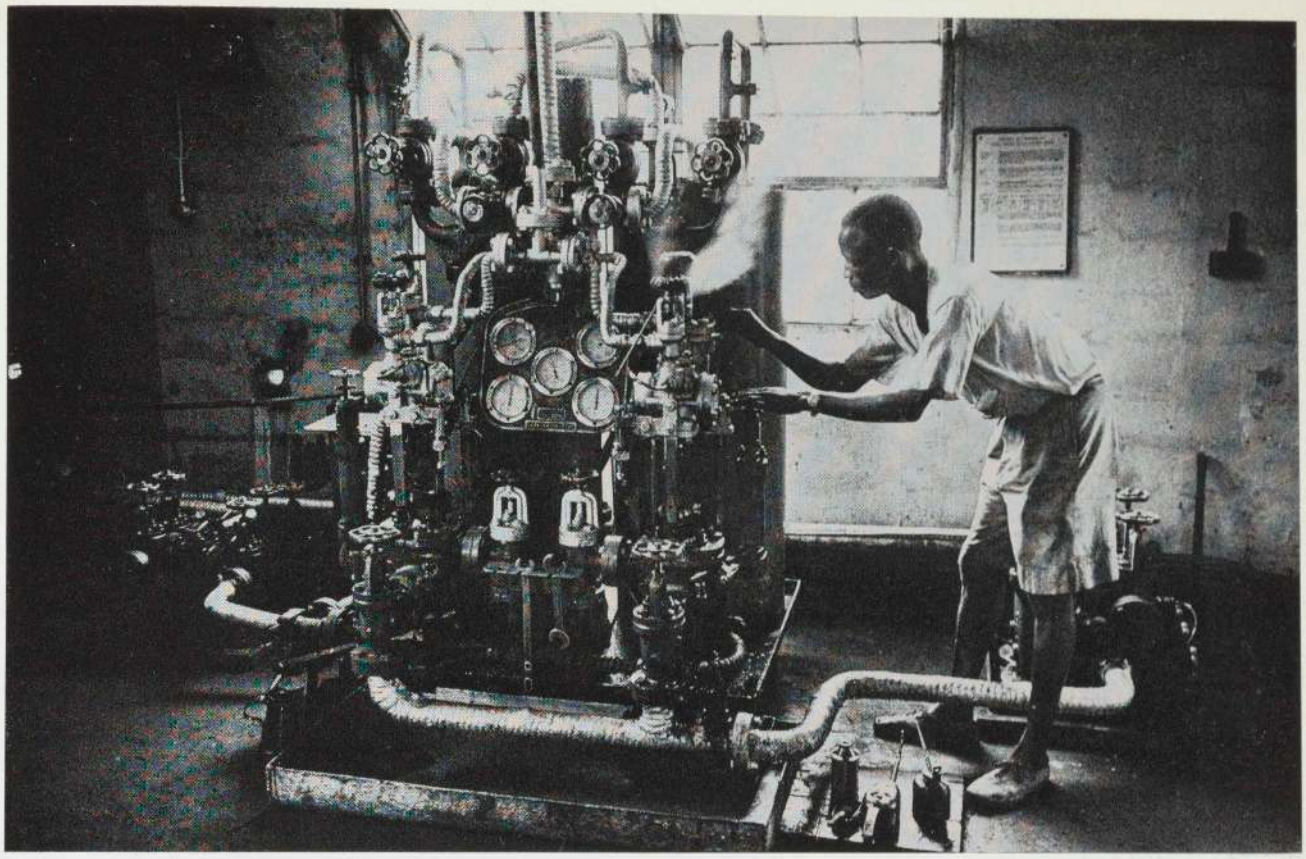
Jean Tinguely
Rotozaza, No. 1. 1967
Iron, wood, rubber balls, and motorized elements,
7′3″ high × 13′6″ long × 7′7″ deep
Owned by the artist

Tinguely has been preoccupied with the idea of the *Rotozaza* for several years; there are sketches for this first version dating from 1965. A main theme in his thinking throughout the 'sixties has been to ridicule the practical and "rational" side of the producing machine, and at the same time emphasize its beauty and flow. For many years he has been trying to find a department store that will let him fill its display windows with a series of machines that will systematically destroy the articles that it offers for sale.

The production of articles that nobody really needs, but which occupy the ground floors of all big stores, is one of the many outward symptoms of something basically wrong in a world of overproduction and undernourishment. In order to control overproduction, without going through the intricacies of selling the product, it becomes necessary for a wilfully destructive war to be going on permanently somewhere. Today, the world is spending over $150 billion per annum on the actual or potential destruction of lives and property, as compared with the capital transfer from rich to poor countries of about $10 billion per year — including a large share for military aid.

The *Rotozaza* is a producing machine with the process reversed. Instead of carrying away what the machine throws out, you have to throw it back in, because the machine demands it.

Because Tinguely loves machines, he hates to see them corrupted and cretinized by ruthless exploitation and greed. The cynical cycle of production for conspicuous consumption, built-in obsolescence, and expendability could hardly be better told than by the *Rotozaza* — the machine that immediately eats up its output. It is, among other things, an instead-of-war machine.



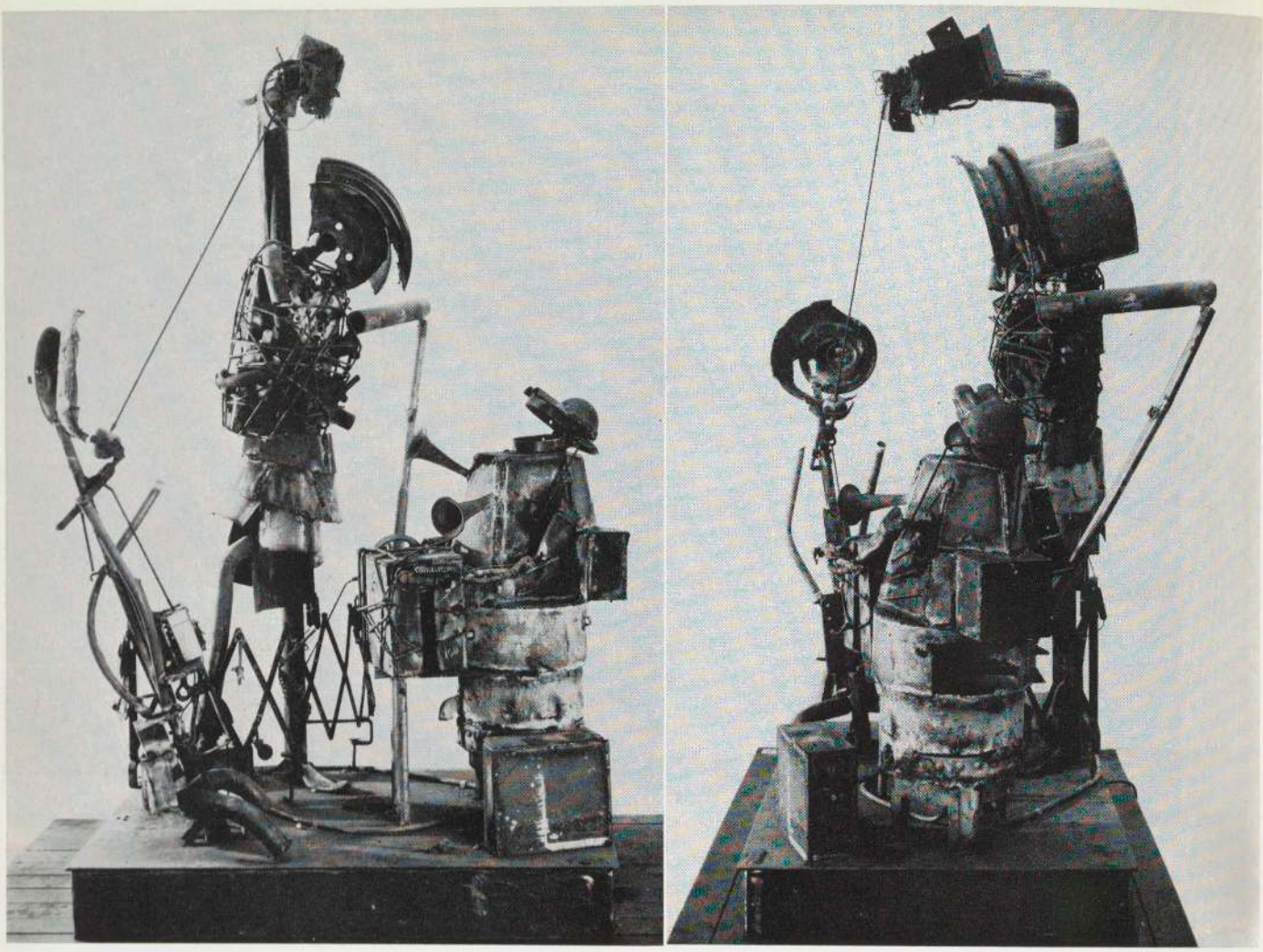
Ed van der Elsken. Dutch, born 1926

Nigeria 1960
Photograph, 7×9½″
Owned by the artist

Probably the greatest political problem facing the world today is the difference among various regions as regards their technological development. Many parts of Europe and America are already leaving the mechanical age to enter the electronic era, while much of Africa, for example, is only beginning to be industrialized.

To some extent, the mechanical age seems linked to the age of colonialism. Both reached their apogee in the nineteenth century; both were based on the instinct for exploitation. The world was prospected to discover and cultivate raw materials with which to feed the machines. It rarely occurred to the ruling powers that the people whose soil produced these materials, and who sweated to bring them forth, should have any appreciable use and benefit from the products. Whenever the natives made any serious trouble, the usual response was to send a gunboat.

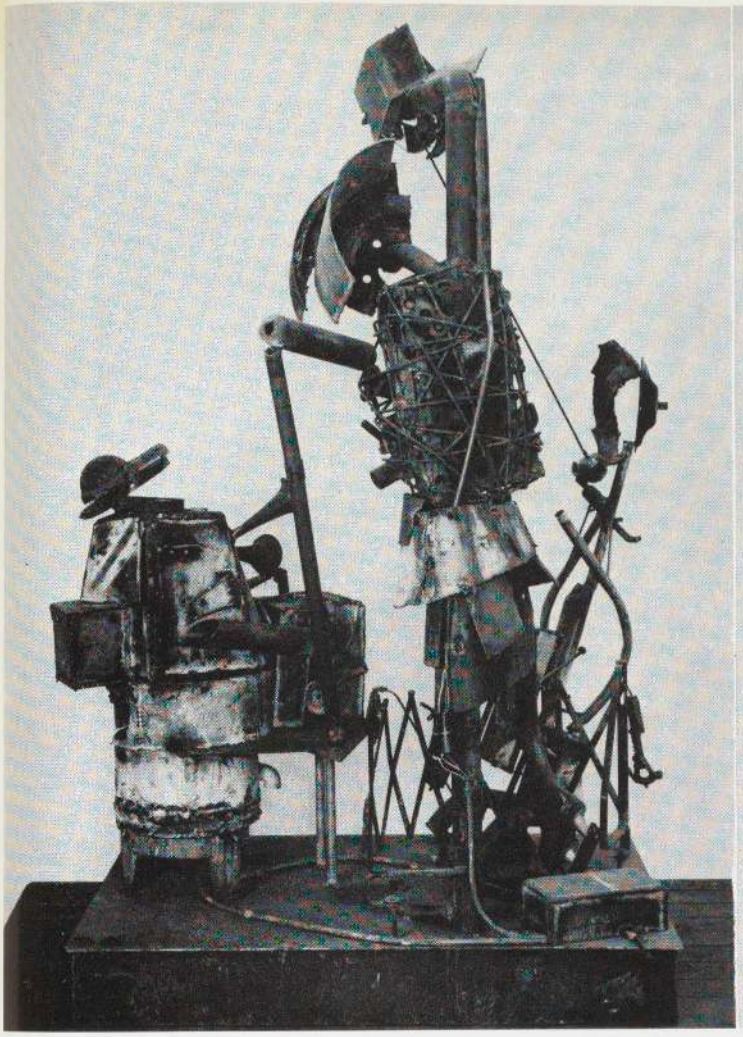
Up to 1950, there were four independent countries in Africa; today, there are more than forty. They are politically aware and highly nationalistic, but technologically extremely underdeveloped. Industrial output in all of Africa (except South Africa) is, in fact, less than that in Sweden alone. Unless foreign governments and private corporations unite with the African nations in a massive and long-range program of industrial development, the social and political results will probably be explosive.

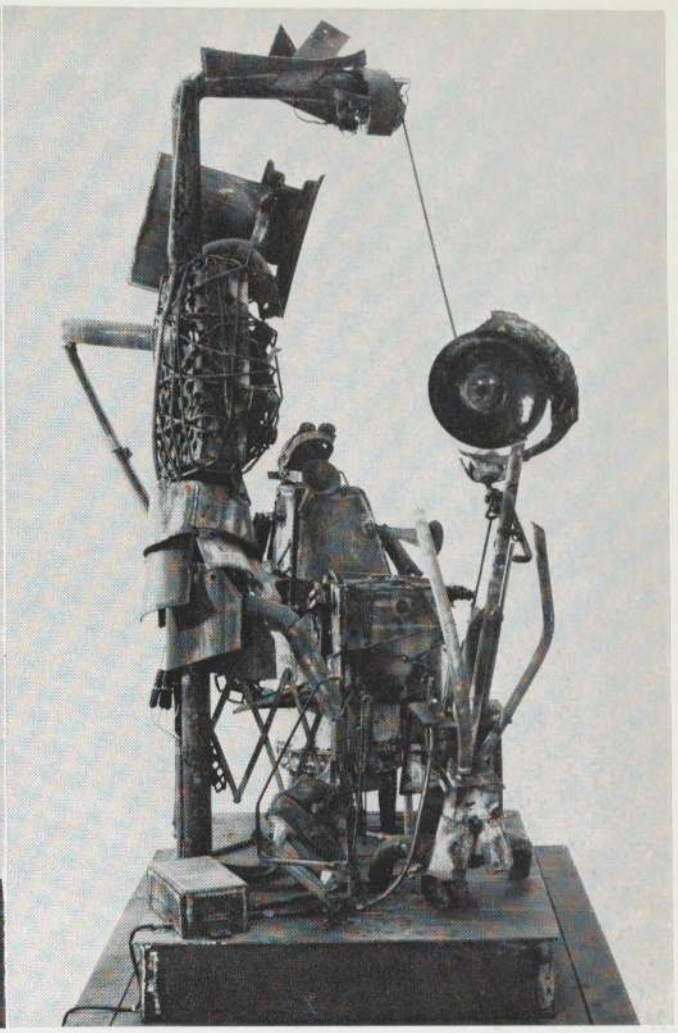


Richard Stankiewicz. American, born 1922
The Apple. 1961
Steel with motor, approximately 8′ high
Owned by the artist

About 1960, Richard Stankiewicz's "junk art" was as influential as the work of Robert Rauschenberg and Jasper Johns. This influence was perhaps felt more strongly in Europe than in America, following Stankiewicz's one-man show in Paris in October, 1960. His way of treating scrap iron introduced a completely new concept of materials into sculpture. He resurrected what had been thrown away or buried; he treated broken, rusted pieces of iron as though they were alive. There is little relation to the loving manner in which Schwitters had used discarded and downtrodden scraps in his *Merz* constructions (see page 116). Stankiewicz's approach is very direct: he awakens machine parts from their dreams and makes them come alive. Anything brought back to life in this way is frightful and menacing. Stankiewicz is apparently afraid of the power of machines; when they are smashed, their degraded strength seems even more frightening than before.

Stankiewicz's junk sculptures undoubtedly had a very strong impact on Tinguely, who saw them during his first

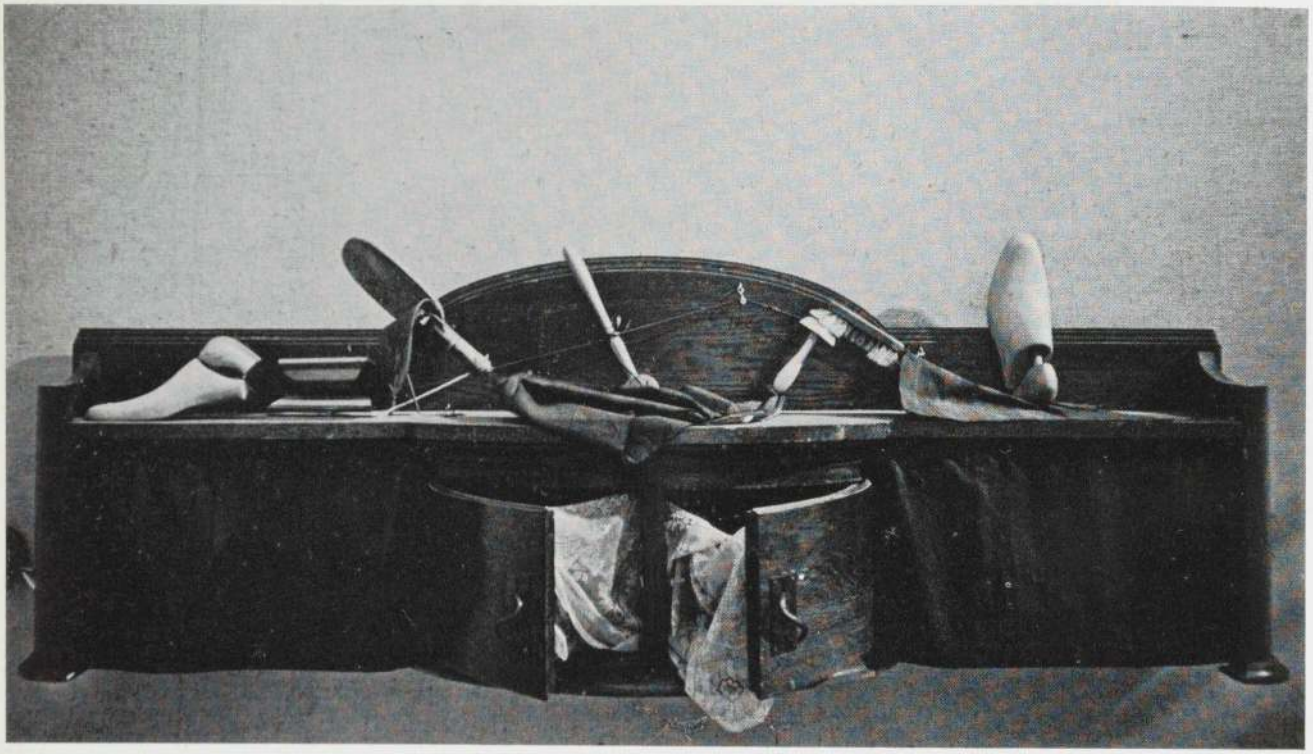




visit to New York in 1960. The two artists, however, use junk in strikingly different ways. Discovery of the possibilities inherent in scrap led Tinguely to an hilarious festival of joyful sloppiness in motion, and Stankiewicz to the creation of a series of fearsome statues that emanate horror and dread.

The Apple is the only one of his works in which Stankiewicz has used motion. This is actually a kind of anti-motion machine, for the motion continually demonstrates its own futility. When one puts money into the box, the tantalizing apple swings but is never caught. The noise of the machine's vain effort is so great that the floor trembles. When more money is put in, the apple swings again, the jaws snap, and the raucous noise is repeated. The more money, the more mechanical movement, and the more loudly voiced frustration.

When *The Apple* had its first showing in the "Motion in Art" exhibition at the Moderna Museet in Stockholm in 1961, the money collected in the box was used to pay for a big party for all those who had worked on the show.



Per Olof Ultvedt. Swedish, born Finland, 1927
. . . *life*. 1962
Wood, cloth, and motors, 21 5/8″ high × 66 1/2″ long
Moderna Museet, Stockholm

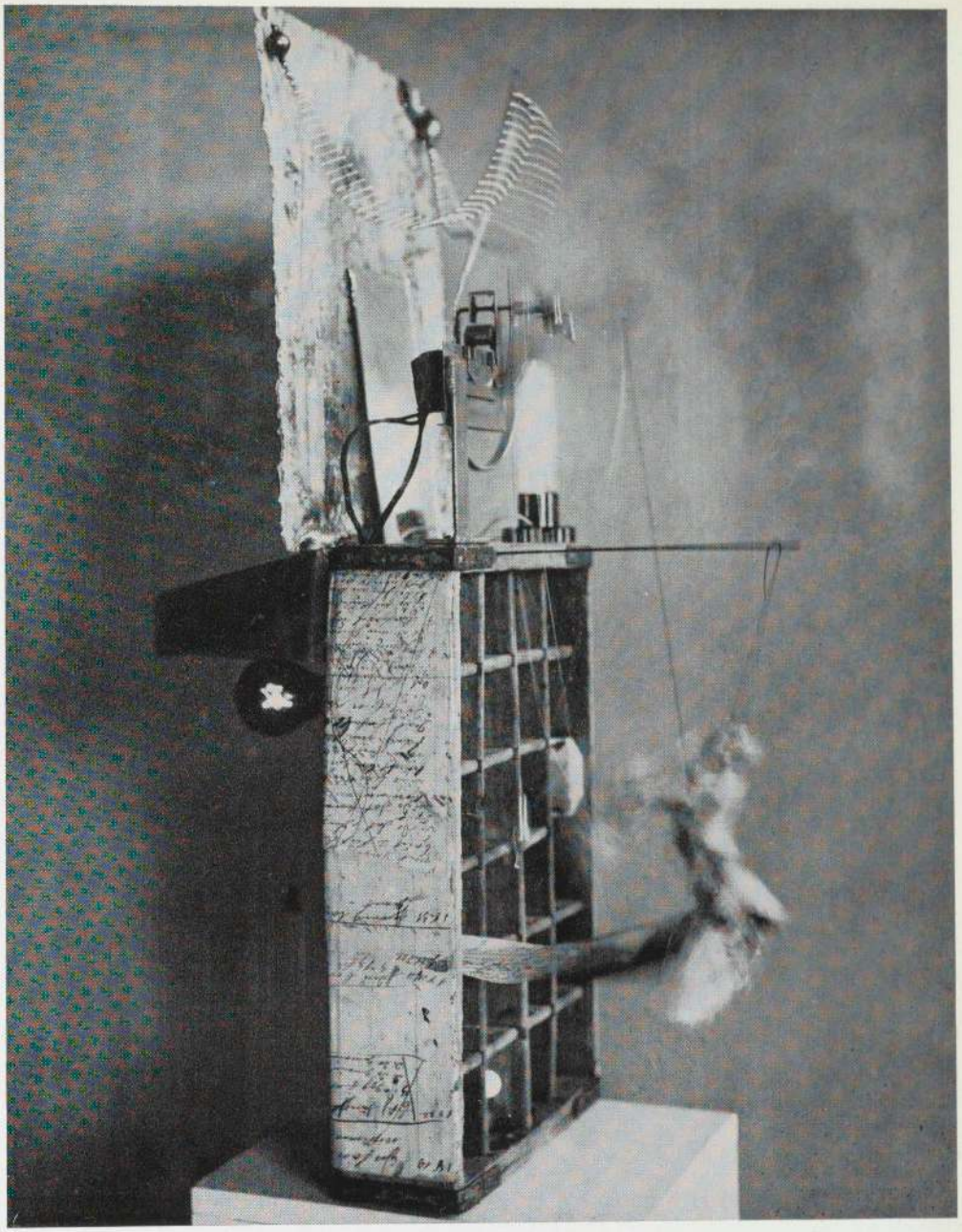
What most interests Ultvedt in machines is their capacity to produce motion. Movement has always been important in his art. His first mobiles were created in 1955 for a ballet in Stockholm. He had his first major exhibition there in 1957 and made a film for the occasion.

Ultvedt uses motion to make hidden things become apparent and to explain something in a surprising way. The secret life of common objects in revealed to be what we might have suspected all along, had we only thought about it.

Ultvedt loves machines because they allow him to avoid the arbitrary and yet give him perfect freedom for ambiguity. Their motion requires that the forms and elements in his pieces be shaped and placed in a definite way, to be able to perform. The machine imposes an order that is functional, not aesthetic. Ultvedt likes this idea because it means that his machines step over the borders of art into the world as a whole.

His pieces clearly lead a sex life of an indolent but persistent kind. The hidden tendencies of everyday objects at once astonish us and confirm our secret suspicions.

The title of this work is, of course, part of "still life."



Robert Watts.
American, born 1923
Pony Express
1960—1961
Wood, steel, polyethylene, brass, glass, motor, switches, and light bulbs, 34″ high × 15″ wide × 20″ deep
Moderna Museet, Stockholm

About 1960, Robert Watts used different kinds of small electric motors to activate very flimsy constructions, assembled from elements of Americana — mostly new, but some from the last century. In this object, the outside of a Coca-Cola crate has been covered with pages from a Pony Express account book. The movement of the ponies is the recurring motif throughout the composition. Everything combines to create a picture of bygone America. The renunciation of craft and efficiency is an ironic denial of the American dream. The lights flashing on and off bring Coney Island nostalgically to mind.

In these works of Watts, one recognizes a spirit like that of some Abstract Expressionist painters, especially Willem de Kooning and Jackson Pollock. They have a common concern with rediscovering American sources.

Watts, who is also an art historian, specializing in primitive, pre-Columbian, American Indian, and African Negro art, began as a mechanical engineer. The pleasure that he finds in using machines for private and irrational purposes is one of the main motivations of his work.

Ray Farhner. American, born 1925

Boot Hill Express. 1966

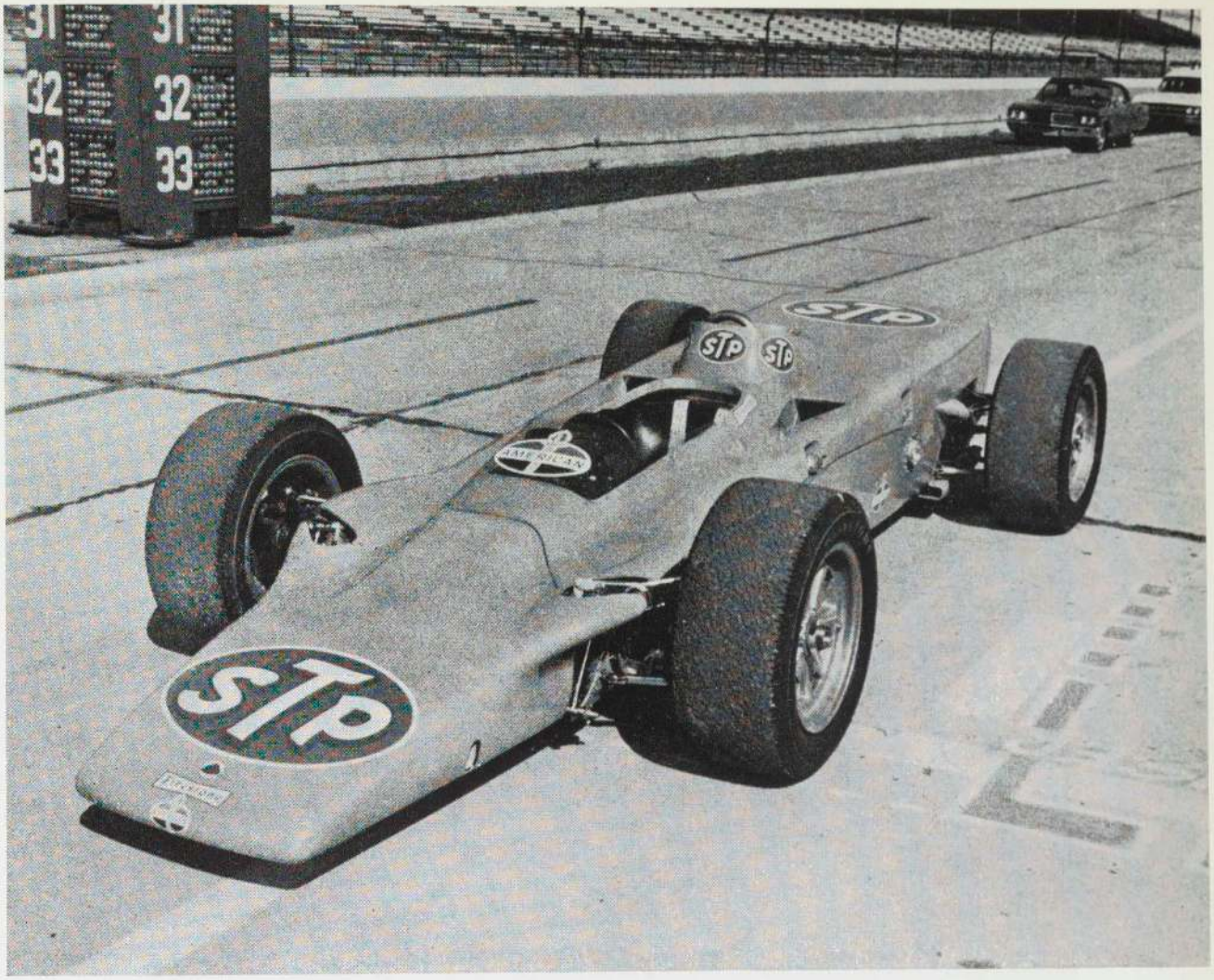
Antique horse-drawn hearse with 500 h.p. Chrysler Street-Hemi engine, 6′6″ high × 6′ wide × 12′6″ long

Owned by the artist, Raytown, Missouri

A machine that makes a comment on itself, its species, or its use becomes a highly charged object. Around the time of the First World War, the Dadaists introduced ironic self-criticism of this kind into their anti-art painting and sculpture. A similar, more recent statement is Claude Shannon's "Little Black Box." The box has a protruding handle that invites you to switch it on; when this is done, the lid opens sufficiently to allow a small hand to reach out from under it — and turn the switch off again! The object was mass produced and sold very well in novelty shops around Times Square and elsewhere. In this device, Shannon demonstrated the principle of feedback, one of the most important concepts in computer technology. Whether he was also inspired by Dada works is not known, but it seems very possible.

The *Boot Hill Express* was constructed from an antique hearse. By a reversal of time, the high-powered engine with which it is equipped is borne on its last journey by a formerly horse-drawn vehicle. Now that all mechanical machines are in a critical phase, the *Boot Hill Express* is an extremely powerful statement, commenting on the car as producer of death and disaster. The idea of built-in death has analogies with the reversal of the cycle of production and consumption that is the theme of Tinguely's *Rotozaza* (see page 174).

The hearse from which the *Boot Hill Express* was constructed was built over a century ago by the Cunningham Coach Works of New York. Besides the high-powered 1966 Chrysler Street-Hemi engine, components from many other cars, including an early Model-T Ford steering wheel, have been incorporated. The headlights and taillights are kerosene-burning lanterns from India. All metal parts are chrome plated, and the body is finished with over thirty coats of gold paint.



Anthony Granatelli. American, born 1923

Colin Chapman. British, born 1929

STP-Lotus Turbocar. 1968
Turbine-engine racing car
2′8″ high × 6′3″ wide × 14′2″ long
Owned by Anthony Granatelli, STP Corporation, Des Plaines, Illinois

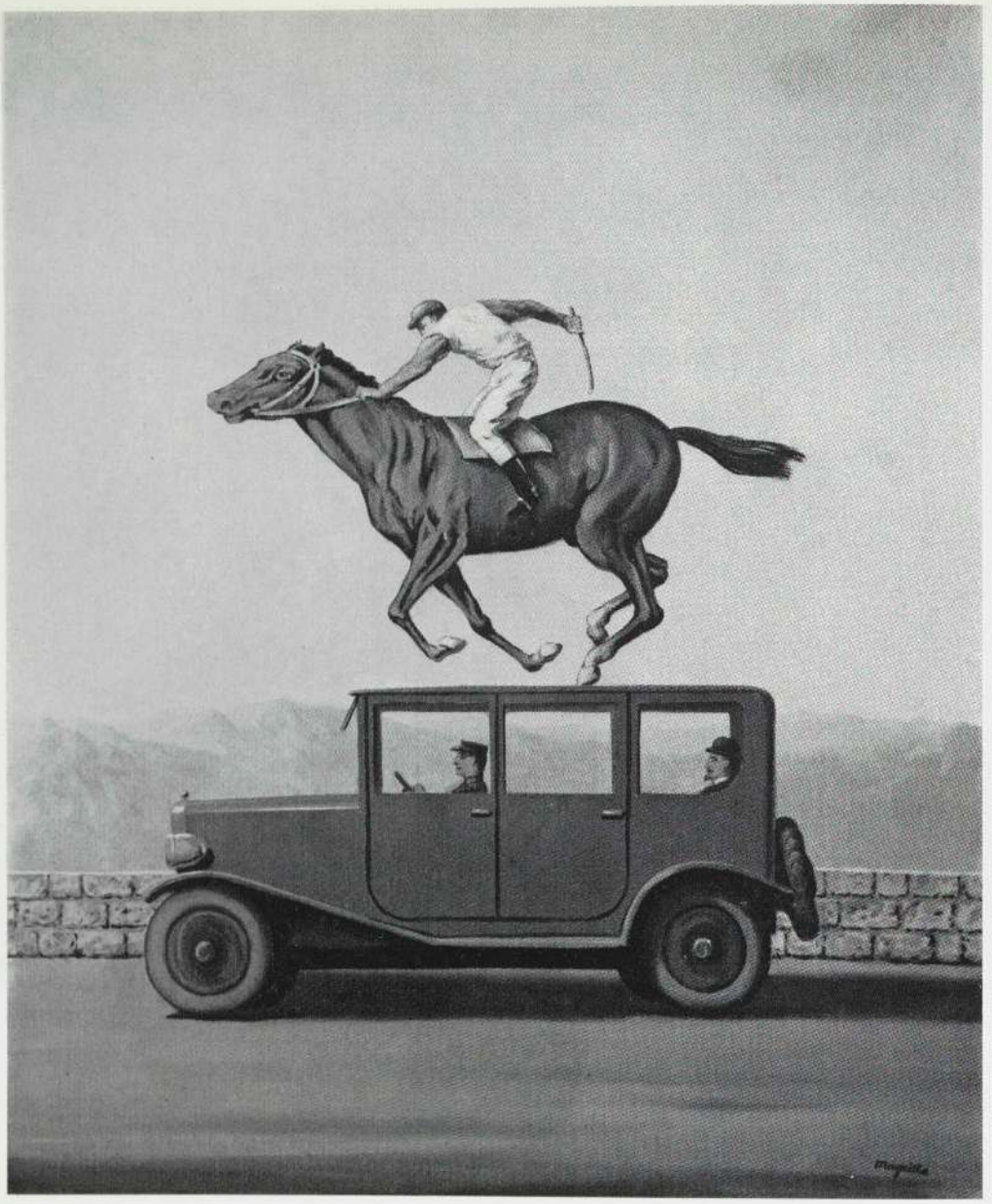
The modern racing car is a very remarkable object, on the borderline between technology and art. Although it has no practical use, it is extremely functional. No one who constructs a racing car would dream of modifying his design for the sake of aesthetics, yet many of the cars must be regarded as extremely beautiful. The racing car is the apotheosis of the great dream of the 'twenties — the beauty of the functional.

Modern racing no longer has any influence on the construction of passenger cars, as it did in Levassor's day (see page 44). Nowadays, inventions made for racing are little used, even in theory, by the automobile industry to develop better and safer cars.

In 1933, Buckminster Fuller in designing his streamlined Dymaxion Car (see page 143) adapted principles of airplane fuselages. The controversial STP-Turbocars incorporate a kind of engine that has been extensively used for aircraft, as well as for speedboats and trains.

Racing is a gratuitous activity — mechanics for the sake of mechanics, speed for the sake of speed. The racer and the artist have in common that they must achieve something entirely on their own. To do so, they must commit themselves without reserve, undistracted by hobbies (though there are artists who never miss an automobile race, if they can possibly afford to go).

In terms of mechanics, there is no greater luxury than a racing car. It is an object that pushes the possible as close to the impossible as one can come.



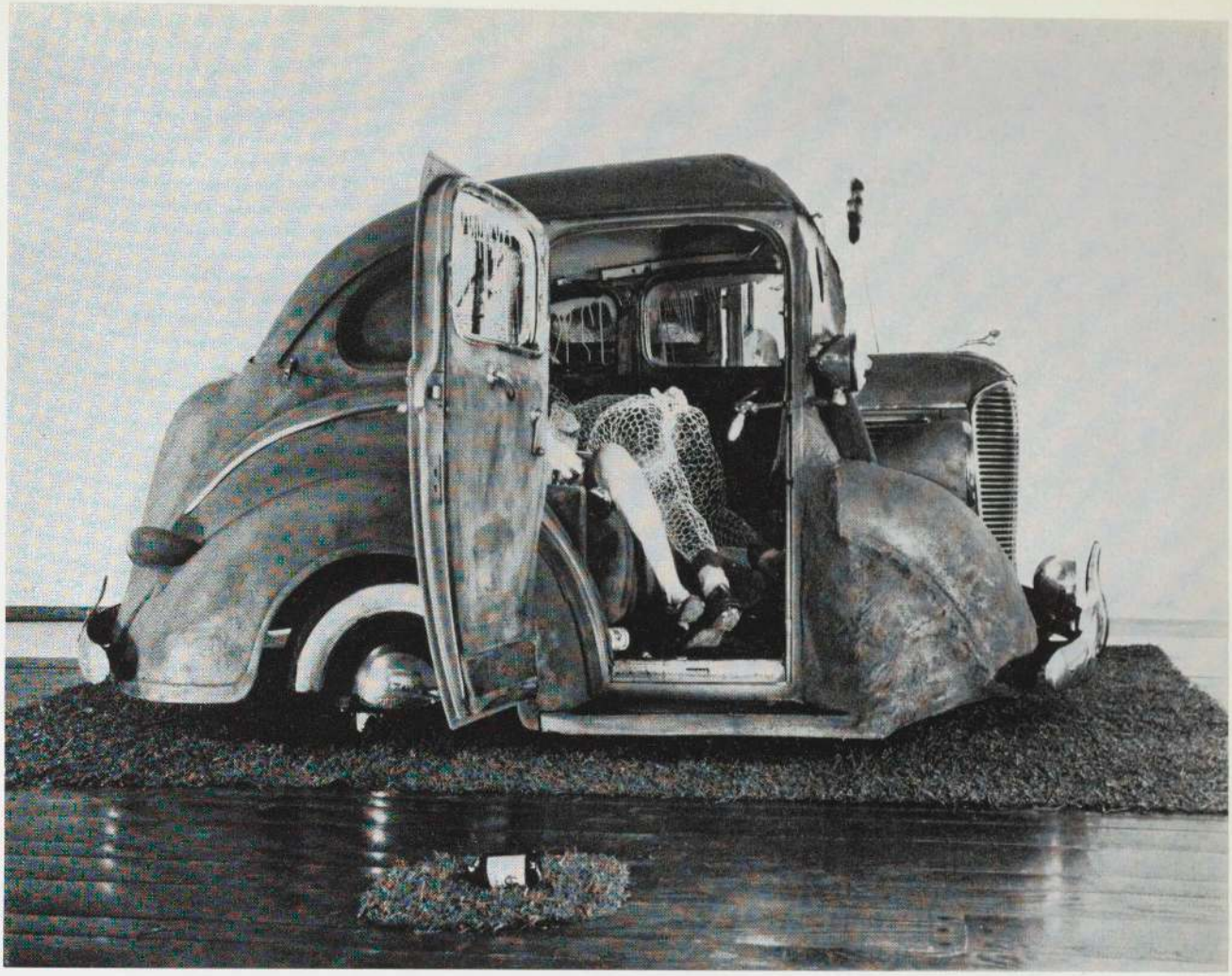
René Magritte. Belgian, 1898—1967
The Anger of the Gods. 1960
Oil on canvas, 24×19¾″
Collection Joachim Jean Aberbach,
Sands Point, New York

In his painting, Magritte characteristically adapts the Surrealist device of juxtaposition. He makes use of many different kinds of short-circuit techniques — which all result in light rather than darkness. When he says, "This is a pipe" or "This is not a pipe," it is, in a sense, either an obvious truth or an obvious lie. By such self-evident statements, he succeeds in bypassing the normal and making us see a mystery.

In *The Anger of the Gods*, Magritte has short-circuited two kinds of movement, mechanical and animal motion. He pitches us into the unknown. We suddenly ask ourselves the question, "What is movement, anyway?"

The easiest way to grasp the situation of the horse and jockey is to realize what happens when you run on an escalator. This only leads to the thought that all this is taking place on a rotating ball.

Still another mystery is why the car Magritte has pictured should be so old, and why it would not seem right if it were otherwise.



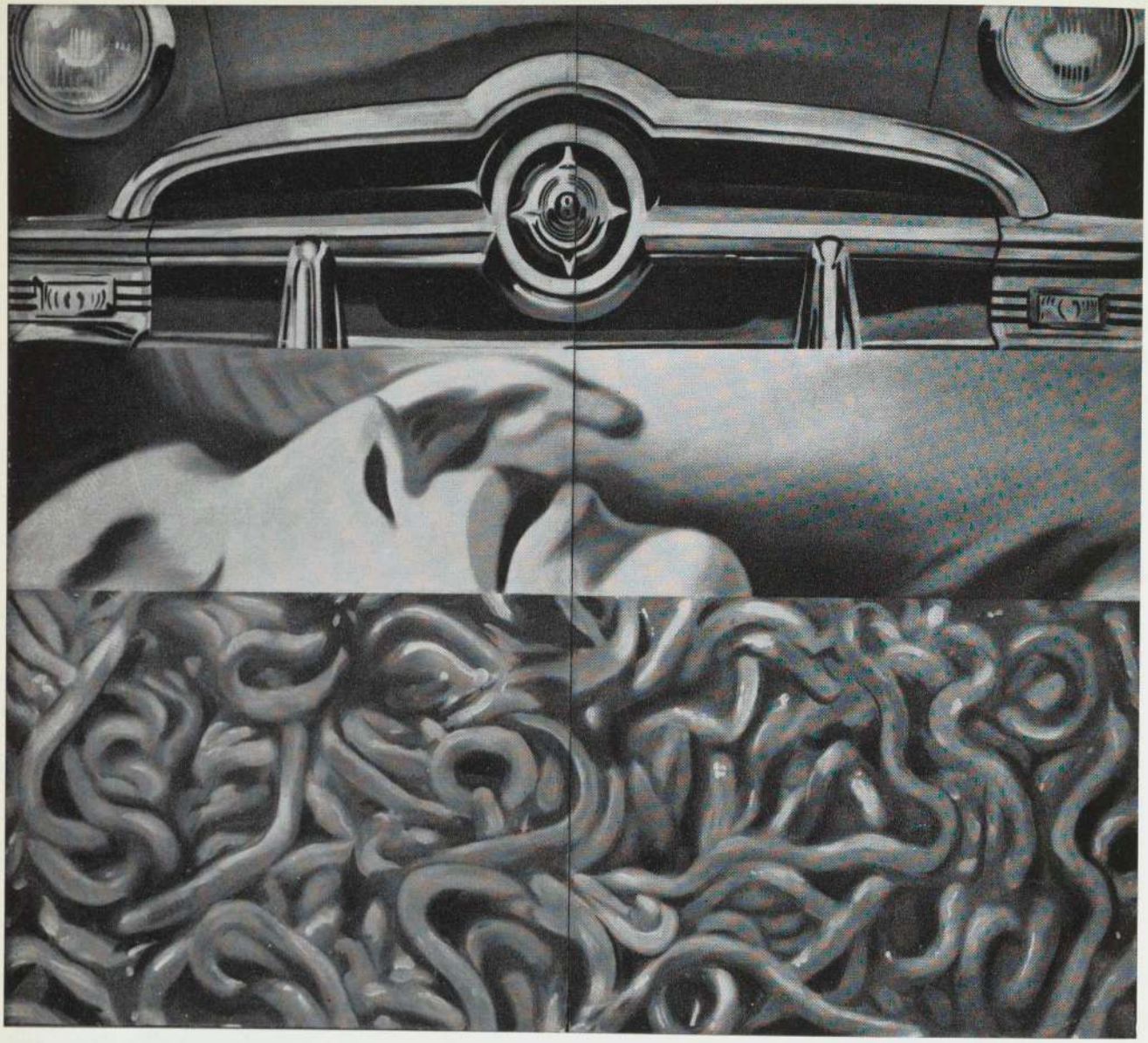
Edward Kienholz. American, born 1927
Back Seat Dodge —'38 (Tableau). 1964
1938 Dodge, plaster mannequins, chicken wire, artificial grass, Fiberglas, flock, and beer bottles, 5′6″ high × 12′ wide × 20′ long
The Kleiner Foundation, Beverly Hills, California
(courtesy of the Los Angeles County Museum of Art)

The basic thing about Los Angeles . . . was that it lacked the dimensions of time . . . There were no seasons there, no days of the week, no night and no day; beyond that, there was (or was supposed to be) no youth and age. But worst and most frightening, there was no past and future — only an eternal dizzying present. — Alison Lurie.[151]

In a city where death is not accepted as real, real life, too, becomes impossible. With his tableaux, Kienholz has forced people to recognize time and has given them a history, whether they want one or not.

Not only the model of the car, but also the brand names on the beer bottles, the style of the shoes, and the raccoon tail on the radio aerial all relate to the war years. John Steinbeck said that a generation of Americans was conceived in Model-T Fords. Kienholz is telling us that during the 'forties, cars like this one produced instead abortions and tears. Having become an accepted place for lovemaking, the cars themselves had become less innocent, and therefore less romantic.

All the qualities of Kienholz's tableaux are present in this passion-pit car. The doors of the car can be opened; when we look in, mirrors give back our own reflection. We are not looking here at some specimen in a nightmare museum devoted to the archeology of the near past; we become participants rather than mere spectators. "Kienholz involves the viewer, forces him into a confrontation with the present by forcing the past at him."[152]



James Rosenquist. American, born 1933
I Love You with My Ford. 1961
Oil on canvas, 6′10¾×7′9½″
Moderna Museet, Stockholm

In Rosenquist's painting, as in Kienholz's tableau, the car, lovers, and tragedy are again associated. Disaster is here made still more explicit through the motif that at first sight creates the strongest visual impression — the bloody spaghetti (or viscera drenched in tomato sauce). The title poses the question: Can you truly love with a car without killing? There is something profoundly disquieting in the composition's strictly horizontal arrangement. The omnipresent violence that dominates the world of cars subjugates everything into deathly stillness.

Much pop art of about this time was an effort to come to terms with life in modern cities. Shortly before, the Abstract Expressionists had concentrated their interest on the extraordinary capacities of the individual; but they had left him like a king without a country, with all everyday problems excluded, and therefore unsolved.

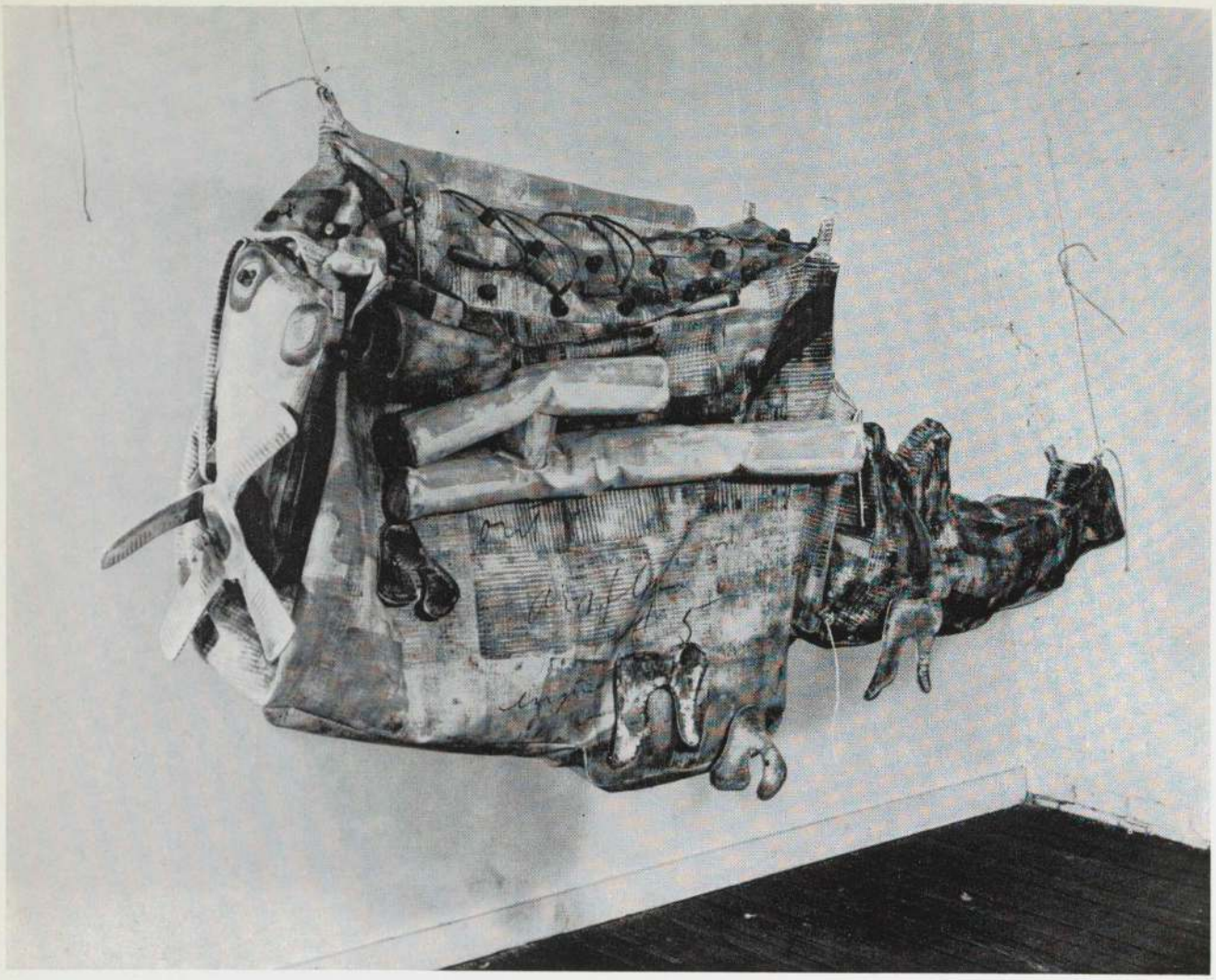
Rosenquist deals with mass products, such as cars (which are frequent in his pictures) in an uncritical way, to the extent that he does not transform them. He depicts cars very much as they actually are, and always in their original size. By juxtaposing them with other elements, often out of scale, as here, he makes us see them more clearly and, at the same time, as mysteries. Their outer aspect is always close to reality and almost always frightening.

César **(César Baldaccini)**
French, born 1921
The Yellow Buick. 1961
Compressed automobile,
59 1/2″ high × 30 3/4″ wide
× 24 3/4″ long
The Museum of Modern Art,
New York
(gift of Mr. and Mrs. John Rewald)

César's compressed cars play skilfully on our feelings for the automobile: the sculptural symbol of our mobility, the very machine with which most people come into intimate daily contact, and on which our present way of life in Western society is based. César shows us this relatively free and individualistic moving machine transformed into an unsculptural, completely static volume, which is still more unmovable because of its great weight. Small traces of its former individuality — its license plates and color — lie frozen on its surface like fossils embedded in stone.

The death that we here contemplate is that of the car itself. Evolution in the field of car destruction has been very rapid. The "Big Squeeze," the American hydraulic press that compresses cars into blocks, already seems to belong to our latter-day archeology. The compressed cars that César chose and used as a kind of readymade may soon perhaps be the only ones in existence. The "Big Squeeze" is no longer practical and has been superseded by a new, also very beautiful, method of destroying automobiles. Condemned cars are slowly brought up against a huge, fast-moving fan and splintered into small particles, which can then be easily sorted according to materials. The blades of the fan are of high-grade steel, but what really makes them function is the tremendous speed at which they rotate.

The evolution is a logical one. It seems far more appropriate for an object of motion to be destroyed by a confrontation with supermotion than by congealing it into its opposite, inertia.



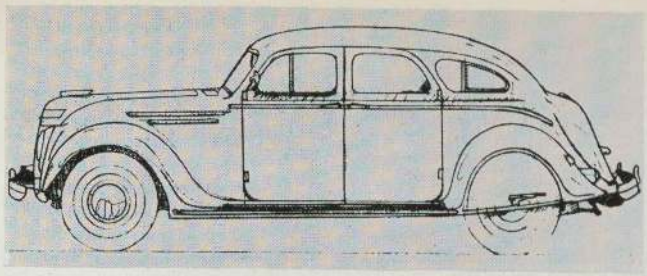
Claes Oldenburg. American, born Sweden, 1929
Airflow (Number 6), Soft Engine. 1966
Stenciled and painted canvas with kapok stuffing,
$53\frac{1}{8}$″ high × $71\frac{7}{8}$″ long × $17\frac{3}{4}$″ deep
Collection Dr. Hubert Peeters, Bruges

"My softening is not a blurring (like the effect of atmosphere on hard forms) but *in fact* a softening, in a clear strong light. *A perception of mechanical nature as body.*"[153]

The Airflow is the most ambitious of all Oldenburg's "soft" projects. He has been working with the theme on and off since 1966 and has gone about the project of a soft car with what is, even for him, unusual care. It is easy to imagine how tempting was the idea of creating a soft version of so hard and incorruptible a machine, and how much anxiety underlay the effort. It seems significant that Oldenburg should have chosen a car from the period when they may have commanded even more attention than they do now. The Chrysler Airflow of the mid-'thirties was the first commercial streamlined automobile. It was designed by Carl Breer, father of one of Oldenburg's friends, the sculptor and film-maker Robert Breer (see page 192). On a visit to Carl Breer in Detroit in January, 1966, Oldenburg saw and studied in great detail a 1936 Airflow, one of the few still in existence.

"The Airflow is imagined as a place with many different sized objects inside it, like a gallery, a butcher shop, like The Store — and could be just as inexhaustible a subject. Science/fiction. Auto-eroticism. I am a technological liar."[154]

Among the sources of inspiration for the Airflow is a text on Walt Whitman by D. H. Lawrence, which Oldenburg inscribed on one of his numerous preparatory draw-



Claes Oldenburg
Airflow Profile (working drawing for sculptural print). 1968
Enlarged photographic print of pen and ink drawing, reworked, 24×60″
Owned by the artist

ings. Lawrence strongly attacks Whitman for his unclear, all-embracing, overwhelming, and all-consuming ways ("Whoever you are, to endless announcements —/ and of these one and all I weave the song of myself"). Lawrence identifies these qualities as American and has a strange, strong vision of Whitman as a man in a car:

He was everything
and everything was in him. He drove an automobile with a very fierce headlight, along the track of a fixed idea through the darkness of this world. And he saw Everything that way. Just as a motorist does in the night.

I, who happen to be asleep under the bushes in the dark, hoping a snake won't crawl into my neck; I, seeing Walt go by in his great fierce poetic machine, think to myself: What a funny world that fellow sees!

ONE DIRECTION! *toots Walt in the car, whizzing along it.*

Whereas there are myriads of ways in the dark, not to mention trackless wildernesses. As anyone will know who cares to come off the road, even the Open Road.

ONE DIRECTION! *whoops America, and sets off also in an automobile.*

ALLNESS! *shrieks Walt at a cross-road, going whizz over an unwary Red Indian.*

ONE IDENTITY! *chants democratic En Masse, pelting behind in motorcars, oblivious of the corpses under the wheels.*

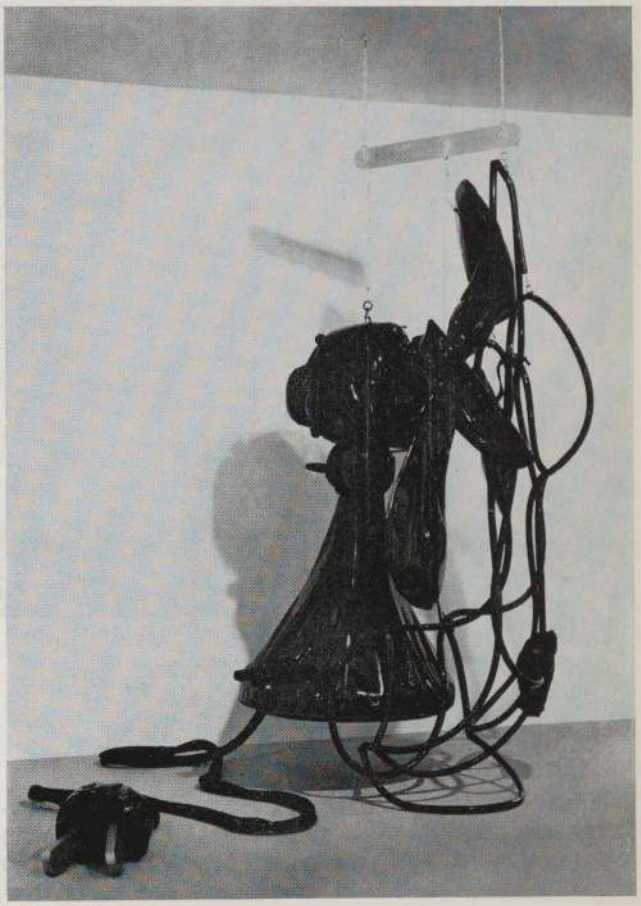
God save me, I feel like creeping down a rabbit-hole, to get away from all these automobiles rushing down the ONE IDENTITY *track to the goal of* ALLNESS![155]

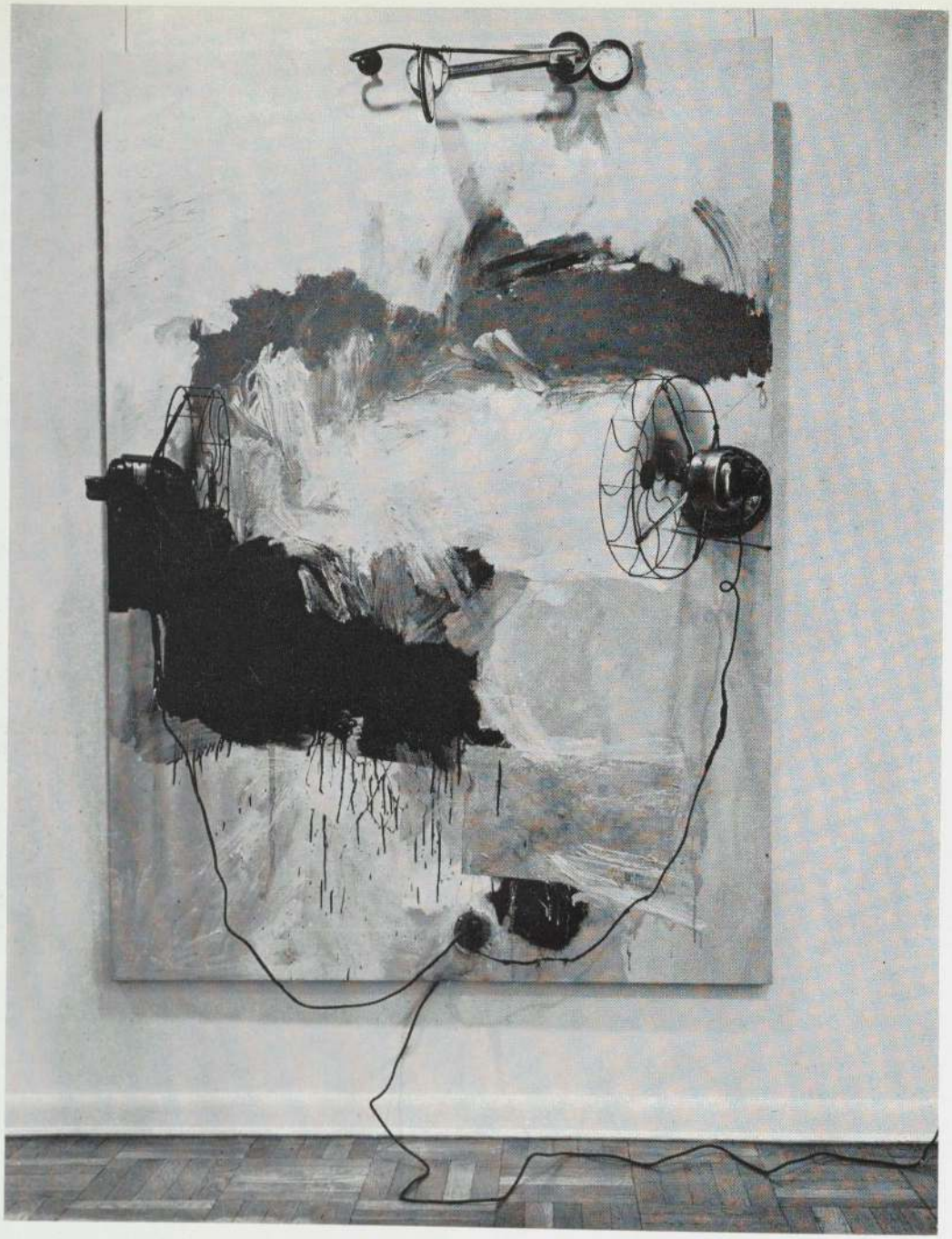
Claes Oldenburg
Giant Soft Fan. 1966—1967
Vinyl, wood, and foam rubber, 10′ high×8′5¼″ wide ×7′9⅞″ deep, including plug
The Museum of Modern Art, New York
(The Sidney and Harriet Janis Collection; fractional gift, 1967)

For several years, Oldenburg has been working on a series of imaginary monuments for specific sites. The *Giant Soft Fan* originated in a projected monument for Times Square — a Banana. When the banana is peeled, you get the four wings of the fan. This manner of conception is typical of the way in which Oldenburg works in gliding meanings. The metamorphosis is carried still further: situated on Bedloe's Island in New York harbor, "The Fan replaces the Statue of Liberty. This is to make you *feel* the large version of the object — i.e. *feel* the Fan the way one feels the Statue of Liberty. It's that heavy, that tall. (There is a resemblance: the base of the Statue of Liberty is somewhat like a fan base; she has this spiked ornament.)"[156]

Oldenburg's first soft fan was made in 1965. He has stated that: ". . . the interest has always concentrated for me on the cage — softening such a structure . . . Removal of the planes (which is what cage is about) results in marvelous spatial confusion, since line only thing left — has no dimensions."[157] This seems in a way to be the opposite of Gabo's "constructed heads" (see page 106).

The *Giant Soft Fan* was first exhibited suspended from the top of the Buckminster Fuller dome for the United States Pavilion at Expo '67, "which may make it a representative object."[158]





Robert Rauschenberg. American, born 1925
Pantomime. 1961
Combine painting: oil on canvas with electric fans, 7 × 5′
Leo Castelli Gallery, New York

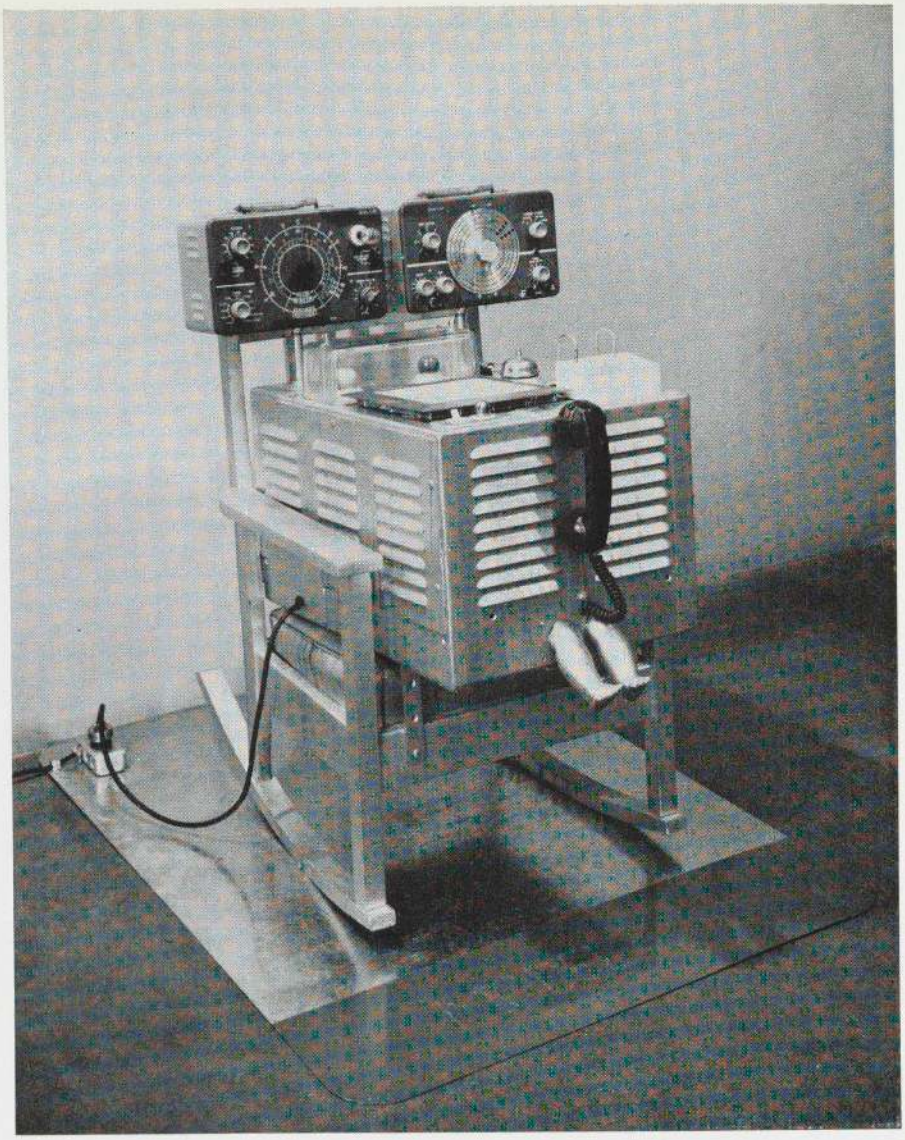
In his "combine-paintings," Rauschenberg consciously explores the no-man's land between art and life. In many of them, he uses technical devices to involve the surrounding space. Some, for example, incorporate radios, whose sound fills the space of the room. The sound belongs both to the piece and to "life." Others contain electric lights that serve the same purpose.

The play of the two fans in *Pantomime* is one of the subtlest uses of mechanical means in a work of art. The two currents of air move over the painting behind them, keeping it fresh and in constant relation to the atmosphere of the room. The display of electric cords connects the work of art to the current of life.

Robert Rauschenberg (artist)
Billy Klüver. Swedish, born 1927 (engineer)
Oracle. 1965
5-part construction: sheet metal with iron, rubber tires, glass fragments, batteries, wire, electrical and electronic components, 59″ high × 57″ wide × 24″ deep;
62″ high × 57″ wide × 35″ deep;
71″ high × 46″ wide × 23¾″ deep;
56″ high × 40″ wide × 23″ deep;
62″ high × 91″ wide × 17″ deep
Leo Castelli Gallery, New York

Oracle is one of the first large-scale projects in which an artist and an engineer collaborated to construct a technically complex work. Its antecedent was one of Rauschenberg's combine-paintings of 1959, *Broadcast,* in which he used radios. Wishing to achieve a situation in which the relationship between object and spectator was less restricted, he conceived the idea of developing the project in three-dimensional objects. Three years of interrupted experiments with the radio system in collaboration with Billy Klüver followed. New technical possibilities that presented themselves during the evolution of the work were incorporated into it. The progression from Rauschenberg's original "combine" idea into an increasingly advanced technology seems to indicate the direction that collaboration between artists and engineers is likely to take in the future.

The underlying theme of *Oracle* is openness and contact with the city. The components of the five sculptural pieces all come from New York, as does also the sound emitted by the five different radios. The five parts are self-contained and may be rearranged at will. The work is like a concentrate of the city situation, characterized by the accidental mixture of sound, mobility, freedom, and at the same time mutual interdependence.



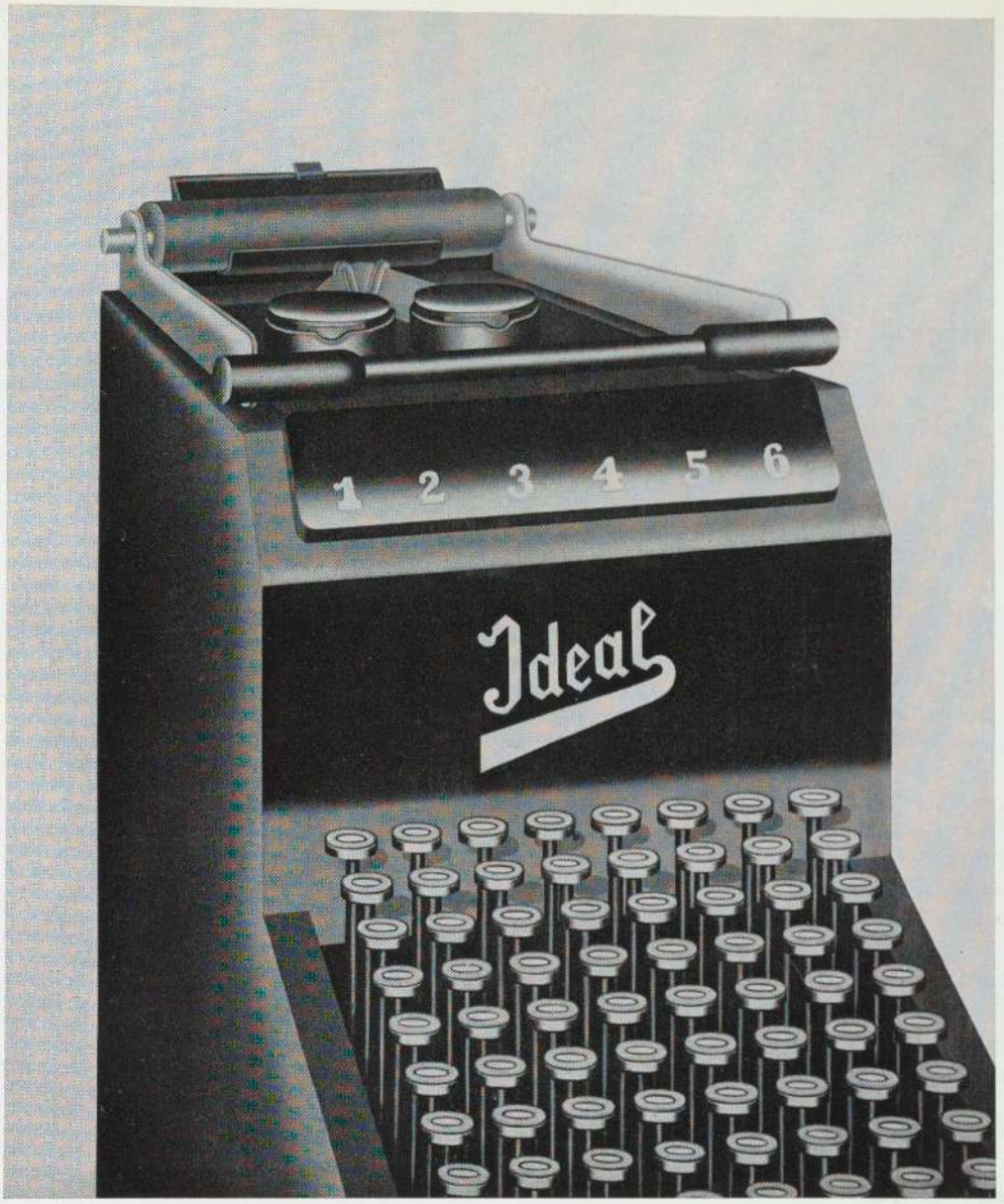
Edward Kienholz
The Friendly Grey Computer — Star Gauge Model 54. 1965
Motorized construction:
rocking chair, doll's legs,
metal case, instrument boxes,
lights, switches, panel with numbers,
index cards, instruction sheet,
and telephone receiver,
40″ high × 39 1/8″ wide × 24 1/2″ deep,
on aluminum sheet 48 1/8 × 36″
The Museum of Modern Art,
New York
(gift of Jean and Howard Lipman)

The computer has captured our imagination more than any other technological advance of our time. The latent fear manifested in early pictures of machine-people, such as those by Bracelli and Petitot (see pages 18—19) has been reborn, but now machines seem even more frightening. Articles in newspapers and magazines continually throw into our faces reports of the super-human speed of the computer's calculations, its infallible memory, its accuracy. Mechanical devices merely replace muscular power, but the new devices challenge the very capacities that man has regarded as making him supreme and unique — his ability to think, his brainpower.

A folklore has rapidly developed about the computer. It has become a wonder child, capable of answering any question, solving any problem. As he does so frequently, Kienholz here makes use of modern folklore. His mood, though still sardonic, is gentler than in the grim *Back Seat Dodge—'38* (see page 183). His directions for operating *The Friendly Grey Computer* advise us:

Flashing yellow bulb indicates positive answer. Flashing blue bulb indicates negative answer. Green jewel button doesn't light so it will not indicate anything. Computers sometimes get fatigued and have nervous breakdowns, hence the chair for it to rest in. If you know your computer well, you can tell when it's tired and sort of blue and in a funky mood. If such a condition seems imminent, turn rocker switch on for ten or twenty minutes. Your computer will love it and work all the harder for you. Remember that if you treat your computer well it will treat you well.

Kienholz kindly programmed the computer to give more "yes" than "no" answers. A question random-found on a card: "Will I ever get a boyfriend?"

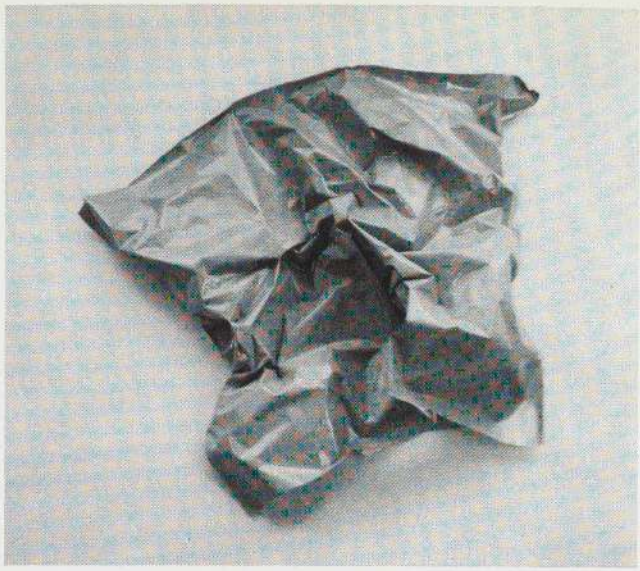


Konrad Klapheck. German, born 1935
Ideal Husband (Der Mustergatte). 1964
Oil on canvas, $59\frac{1}{8} \times 51\frac{1}{4}''$
Collection P. Janlet, Brussels

Klapheck's personified machines are a reminder that Freud regarded all the manufactured articles that surround us as sexual symbols. They can be divided into male or female. In Klapheck's well-dusted world, the typewriter is male, because "all the most important decisions of our lives have been taken over by it. It has become a substitute for the father, the politician, the artist."[159]

"With the help of the machine, I can draw things out of myself that were previously unknown to me; it compels me to yield up my most secret wishes and innermost thoughts."[160]

The world of Klapheck's machines seems somewhat similar to the society, rooted in ceremony and established convention, that Luis Buñuel has described and revolted against in his film *L'Age d'or* (1930). In such a milieu, people are so indoctrinated that their behavior can be predicted with nearly complete certainty. They react like automata; a given stimulus will almost invariably produce a given reaction. It is a world of human machines, each fulfilling its so-called tasks, regardless of what these may lead to in terms of good or evil. Klapheck has discovered what they are up to and is observing them.



Robert Breer. American, born 1926

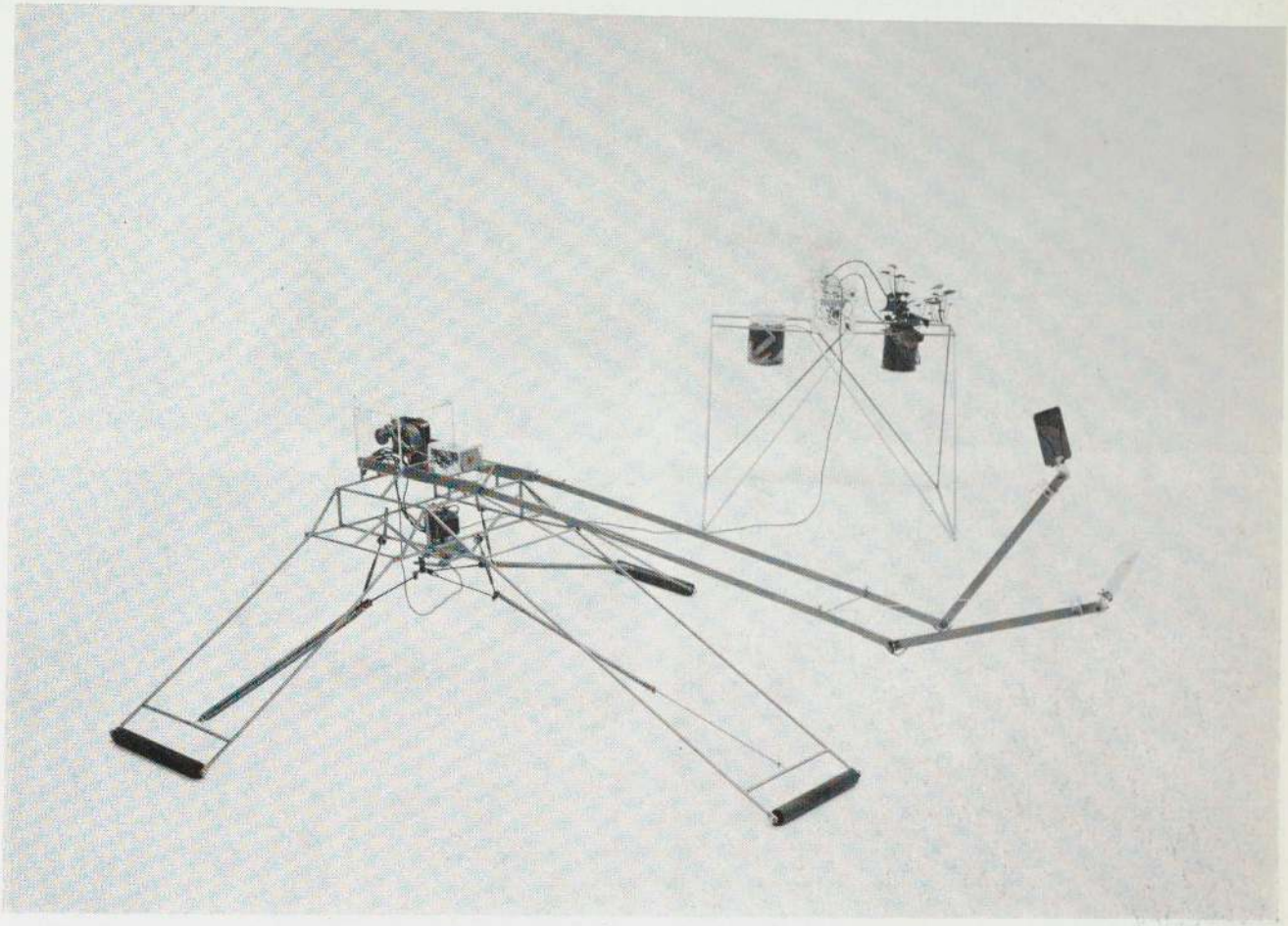
Rug. 1967

Kinetic sculpture: plastic sheet and battery-driven metal wagons, 3″ high × 36″ wide × 48″ deep

Moderna Museet, Stockholm

The functioning of hidden mechanisms has become as interesting for artists in the 'sixties (for example, Ultvedt, page 178; Shannon, opposite) as the display of mechanical parts was a few years earlier. We have come full circle to concealing mechanism, as Vaucanson and Jacquet-Droz did in their automata (see pages 20—21). In fact, the philosophical problem of distinguishing what has been created by God or nature, and what has been created by man, is identical. Breer has said of *Rug:* "The only way I can think of it in relation to a machine is that since it's not an animal, it must be a machine."

In *Rug*, the interaction of the rational motor and the non-rational forms seems an accurate way of portraying the conditions of our existence. When we want to see the motors of our cars, we are used to raising hard hoods. Here, the artificial yet somehow organic-looking, soft, metal-colored, plastic material presents a contrast to the metal motors we suspect are hidden under it. Our reactions are ambivalent. We feel incapable of stopping the inexorable, uncompromising movements of the rug; its determinism repels us and inspires a vague uneasiness. At the same time, we could easily handle the light material and small-sized rug. We become inclined to protect this helpless creature. The conflict grows acute and complete; as so often, we oscillate between disgust and sympathetic inclination.



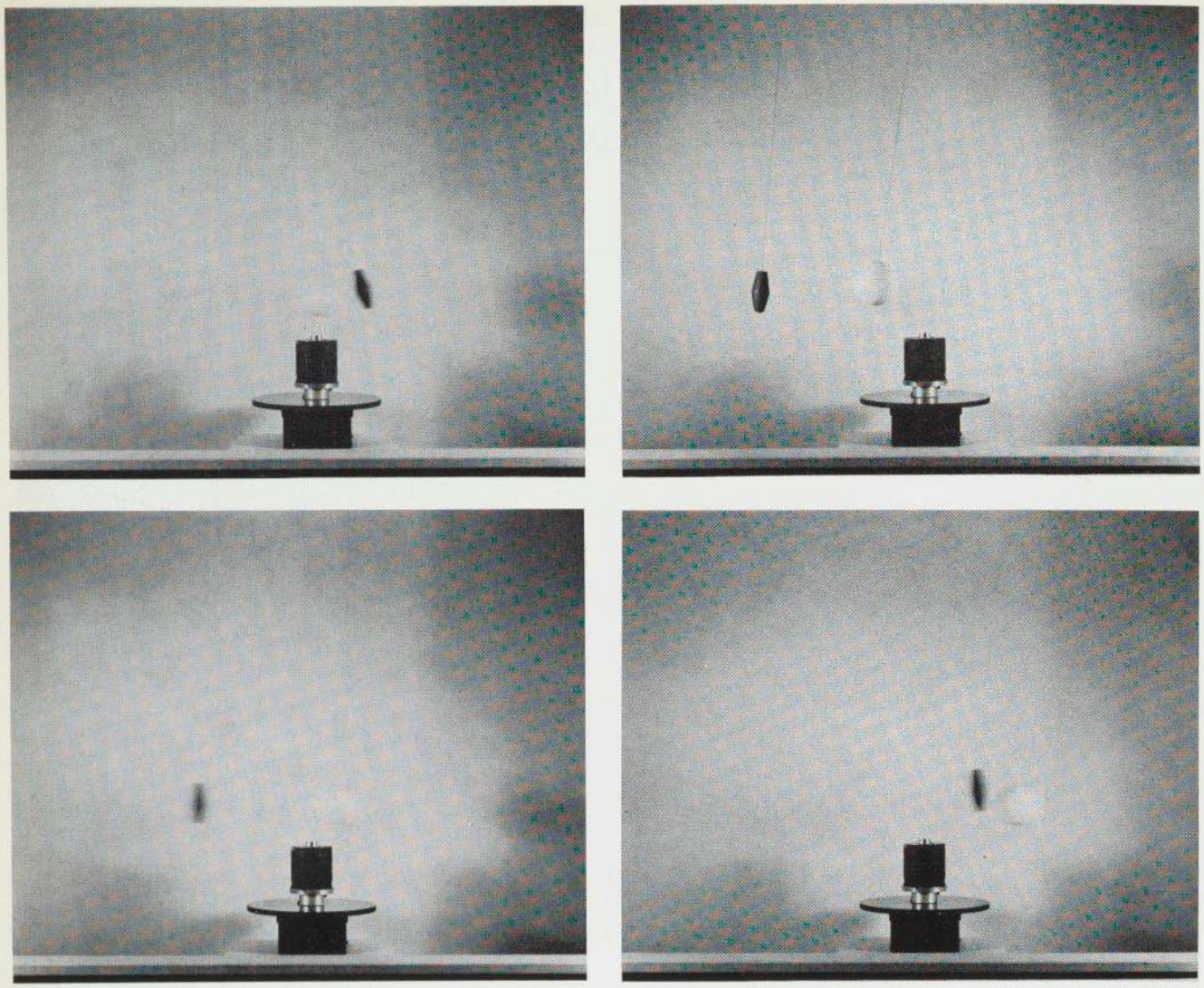
Thomas Shannon. American, born 1947
Squat. 1966
Metal, plexiglass, and electronic components with live plant, in two parts: a) stand with plant, 25″ high ×30″ wide×21″ deep at base; b) main element, 25″ high×51″ wide×64″ deep (floor area), arms, 77″ long (extended)
Collection John Kingsley Shannon, Chicago

To create a more intense communication between objects of art and the public is one main trend of the 'sixties. Many artists have tried to replace the rather abstract cerebral and emotional relationship between traditional painting and sculpture and the spectator with a more physical and direct involvement. The creation of "environments" and "intermedia" spectacles have been efforts in this direction.

Technology offers the possibility of creating objects that respond to the spectator's action, for example his voice or his movements. This opens up a vast field.

Squat, which combines mechanical, electronic, vegetable and animal elements, anticipates the time when brains can be channeled directly to computers.

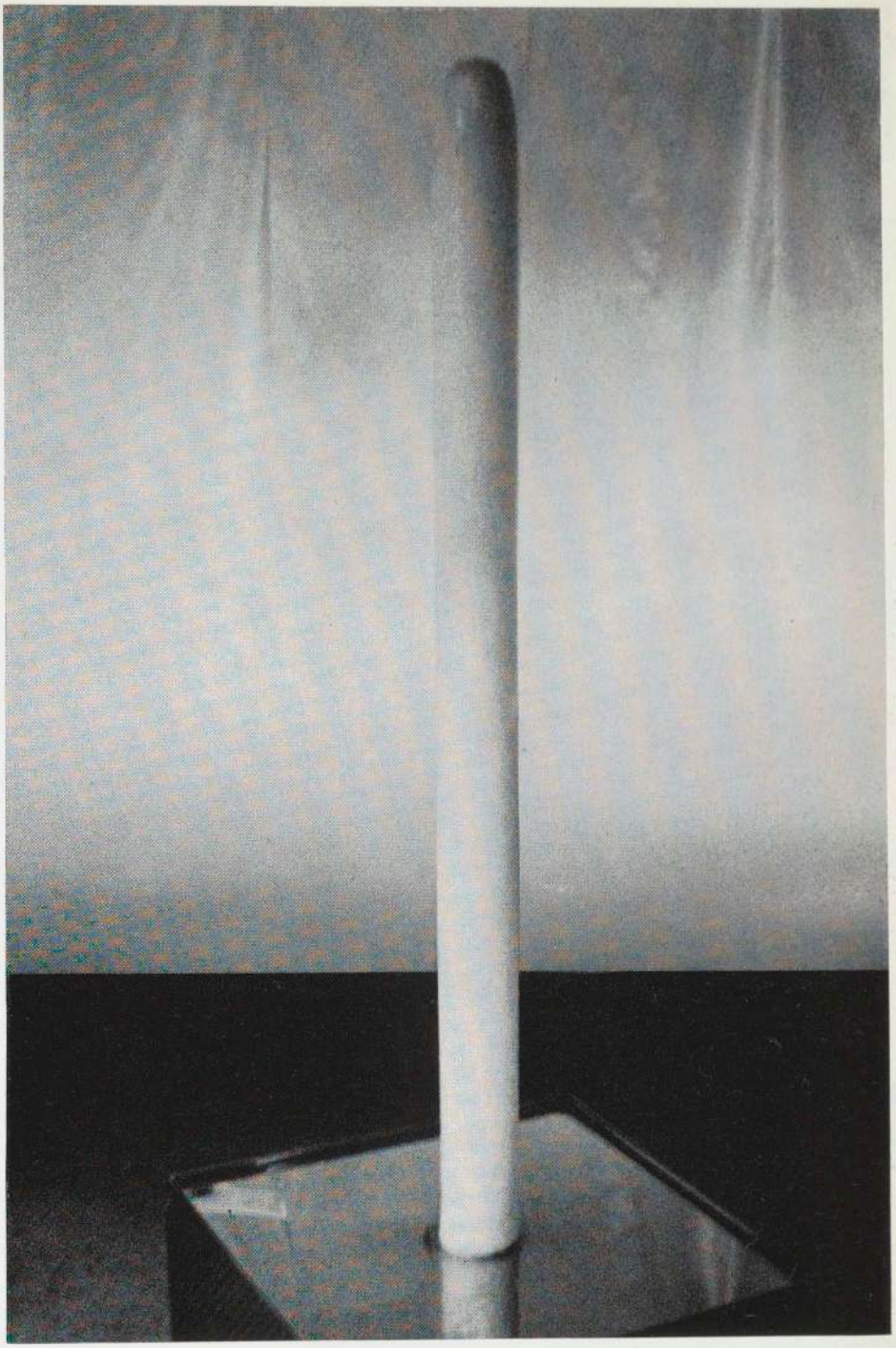
The plant and the body of the spectator/participant each have an electric potential, which is utilized to activate the motors. When the plant is touched, a small electrical charge is transmitted and amplified to switch on a vibrating circuit. Touch, motors on; touch again, motors off. When the motors are on, the three roller appendages retract and extend in sequence, making the three-legged bulk undulate. Simultaneously, another motor makes the two mirror appendages alternately extend and retract. Shannon says: "That describes what happens except for the hums, chirps, and creaks that continually change."



Takis (Takis Vassilakis). French, born Greece, 1925
Tele-Sculpture. 1960
3-part construction: electromagnet, cork and wood with magnets, steel wire, $10^{5}/_{8}$" high
The Museum of Modern Art, New York
(gift of Dominique and John de Menil)

The principle underlying this work is a simple one. The upright cylinder is an electromagnet that switches on and off at regular intervals. When it is on, it attracts the suspended black spool-shaped form and repels the white sphere; when it is off, the black and white forms mutually attract one another. The rather mysterious force of magnetism, in contrast to the more "rational, understandable" force displayed in mechanical apparatus, gives to Takis' sculpture an intangible discontinuity.

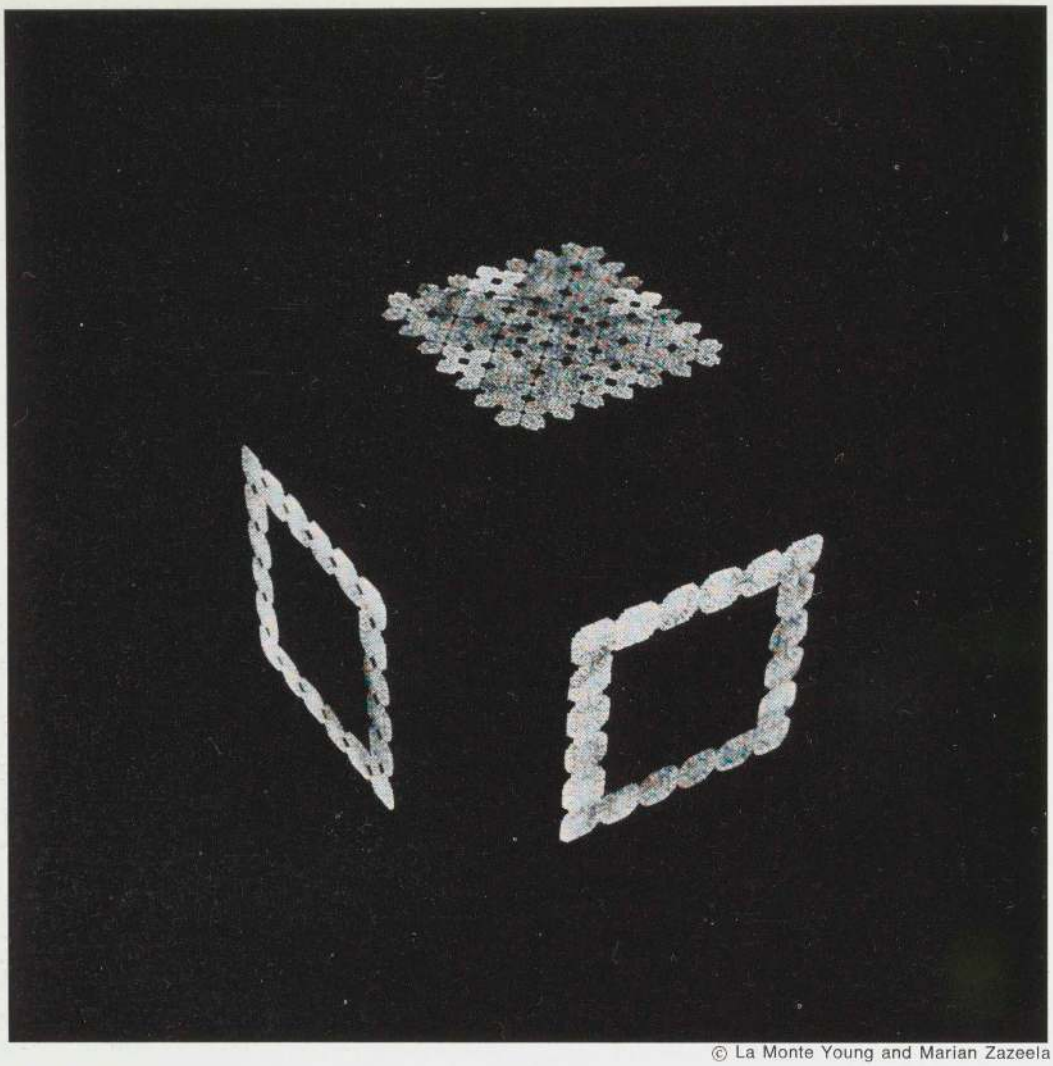
Takis has made many versions of this work. He has used magnets so extensively that his work has become almost synonymous with magnetic devices, and few other artists have cared to use them. It might seem one of the drawbacks of the anarchic individualism of modern art that once an artist has laid claim to an effect, others fear to use the same means lest they be called plagiarists. But a certain lack of courage and snobbishness may be rather more to blame for this.



Hans Haacke
German, born 1936
Ice Stick. 1966
Refrigeration unit, 54″ high,
on base 14″ high
Howard Wise Gallery,
New York

For several years, Haacke has been doing works in which the central theme is collaboration with forces of nature. He has, for example, used a breeze to move a veil. He has kept his work clean and pure, and has isolated the agency employed, leaving nothing to chance.

Haacke's use of cold to erect this sculpture by condensation of moisture in the air demonstrates his proposition in a very direct way. Technology, exemplified in the refrigeration unit, artificially produces a natural phenomenon, cold; but instead of exploiting it for some practical reason, such as the preservation of food, the artist has induced it to create an image of itself.

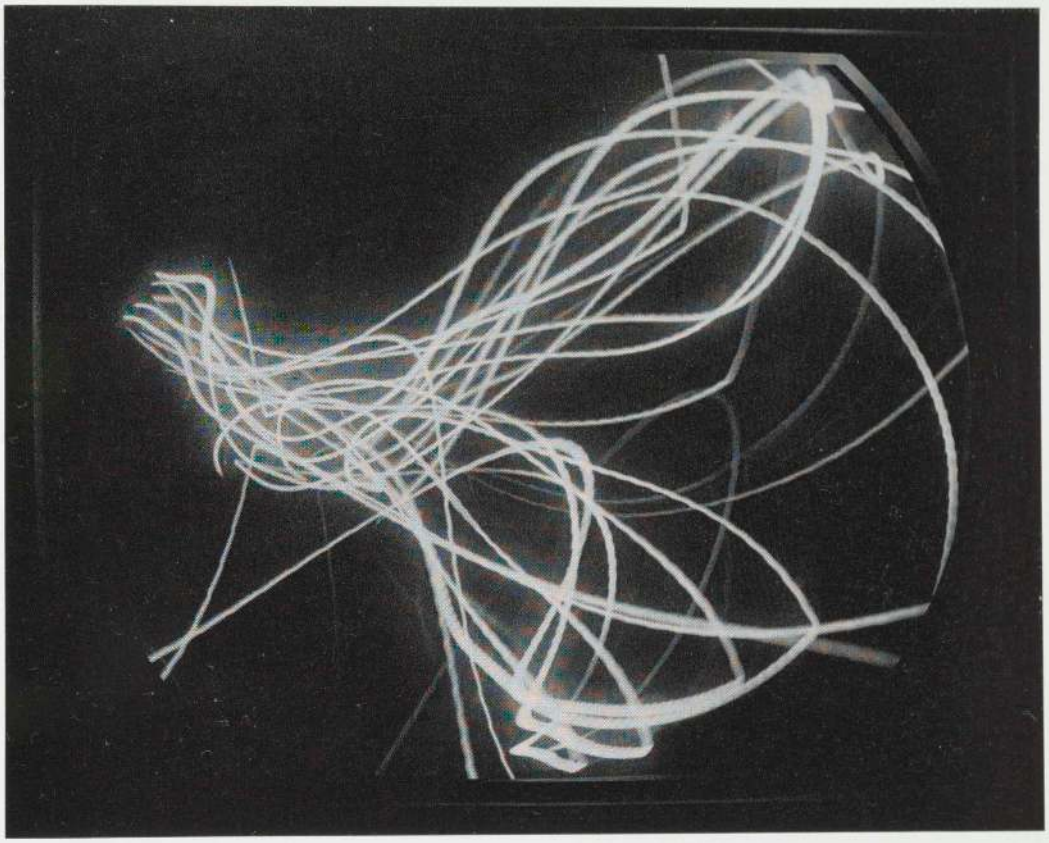


Marian Zazeela. American, born 1940 (visual design)
La Monte Young. American, born 1935 (sound)
Title To Be Determined. 1967—1968
Music and light sculpture: electronic circuitry, ultraviolet light, litho film, painted acetate, and plexiglass on wooden base, 18″ high × 16″ wide × 16″ deep
Private collection, Beverly Hills, California
(on loan from the artists for their lifetimes)

This collaborative work, inspired in part by the concept of the traditional music box playing a composed work, is the first in a projected series of electronic music and light sculptures.

The work generates a pair of sine waves, whose components are locked to each other to demonstrate the frequency and the amplitude ratio standard 64:63. This ratio was selected from a subset of two categories in La Monte Young's "The Two Systems of Eleven Categories," which is the first revision of "2—3 PM 12 XI 66 — 3:43 AM 28 XII 66 for John Cage," from *Vertical Hearing or Hearing in the Present Tense.* When connected to any standard monophonic or stereo hi-fi system, the instrument produces a continuous, periodic, composite sound-waveform environment. In combination with the pink and green light design, this is a performance of a section of Zazeela and Young's music and light composition, *Map of 49's Dream: The Two Systems of Eleven Sets of Galactic Intervals Ornamental Lightyears* from a longer work, *The Tortoise, His Dreams and Journeys.*

When one moves around a room in which this music and light sculpture is functioning, the vibrations of the sound waves can be felt as well as heard. At some places in the room, the sound almost disappears, because it goes over one's head; elsewhere it becomes very strong, because it passes at ear level.



Nam June Paik. Korean, born 1932

McLuhan Caged. 1967
Video tape recorder, 27×16″
Shadow-mask color television screen, stereo tape recorder and amplifier, 35×25″

$\pm\sqrt{}$ *Rondo Electronique.* 1966—1968

Bonino Gallery, New York, and Howard Wise Gallery, New York

Paik's manipulation of the TV set has the subtle brutality of judo, which turns someone's own force against himself. It is a direct frontal attack on the principal modern machine for manipulating men's minds for commercial or ideological reasons. Paik's counter-terrorism is, of course, based on ridicule.

Born in Seoul, Paik graduated in aesthetics from the University of Tokyo; studied music, art history, and philosophy in Germany; and since 1958 has been doing experimental work in electronic music in Germany and the United States. In 1965, he participated in John Cage's "Variation No. 5 with Electronic Television" at Philharmonic Hall, New York.

Only someone who had been deeply involved with the possibilities of the television medium could handle it with such precision. Paik has, in fact, a great faith in TV:

Someday artists will work with capacitors, resistors & semi-conductors as they work today with brushes, violins and junk.[161]

I have treated cathode ray tube (TV screen) as a canvas, and proved that it can be a superior canvas. From now on, I will treat the cathode ray as a paper and pen .... If Joyce lived today, surely he would have written "Finnegan's Wake" on videotape, because of the vast possibility of manipulation in magnetic information storage.[162]

THE NEW YORK TIMES, SUNDAY, NOVEMBER 12, 1967

EXPERIMENTS IN ART AND TECHNOLOGY ANNOUNCES A COMPETITION FOR ENGINEERS AND ARTISTS AND REQUESTS SUBMISSION OF WORKS OF ART MADE IN COLLABORATION TO BE SELECTED FOR AN EXHIBITION AT THE MUSEUM OF MODERN ART, NEW YORK CITY

The Museum of Modern Art, New York, has asked Experiments in Art and Technology to collaborate on a section dedicated to new technology in art as an extension of a major exhibition entitled THE MACHINE, to be held in the fall of 1968 and directed by K. G. P. Hulten, Director of Moderna Museet, Stockholm. The main body of the exhibition will be an historical survey of works of art commenting on the machine and the mechanical world.

Works to be considered for inclusion in the exhibition should be submitted by June 1, 1968 to Experiments in Art and Technology.

Experiments in Art and Technology is established to develop an effective collaboration between engineer and artist. The raison d'etre of Experiments in Art and Technology is the possibility of a work which is not the preconception of either the engineer or the artist but which is the result of the exploration of the human interaction between them. To encourage this aim in the works to be considered for the exhibition, Experiments in Art and Technology announces a competition for the best contribution by an engineer to a work of art produced in collaboration with an artist. The project may be initiated by either an artist or an engineer.

Experiments in Art and Technology will grant a first-place award of $3,000 and two second-place awards of $1,000 each to the engineer for his technical contribution to the collaboration. The jury will consist of scientists and engineers from the technical community who are not necessarily familiar with contemporary art. The jury will not be informed about the names of the collaborating enigneers. The awards will be for the most inventive use of new technology as it evolves through the collaboration of artist and engineer.

Final selection of the works to be shown at the Museum of Modern Art will be made by Mr. Hulten in consultation with the Jury.

Experiments in Art and Technology will help interested engineers and artists to establish contact. Engineers or artists who find the competition and the exhibition of interest should contact Experiments in Art and Technology at 9 East 16th Street, New York, New York, 10003. The Exhibition is international.

Art and Technology

Technology now totally dominates every step of everyday life. The artist's creativity is only slowly reestablishing its prestige, after having been almost wholly eclipsed by science and technology during the nineteenth century. During that time, artists lost the tradition of an understanding of materials and their capacities. Art and science, emotion and reason, became divorced and developed independently.

To confront the men who are shaping the new technology with the sense of individual responsibility and freedom that reigns in art is an important task. What must be abolished is the determinist notion that technology develops independent of the people who work with it. Since technology is nothing but a tool, it is neutral. Those who work with it must learn from artists to take full responsibility for what they do.

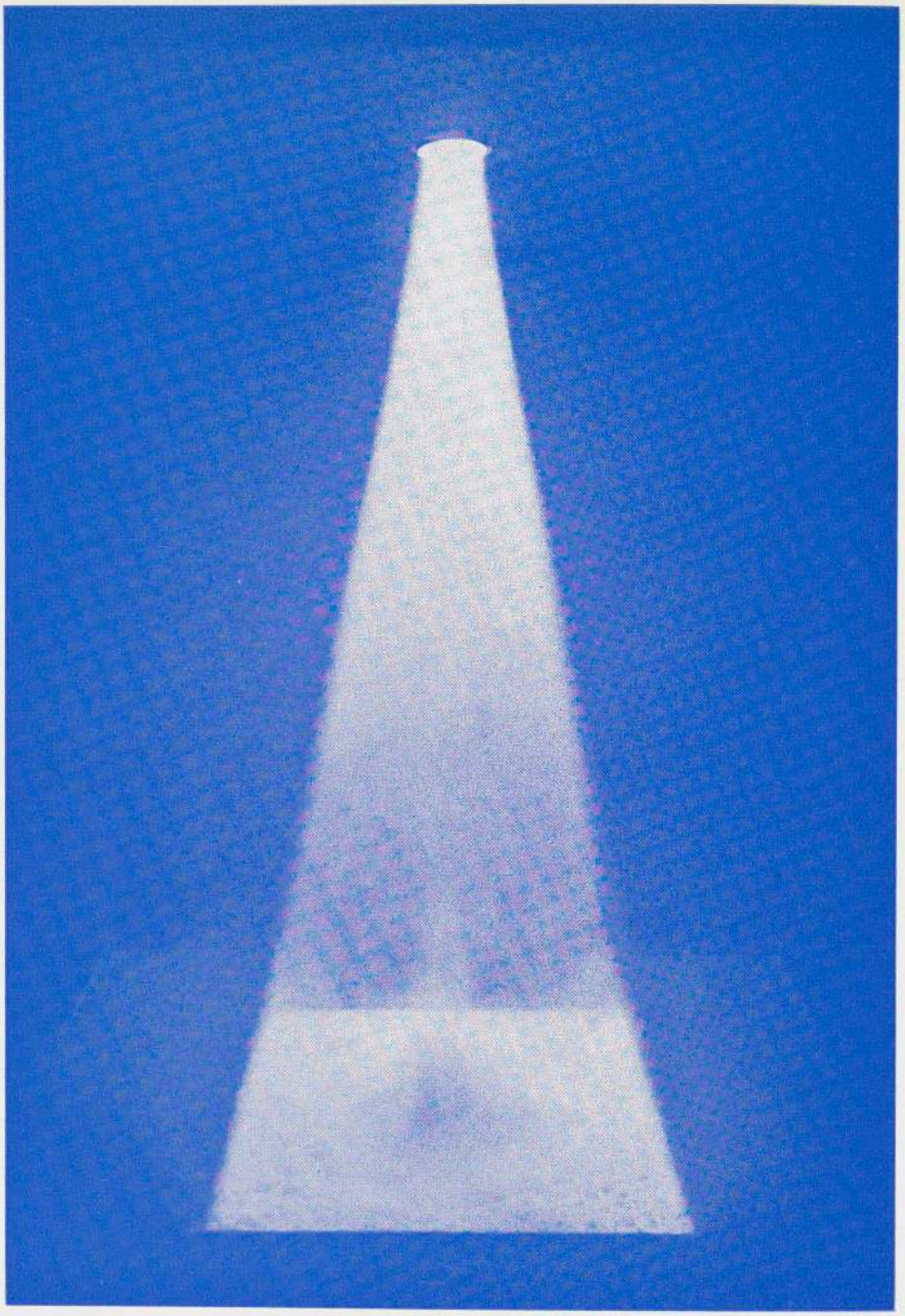
The international organization Experiments in Art and Technology (E.A.T.) was founded to try to establish a better working relationship among artists, engineers, and industry. In line with that purpose, E.A.T. agreed to arrange a competition in connection with the exhibition "The Machine as Seen at the End of the Mechanical Age." In response to the announcement of this competition, reproduced on the preceding page, approximately two hundred works, using a wide variety of means, were submitted from nine countries.

The jurors were: James M. Brownlow, International Business Machines Research Laboratories; Michael D. Golder, Plastic Research and Development Center, Celanese Plastics Company; Cyril M. Harris, Professor of Electrical Engineering and Architecture, Columbia University; John W. Pan, Bell Telephone Laboratories; and William G. Rosen, Special Assistant to the Director, National Science Foundation, and Executive Secretary of the Committee on Academic Sciences and Engineering of the Federal Council for Science and Technology. In making the awards for the most inventive use of new technology as it evolves through the collaboration of the artist and engineer, the jurors were asked to base their judgments on these criteria: First, how inventive and imaginative is the use of technology? Second, to what extent have the engineer and the artist collaborated successfully?

The prizes mentioned in the announcement were awarded to the following engineers for their technical contributions: Ralph Martel, first prize; Frank T. Turner, Niels O. Young, second prizes. In announcing their decision, the jurors issued the following statement:

In each of the winning entries a spectrum of technology was used with great impact on the art forms. Evident is the realization that neither the artist nor the engineer alone could have achieved the results. Interaction must have preceded innovation. Going beyond a demonstration of technical prowess or an intricate orchestration of art and technology, the engineer and artist together have created more than a well-executed realization of fantasy. The unexpected and extraordinary, which one experiences on viewing these pieces, result from inventiveness and imagination, stimulated not by the brute force of technical complexity but by probing into the workings of natural laws.

In advance of the jury's deliberation, the director of the exhibition had already made a preliminary selection of nine works from the competition; they are documented on the following pages. Some very interesting environmental works, including entire rooms, unfortunately had to be excluded from consideration because of their size and the limited space available. When the jurors' decision was announced, it was remarkable that their awards should have gone to three of the nine works already selected.

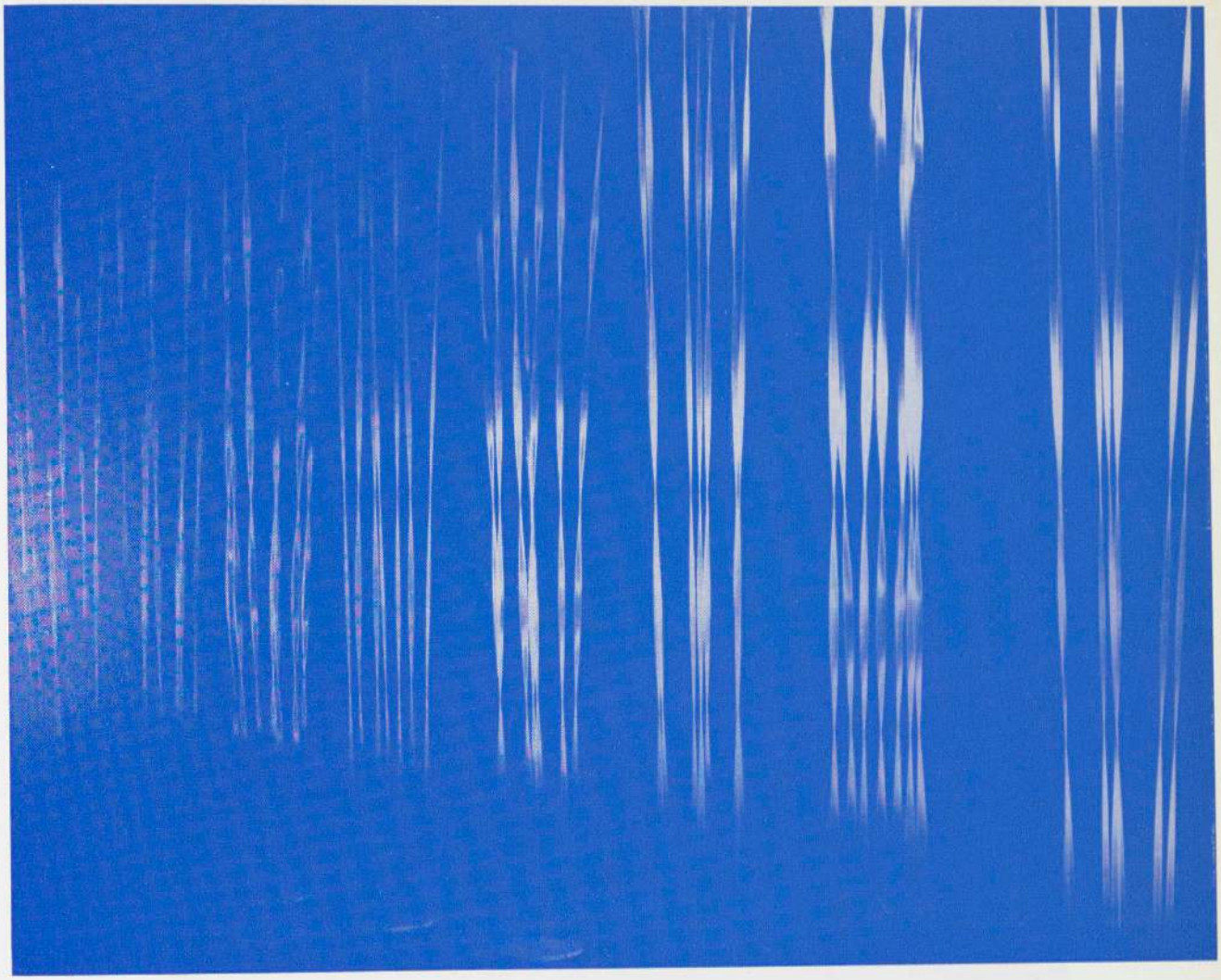


Jean Dupuy
French, born 1925 (artist)
Ralph Martel
American, born 1935 (engineer)
Heart Beats Dust. 1968
Dust, plywood, glass, light, electronic equipment, 7′ high × 2′ wide × 2′ deep (including active cube, 2′ on each side, *illustrated*)

The essential material of this sculpture is dust, enclosed in a glass-faced cube and made visible by a light beam of high intensity. The dust is activated by acoustic vibrations produced by the rhythm of heart beats. As an artist, Dupuy worked with polyethylene plastic, which by generating static electricity attracts and retains dust. While seeking a means to avoid this, he had the idea of utilizing the dust itself as a medium.

Like many works of recent years, *Heart Beats Dust* manifests a new form of cooperation with nature. A sensitive collaboration between natural forces within and outside the human body has here been achieved.

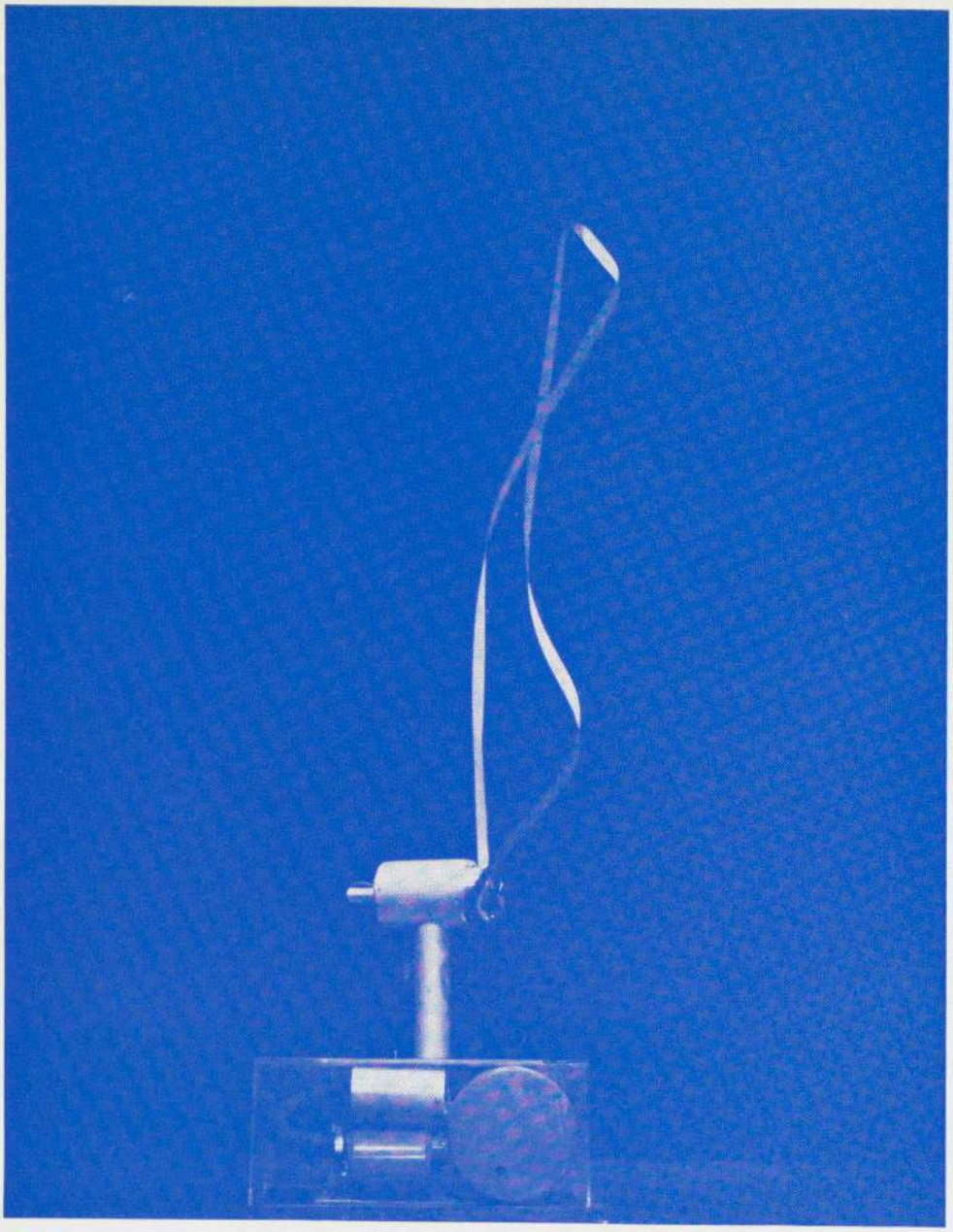
An earlier use of dust as an artistic medium was by Marcel Duchamp. While he was working on the *Large Glass* (see pages 80—81), after having left it untouched for a long time he found it covered with dust and decided to let some of it be the material for the sieves above the chocolate grinder. He fixed the dust in that area with varnish. In 1920, Man Ray took a famous photograph of this *Breeding of Dust (Elevage de Poussière)*.[163]



Wen-Ying Tsai. American, born China, 1928 (artist and engineer)
Frank T. Turner. American, born 1911 (engineer)
Cybernetic Sculpture. 1968
Multiple stainless steel units, each 9′4″ high × 20″ diameter at base; oscillator, stroboscopic lights, electronic equipment

This sculpture is based on the principle of the harmonic motion in a "standing wave" produced by a vibrating rod — the same idea that Gabo explored earlier (see page 106). Here, several units are grouped together. Their visual effect when in motion is continually modulated by high-frequency stroboscopic lights. The lights react to sound, such as that of a voice or the clapping of hands. The sense of contact with the sculpture that the viewer obtains is due to the subtlety of the work's reaction; the response of the trembling rods seems a direct translation of his voice.

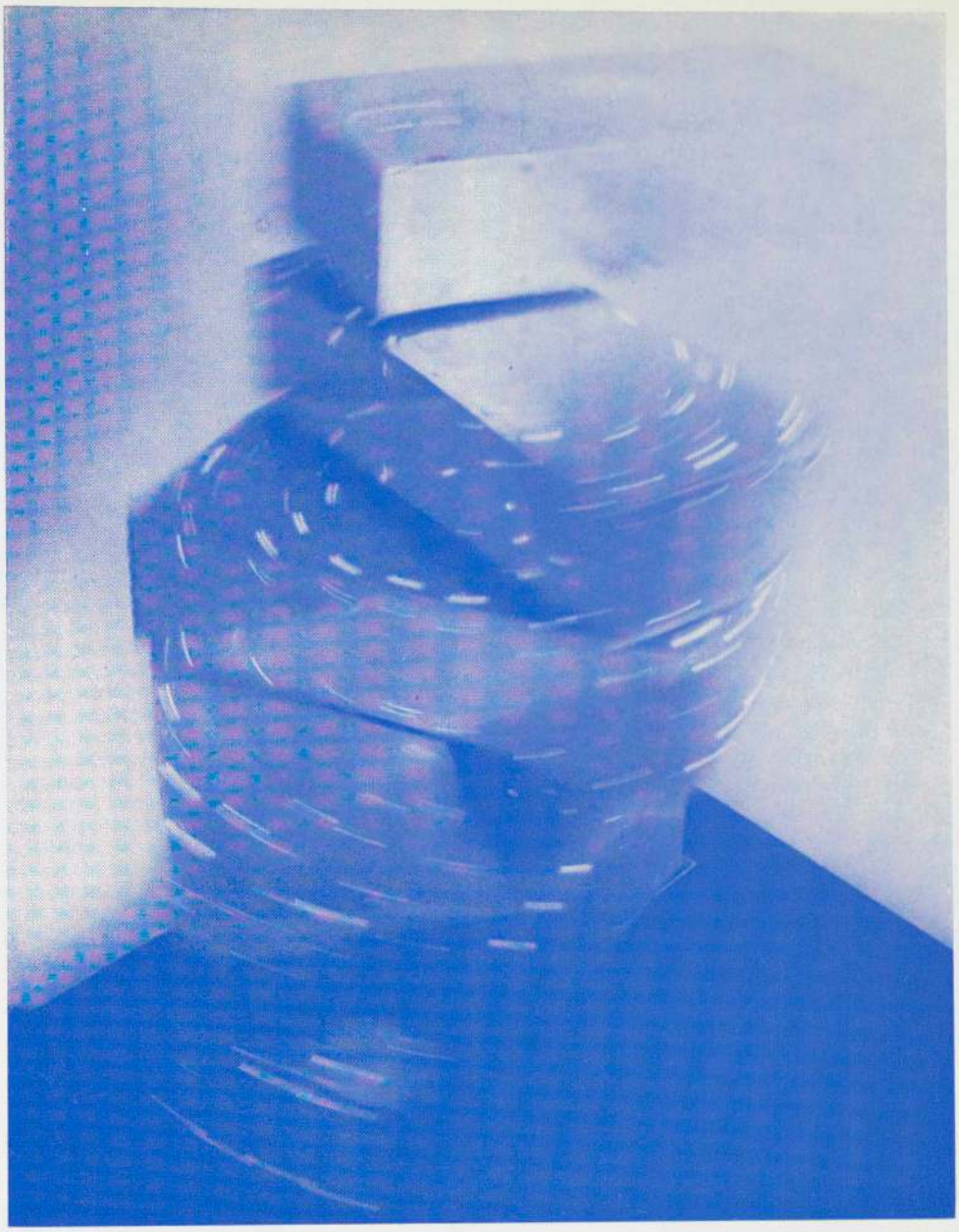
The technical solution that produces this illusionistic feat is at once so discreet and so efficient that it strikes us as perfect.



Lucy Jackson Young. American, born 1930 (artist)
Niels O. Young. American, born 1930 (engineer)
Fakir in 3/4 Time. 1968
Base: aluminum, plastic, and motors, approximately 30″ high by 25″ wide × 16″ deep; fountain effect: textile cord or tape, adjusting from 4 to 40′ above base

The creators of this mechanical fountain point out that it is the first machine to do the Indian rope trick. The basic principle by which a loop of otherwise limp cord could be coaxed into apparent rigidity and made to stand up was discovered only a couple of years ago. It is the same principle as that of the lariat, in which the motion of a loop of cord along its own length causes it to become rigid. In *Fakir in 3/4 Time*, the cord, instead of being swung at the end of a tether, is gobbled in and spewed out again by means of an electric motor and sheave, at the rate of 100 miles per hour. Because of its speed, the stream of cord resists deflection until it reaches the end of its loop, when it has to turn about and return to the machine. The head operates by means of a vacuum capstan.

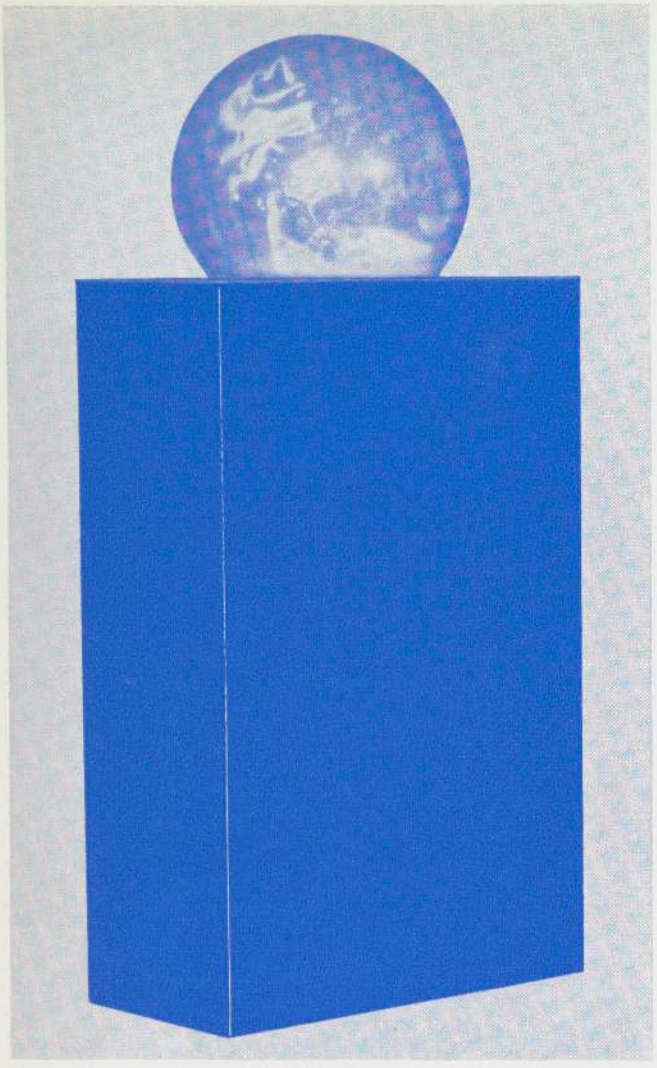
Fakir in 3/4 Time has the elegance of a very simple solution. The choreography of this mechanical fountain is manually adjustable, but theoretically it could be programmed in a way similar to *Arm* (opposite).

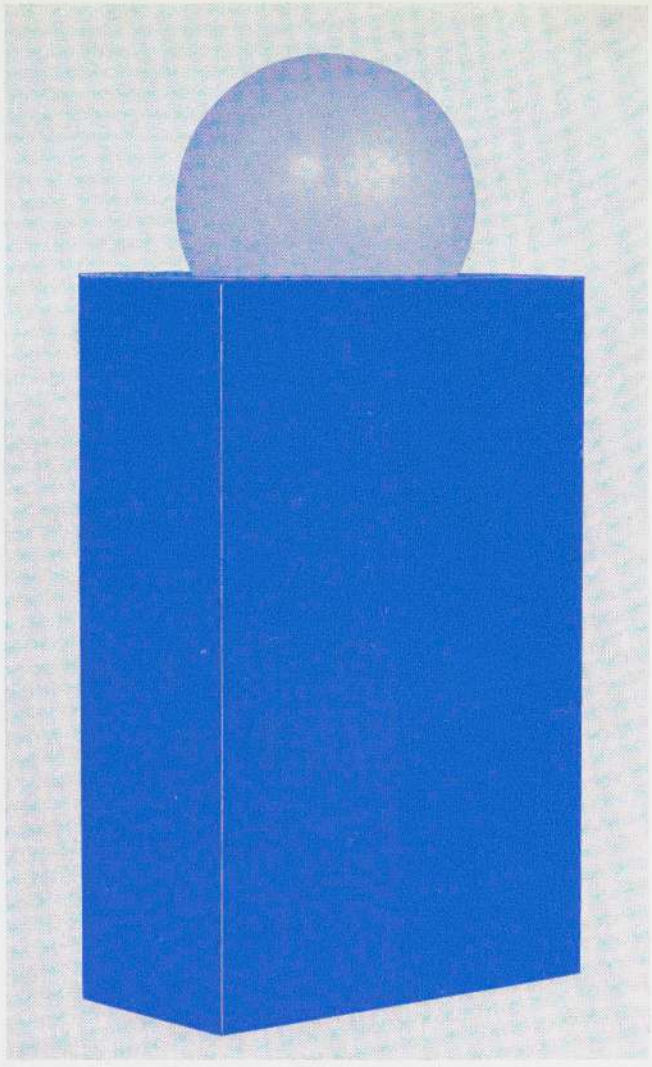


Hilary Harris. American, born 1929 (artist)
James Macaulay. Scottish, born 1923 (engineer)
Arm. 1967—1968
Anodyzed aluminum, aluminum alloy, motors, electronic equipment, 55″ high (including base and 5 elements) ×21″ wide×16″ deep; maximum radius of arm, 55″

Arm is born out of a collaboration between an artist and an engineer who have been working together for many years, mostly in animated and documentary films. Film is, of course, a medium in which there is a constant, natural, and for the most part unproblematic collaboration between artists and engineers, who jointly develop an increasingly refined technique.

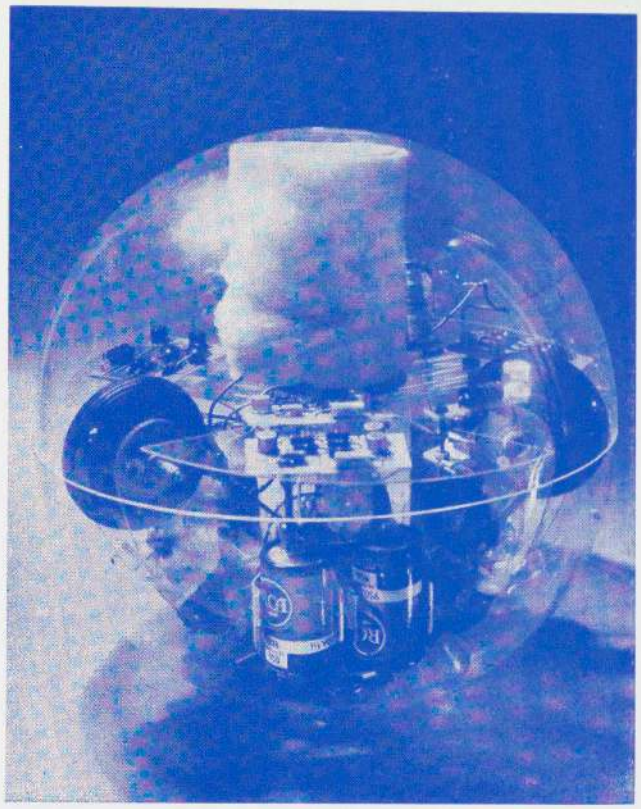
All of Hilary Harris' earlier work — which has included dance, still photography, sculpture, and film — has concentrated on movement as its underlying theme. In *Arm*, a highly advanced mechanical technology is used in combination with electronics to create a nonfigurative choreography. Each of the five articulated elements is capable of independent movement. The motor within each one is controlled by a master motor in the base, and this in turn reacts to instructions, programmed by the choreographer, which are read continuously by the mobile as it performs.





Lillian Schwartz. American, born 1927 (artist)
Per Biorn. Danish, born 1937 (engineer)
Proxima Centauri. 1968
Plastic, ripple tank, slides, slide projector, motors, electrical equipment; base, 55″ high × 30″ wide × 30″ deep; globe, 30″ diameter

Changing patterns appear on the surface of a white translucent dome, which at times seems to become a gelatinous mass that shakes, breathes, and then returns to still images. As the spectator approaches the sculpture, the dome throws off a red glow, while slowly sinking into the base and thus inviting the viewer to come still closer to observe this phenomenon. The dome is now resting inside the base. Peering down into the rectangle, the viewer sees the spectacle of a series of abstract pictures focused on the globe — which having lured the viewer into the position that it desired, now shows him its material. When he leaves the sculpture, the red glow reappears as the dome surfaces. When it has assumed its original position, the red turns off, and the changing patterns begin again, awaiting the approach of another spectator.

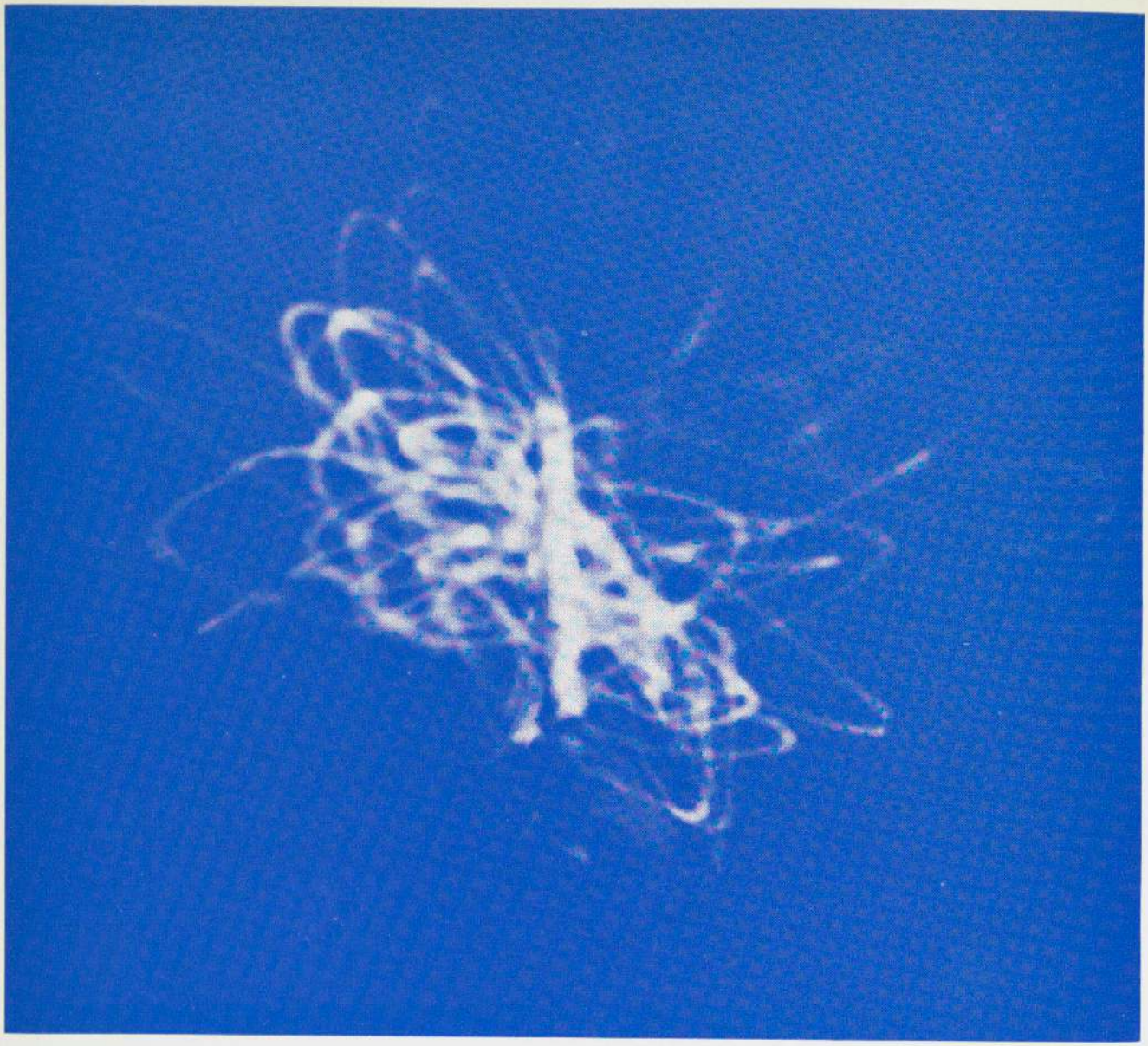


Robin Parkinson. American, born 1943 (artist)
Eric Martin. American, born 1943 (engineer)
Toy-Pet Plexi-Ball. 1968
Plexiglass, electrical equipment, motor, microphone, synthetic fur bag; sphere, 11″ diameter

The *Toy-Pet Plexi-Ball* has three "eyes" and one "ear" that respond to light and sound. Its creators explain:

If a person, in the same room with the sphere, makes a loud noise, such as clapping his hands, the sphere begins to roll. If, after five seconds, he makes no other loud noises, the sphere will stop. If he continues making noise for the five seconds, the sphere continues to roll for a longer period in the same direction. If the sphere has stopped and the person makes a noise a second time, the sphere rolls in another direction. If he directs the sphere toward any other object, it eventually sees a reflection of its blinking and goes in either of two other directions. If he approaches the sphere and gets in front of the light source, the sphere sees him and begins to move in one of three directions. A controlled series of sounds can guide the sphere in the direction of another person or pursue him around the room.

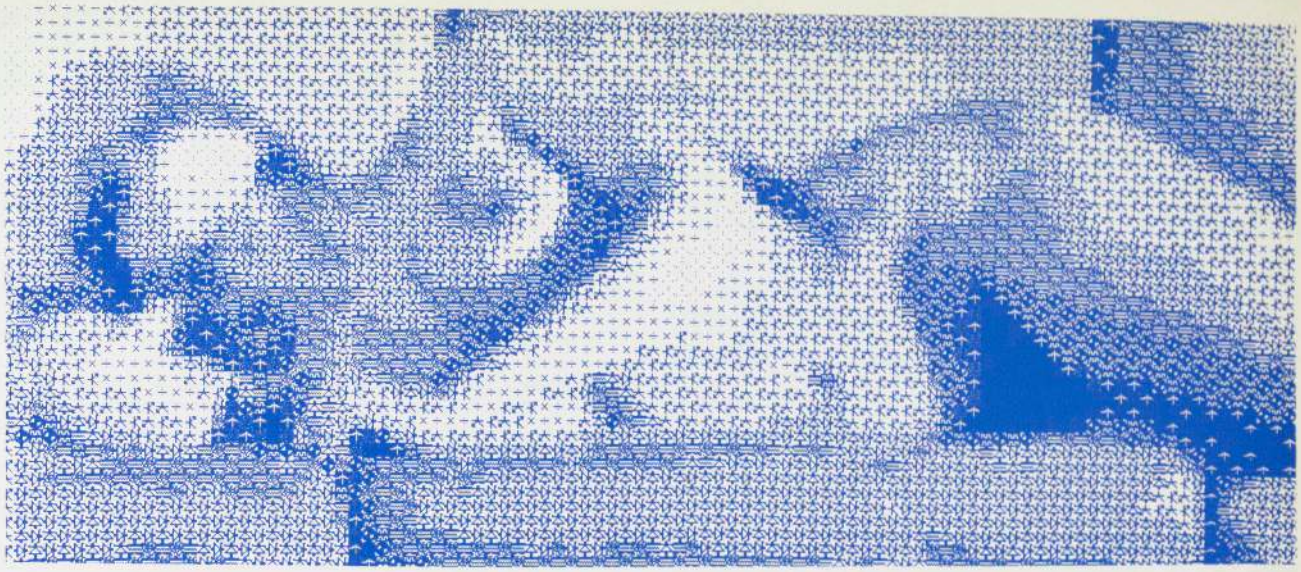
The only override to the sphere's internal decision-making process consists of throwing a blanket over the sphere, or putting it in its special bag. The sphere then remains in a dormant state until released.



John William Anthes. American, born 1946 (artist)
Tracy S. Kinsel. American, born 1930 (engineer)
ELLI. 1968
Helium-neon laser, mirrors, target, loudspeakers, electronic and electrical devices, 51″ high ×26″ wide×26″ deep

In recent years, there have been many projects that utilized laser light. The interest of ELLI (Electronic Laser Light Image) is that it presents a three-dimensional light image that responds to information given to it. "The viewer can have dialogue with image (extension of Elli's soul) . . . the image has dialogue with surroundings." There are alternative methods of operation. In one, the music from a magnetic tape generates the audio signals that control the image; in the other, the observer controls the light images by depressing keys on the keyboard of an electronic organ. The images produced can be either stationary or in motion; by forming "chords," one can make them increasingly complex.

The completely dematerialized sculpture that Gabo predicted as a further step beyond his *Standing Wave* of 1920 has here been achieved.



Leon D. Harmon
American, born 1922 (artist)
Kenneth C. Knowlton
American, born 1931 (engineer)
Studies in Perception, I. 1968
Computer-processed photographic print, 30×60″

Computer graphics were created for utilitarian purposes. Among the uses are to study the field of view seen from the pilot's seat in an airplane, or to analyze a flat image in order to manipulate graphic data. The characteristics of the computer at the moment are strikingly shown in "computer art."

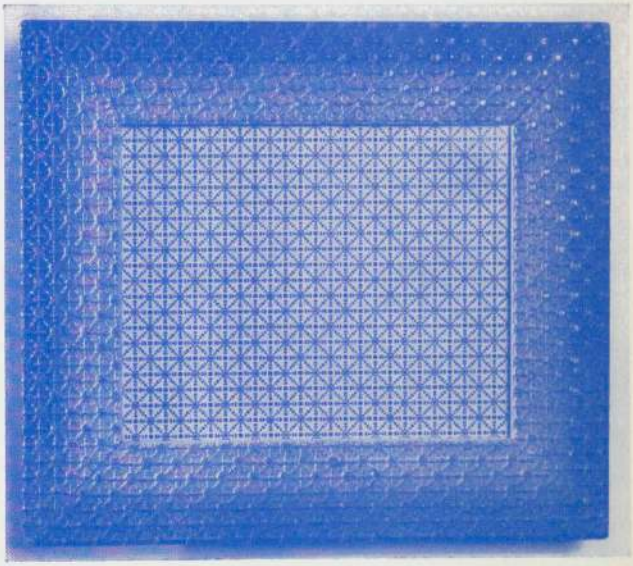
The computer can act as an intelligent being: process information, obey intricate rules, manipulate symbols, and even learn by experience. But since it is not capable of initiating concepts, it cannot be truly creative; it has no access to imagination, intuition, and emotion.

The computer is only a tool which, at the moment, still seems far removed from those polemic preoccupations which concern art. However, even now seen with all the prejudices of tradition and time, one cannot deny that the computer demonstrates a radical extension in art media and techniques. The possibilities inherent in the computer as a creative tool will do little to change those idioms of art which rely primarily on the dialogue between the artist, his ideas, and the canvas. They will, however, increase the scope of art and contribute to its diversity. — Jasia Reichardt, 1968.[164]

Richard Fraenkel. American, born 1923 (artist)
Jeffrey Raskin. American, born 1945 (engineer)
Picture-Frame. 1968
Ink drawing on paper embossed frame, 12¼×14½″

Studies in Perception, I was produced by scanning a photograph with a machine similar to a TV camera and converting the electrical signals into numerical representations on a tape. The computer analyzed the image into levels of brightness, but instead of using randomly sprinkled dots to produce values of light and dark, the dots were organized into small patterns, visible at close view but imperceptible at a greater distance.

Picture-Frame was made by computation analysis of the relief molding of an old picture frame; the resultant tape was then run through a pen-and-ink arrangement on a computer to carry the design into the picture area. As Fred Waldhauer of E.A.T. remarked, with reference to the frame being preliminary to the picture: "This is probably what the computer would do, if it could think."



Notes

In the case of translated material, wherever a source in English is cited, it has been quoted verbatim. If no source is given, the translation is that of the editor, unless otherwise indicated.

1 *Leonardo da Vinci's Aeronautics*. London, Her Majesty's Stationery Office, 1967, p. 3.

2 Quoted in John Cohen, *Human Robots in Myth and Science*. South Brunswick and New York, A. S. Barnes and Company, 1967, p. 68.

3 *Bracceli: Bizarrie*, with an essay on Bracceli by Tristan Tzara. Paris, Alain Brieux, 1963.

4 *Le Mécanisme du Flûteur automate . . .* Paris, Jacques Guérin, 1738. Gravelot's engraving appeared as the frontispiece for this prospectus.

5 A detailed history of the duck is given in Alfred Chapuis and Edmond Droz, *Automata* (Neuchâtel, Editions du Griffon, 1958, pp. 239–247) and in a more recent monograph by André Doyon and Lucien Liaigre (*Jacques Vaucanson, Mécanicien de génie*. Paris, Presses Universitaires de France, 1966, pp. 65—108). It was sold by Vaucanson in 1743, shown in several German cities and St. Petersburg, and after its return from Russia was bought by a German in Helmstedt. There Goethe saw it in 1805 and described it in his journal. "We found Vaucanson's automata completely paralyzed," Goethe reported. "The duck had lost its feathers and, reduced to a skeleton, would still bravely eat its oats but could no longer digest them." Lost sight of for several decades, the duck was rediscovered about 1840, and a German clockmaker, Johann-Bartholomé Reichsteiner, undertook to put it back into working order. The task took three and a half years and cost him much labor and great expense. At its premiere in restored state at La Scala in Milan in 1844, the duck was again received with enthusiasm and then went on a new round of exhibitions. The records thereafter become confused because of the appearance in 1847 of a new duck made by Reichsteiner, on somewhat different principles; the last report of Vaucanson's original seems to be contained in a letter written from Marseilles in 1863.

6 Quoted in *Technology in Western Civilization*, edited by Melvin Kranzberg and Carroll W. Pursell, Jr. New York, Oxford University Press, 1967, vol. II, p. 39.

7 Quoted in Stephen F. Mason, *A History of the Sciences* (new revised edition). New York, Collier Books, 1962, p. 187.

8 In the first and second editions of Morghen's *Raccolta*, issued between 1764 and 1772, the voyagers to the moon were identified as "Cavaliere Wild Scull and M. de la Hire." In an article on "The Three Editions of Filippo Morghen's *Raccolta*" in *The Art Bulletin* (Chicago, vol. XIX, March 1937, pp. 112—118), Grant McColley has suggested that Morghen may have been influenced to alter the third edition by his friend Sir William Hamilton, a scientist and Fellow of the Royal Society, who was British envoy to the court of Naples.

9 *Uppfinningarnas Bok*, edited by O. W. Alund. Stockholm, 1872—1875. Passage quoted translated by K. G. P. Hultén.

10 Quoted in C. H. Gibbs-Smith, *The Great Exhibition of 1851*. London, His Majesty's Stationery Office, 1950, p. 26.

11 Quoted in *ibid.*, p. 7.

12 *Space, Time and Architecture* (3rd edition). Cambridge (Massachusetts), Harvard University Press, 1954, p. 250, p. 255.

13 Lawrence Gowing and Richard Hamilton, preface to exhibition catalogue, *Man Machine & Motion*. University of Durham, Newcastle upon Tyne, 1955.

14 *Mechanization Takes Command*. New York, Oxford University Press, 1948, p. 24.

15 Quoted in Georges Sadoul, *Histoire générale du cinéma. I. L'Invention du cinéma, 1832–1897*. Paris, Editions Denoël, 1946, p. 237.

16 *The Horse in Motion . . .*, preface by Leland Stanford, text by J. D. Stillman. Boston, James R. Osgood and Company, 1882, p. iv.

17 *Imago: Journal of Photography of the George Eastman House* (Rochester, New York), vol. II, April 1953.

18 Quoted in Beaumont Newhall, *The History of Photography from 1839 to the Present Day* (revised, enlarged edition). New York, The Museum of Modern Art, 1964, p. 97.

19 *Ibid.*, p. 99.

20 "Artist and Automobile," in *Man and Motor: The 20th Century Love Affair*, edited by Derek Jewell. New York, Walker and Co., 1967, p. 119.

21 *Histoire de la locomotion terrestre*, text and documentation by Baudry de Saunier, Charles Dollfus, and Edgar Geoffroy. Paris, *L'Illustration*, 1935, p. 278.

22 *Ibid.*, p. 279.

23 Letter from Feininger to Alfred H. Barr, Jr., August 1944, quoted in *Lyonel Feininger — Marsden Hartley*. New York, The Museum of Modern Art, 1944, pp. 7–8.

24 Stuart Legg, "A Note on Locomotive Names," *London Bulletin*, nos. 4–5, July 1938, p. 20, p. 25.
The first main-line passenger service was inaugurated in 1830. As this catalogue goes to press, the newspapers record the end of an era, with the last trip by the last British steam-powered train:
LIVERPOOL, August 11 (Reuters). — *Steam officially bowed out of British Railways today amid popping champagne corks, bunting, bells and hooters, clicking cameras — and more than a few heavy hearts. In the face of progress, 138 years after George Stephenson's Rocket opened the first train passenger service, Britain's last steam locomotive made a final nostalgic journey from here to Carlisle and back. Aboard the train were more than 400 steam enthusiasts who paid 15 guineas ($ 37.80) for the privilege of sharing the passing of "Puffing Billy" from the British scene. . . .*
A century and a half of manmade history has now gone to the wreckers' yards. . . . By 1967 all passenger traffic switched to diesel or electrified lines. And last month steam was dealt the final blow when it was decided it was no longer worthy even to haul freight . . . Today's 314-mile journey Liverpool to Carlisle was a last chance to indulge in nostalgia of the love affair with steam that embraced generations of young boys, and many of their fathers. . . .
— International Herald Tribune (Paris), August 12, 1968.

25 Quoted in Theodore Lux Feininger, *Lyonel Feininger: City at the Edge of the World*. New York, Frederick A. Praeger, 1965, p. 27.

26 *The Photographs of Jacques Henri Lartigue*. New York, The Museum of Modern Art, 1963, p. 2.

27 *Man Machine & Motion*, p. 11.

28 Translated by Reyner Banham, "Futurist Manifesto," *The Architectural Review* (London), vol. CXXVI, August–September 1959, pp. 77–80.

29 Quoted in Joshua C. Taylor, *Futurism*. New York, The Museum of Modern Art, 1961, pp. 46–48.

30 Quoted in *ibid.*, p. 129.

31 *Loc. cit.*

32 "Symbolisme plastique et symbolisme littéraire," *Mercure de France* (Paris), February 1, 1916; reprinted in *Archivi del Futurismo*. Rome, De Luca, 1962, I, pp. 204–210.

33 Translated from a manuscript written by de Chirico during his sojourn in Paris, 1911–1915; published in James Thrall Soby, *Giorgio de Chirico*. New York, The Museum of Modern Art, 1955, p. 252.

34 *Giorgio de Chirico*, p. 65.

35 *Epstein: An Autobiography*. New York, Dutton & Co., 1955, p. 56.

36 *Jacob Epstein, Sculptor*. Cleveland and New York, World Publishing Company, 1963, p. 98.

37 *Wyndham Lewis the Artist, from 'Blast' to Burlington House*. London, Laidlaw & Laidlaw, 1939, p. 78.

38 Introduction to exhibition catalogue, *Wyndham Lewis and Vorticism*. London, The Tate Gallery, July 6—August 19, 1956, p. 3.

39 *Blast No. 1;* reprinted in *Wyndham Lewis the Artist*, p. 128.

40 *Blast No. 2;* reprinted in *ibid.*, p. 151.

41 Quoted in John I. H. Baur, *Joseph Stella*. New York, Shorewood Publishers, Inc., 1963, p. 13.

42 *Loc. cit.*

43 "Suprematism," *The Non-Objective World, Part II* (1927), translated by Howard Dearstyne. Chicago, Paul Theobald, 1959; reprinted in *Modern Artists on Art: Ten Unabridged Essays*, edited by Robert L. Herbert. Englewood Cliffs (New Jersey), Prentice-Hall, Inc., 1964, p. 98.

44 Letter to Walter Pach, January 16, 1913, quoted in *Raymond Duchamp-Villon, 1876—1918*, introduction by George Heard Hamilton, notes by William C. Agee. New York, Walker and Company, 1967, p. 103.

45 *Ibid.*, p. 23.

46 "La Tour Eiffel" (1913), published in *Poème et Drame* (Paris), vol. VII, January–March 1914, pp. 22–29; translated by John Savacool in *Raymond Duchamp-Villon, 1876—1918*, p. 116.

47 "Le Contraste simultané," lecture given at Sao Paulo, Brazil, June 12, 1924; translated in exhibition catalogue, *Robert and Sonia Delaunay*. Ottawa. The National Gallery of Canada, 1965.

48 Letter from Feininger to Alfred H. Barr, Jr., August 1944, quoted in *Lyonel Feininger — Marsden Hartley*, p. 8.

49 "Marcel Duchamp, Anti-Artist," *View* (New York), series V, no. 1, March 1945 (Marcel Duchamp Number), p. 21, p. 23; reprinted in *The Dada Painters and Poets: An Anthology*, edited by Robert Motherwell. New York, Wittenborn, Schultz, 1951, p. 310.

50 Quoted by Katherine S. Dreier in her statement on Duchamp in *Collection of the Société Anonyme: Museum of Modern Art 1920*. New Haven (Connecticut), Yale University Art Gallery, 1950, p. 148.

51 Katharine Kuh, *The Artist's Voice*. New York, Harper and Row, 1960, p. 90.

52 Guillaume Apollinaire, *The Cubist Painters: Aesthetic Meditations* (1913), translated by Lionel Abel. (The Documents of Modern Art.) New York, Wittenborn and Company, 1944, p. 48.

53 Unpublished discoveries generously made available to the author by the noted authority on Duchamp, Professor Ulf Linde of the Royal Academy of Art, Stockholm. The idea that the *Large Glass* contained alchemical references had apparently occurred to Robert Lebel: "When we asked him Duchamp merely replied: 'If I have practised alchemy, it was in the only way it can be done now, that is to say without knowing it.' For some this is an insufficiently conclusive answer, since it does not exclude the possibility that he might have rediscovered alchemy" (*Marcel Duchamp*, translated by George Heard Hamilton. New York, Grove Press, Inc., 1959, p. 73). Lebel makes a similar reference in André Breton and Gérard Legrand, *Formes de l'art. 1. L'Art magique*. Paris, Club Français de l'Art, 1957, p. 98.

54 Eugène Canseliet, *Alchimie: Etudes diverses de symbolisme hermétique et de pratique philosophale*. Montreux, Jean-Jacques Pauvert, 1964, plate XIV; related texts, verso of plate and pp. 63–64.

55 Kurt Seligmann, *Magic, Supernaturalism, and Religion* (paperback edition of *The History of Magic*. New York, Pantheon Books, Inc., 1948). New York, Grosset and Dunlap, 1968, p. 145 and figure 47.

56 E. g., woodcut reproduced on p. 80, after C. G. Jung, *Psychology and Alchemy*. (Bollingen Series XX.) New York, Pantheon Books, Inc., figure 231, p. 565.

57 Oswald Wirth, *Le Tarot des imagiers du moyen âge*. Paris, Editions Tchou, 1966, p. 277.

58 Notes by Jean Schuster, published as "Marcel Duchamp, vite," *Le Surréalisme, même* (Paris), no. 2, Spring 1957, pp. 143–145; reprinted in *Marchand du sel: Ecrits de Marcel Duchamp*, edited by Michel Sanouillet. Paris, Le Terrain Vague, 1958, p. 173.

59 *Loc. cit.*

60 *La Mariée mise à nu par ces Célibataires, même [Boîte Verte]*. Paris, Edition Rrose Sélavy, 1934. *The Bride Stripped Bare by Her Bachelors, Even: A Typographic Version by Richard Hamilton of Marcel Duchamp's "Green Box,"* translated by George Heard Hamilton. (The Documents of Modern Art.) New York, George Wittenborn, Inc., 1960.

61 "French Artists Spur on American Art," *New York Tribune*, October 24, 1915, part IV, p. 2; quoted by William B. Camfield, "The Machinist Style of Francis Picabia," *The Art Bulletin* (New York), XLVIII, September–December, 1966, p. 309, p. 313.

62 The lost painting is reproduced in the issue edited by Picabia of *The Little Review* (New York), Spring 1922.

63 *Dada, Surrealism, and Their Heritage*. New York, The Museum of Modern Art, 1968, p. 27.

64 Statement in *291* (New York), no. 12, February 1916; quoted by Camfield, *op. cit.*, p. 315.

65 Max Goth [Maximilien Gautier], "D'un certain esprit . . .," *391* (Barcelona), no. 2, February 10, 1917; reprinted in *391: Revue publiée de 1917 à 1924 par Francis Picabia*, edited by Michel Sanouillet. Paris, Le Terrain Vague, 1960, p. 24.

66 Camfield, *op. cit.*, p. 315.

67 Gabrielle Buffet-Picabia, *Aires abstraites*. (Collection les Problemès de l'Art.) Geneva, Pierre Cailler, 1957, p. 37.

68 Statement on Picabia in *Collection of the Société Anonyme*, p. 5.

69 "Some Memories of Pre-Dada: Picabia and Duchamp," translated by Ralph Manheim, in *The Dada Painters and Poets*, p. 266.

70 "The Picabia/Breton Axis," *Artforum* (Los Angeles), vol. V, September 1966, p. 17. (N.B.: On p. 92, for "Richard Hunt" read "Ronald Hunt.")

71 (Barcelona), 1917; reproduced in *391*, ed. Sanouillet, p. 17.

72 Reproduced in Michel Sanouillet, *Picabia*. Paris, L'Oeil du Temps, 1964, p. 41.

73 "L'Oeil cacodylate," *Comœdia* (Paris), November 29, 1921. *Les Yeux chauds* is reproduced in *The Little Review*, Spring 1922, facing p. 16.

74 "Pourquoi j'ai écrit 'Relâche'," in *Les Ballets suédois dans l'art contemporain*. Paris, Editions du Trianon, 1931, p. 74.

75 "Dada Painting or the Oil-Eye," *The Little Review* (New York), Autumn-Winter 1923–1924, p. 12.

76 Statement on Ribemont-Dessaignes in *Collection of the Société Anonyme*, p. 187.

77 *Self Portrait*. Boston and Toronto, Little, Brown and Co., 1963, p. 92.

78 *Ibid.*, p. 73.

79 *Ibid.*, pp. 128–129.

80 Newhall, *The History of Photography*, p. 161.

81 Ben Wolf, *Morton Livingston Schamberg*. Philadelphia, University of Pennsylvania Press, 1963, p. 30, p. 54.

82 *Ibid.*, p. 15.

83 "The Richard Mutt Case," *The Blind Man* (New York), 2, May 1917.

84 "Phare de la Mariée," *Minotaure* (Paris), 6, Winter 1935; translated as "Lighthouse of the Bride," in *View* (New York), 1945, March 1945, p. 7; reprinted in Lebel, *Marcel Duchamp*, p. 89.

85 Quoted by Man Ray, in William C. Seitz, *The Art of Assemblage*. New York, The Museum of Modern Art, 1961, p. 46.

86 Interview with James Johnson Sweeney, "Eleven Europeans in America." *The Bulletin of The Museum of Modern Art* (New York), vol. XIII, nos. 4–5, 1946, p. 20.

87 *Self Portrait*, p. 69.

88 Letter to Jacques Doucet, October 19, 1925 (?), published in *Marchand du sel*, p. 190.

89 *Self Portrait*, pp. 99–100.

90 Instructions accompanying the Rotoreliefs; quoted in Lebel, *Marcel Duchamp*, p. 173.

91 Quoted by Ruth Olson and Abraham Chanin, *Naum Gabo — Antoine Pevsner*. New York, The Museum of Modern Art, 1948, p. 18. Gabo's ideas about using a new element in art, "kinetic rhythms as the basic forms of our perception of real time," were further developed in the manifesto that he issued in conjunction with Pevsner in 1920 (translated as "The Realistic Manifesto," in *Gabo*, with introductory essays by Herbert Read and Leslie Martin. Cambridge [Massachusetts], Harvard University Press, 1957, pp. 151—152).

92 "Notes on Tatlin," translated by Keith Bradfield, in exhibition catalogue, *Vladimir Tatlin*, Stockholm, Moderna Museet, July–September 1968, p. 6.

93 "The Constructivist Ethos: Russia 1913—1932. Part I," *Artforum* (Los Angeles), vol. VI, September 1967, pp. 22—29.

94 *Merz* (Hanover), vol. II, April—July 1924, p. 84; reprinted in *Manifeste Manifeste 1905—1933*, edited by Dieter Schmidt. Dresden, VEB Verlag der Kunst, 1965, p. 318.

95 "Tatlin och konstruktivismen," in exhibition catalogue, *Rörelse i Konsten* ("Motion in Art"), Stockholm, Moderna Museet, May 17–September 3, 1961. English translation by K. G. P. Hultén.

96 "Tatlin at Home prend forme," in exhibition catalogue, *Raoul Hausmann*, Stockholm, Moderna Museet, October 21–November 19, 1967.

97 "L'Esprit de nôtre temps 1919," in *ibid.*

98 Another "meta-mechanical" picture of the same year, *Dada-merika*, is reproduced in an article on Grosz by Willi Wolfradt, *Jahrbuch der Jungen Kunst* (Leipzig), vol. II, 1921, p. 111.

99 "Merz," *Ararat* (Munich), vol. II, 1921, p. 6; English translation by Ralph Manheim in *The Dada Painters and Poets*, pp. 60–61.

100 Letter from Hannah Höch, April, 1959, published in Walter Mehring, *Berlin Dada*. Zurich, Verlag der Arche, 1959, p. 91.

101 Reproduced in *391*, ed. Sanouillet, p. 49.

102 "Au-delà de la peinture," *Cahiers d'Art* (Paris), vol. XI, no. 6/7, 1936, pp. 169–172; English translation in *Beyond Painting . . .* (The Documents of Modern Art.) New York, Wittenborn, Schultz, 1948, p. 14.

103 In an article that appeared as this catalogue went to press ("Klee's Twittering Machine," *The Art Bulletin* [New York], vol. L, March 1968, pp. 67–69), Maurice L. Schapiro has identified the machine in Klee's picture as a well-known form of bird trap, "in the Latin sense of a trick or trap: *machina*." He draws analogies between the four differentiated birds and the four figures that represent the cycle of success and failure in the traditional iconography of the Wheel

of Fortune. "If the *Twittering Machine* shows a limed twig, lures, and a death trap, these seem to express the idea that we are all ensnared by existence. . . . the raucous twittering makes us aware that . . . the arrows of Death are marked for every bird that sings" (p. 69).

104 El Lissitzky, "Die plastische Gestaltung der elektromechanischen Schau – Sieg über die Sonne," foreword to album of lithographs issued at Hanover, Leunis and Chapman, 1923. English translation adapted from one by Standish D. Lawder in *Form* (Cambridge), no. 3, December 1966.

105 "Nasci," *Merz* (Hanover), vol. II, April–July 1924; reprinted in *Manifeste Manifeste*, pp. 315–317.

106 "The Constructivist Ethos . . . Part I," p. 28.

107 Illustrated in *De Stijl* (Leiden), no. 6, May—June 1923, and in Friedrich Kiesler, "Debacle of the Modern Theatre," *The Little Review* (New York), 1926 (Special Theatre Number), p. 60, p. 63.

108 "Man and Art Figure" in *The Theater of the Bauhaus*, edited and with an introduction by Walter Gropius, translated by Arthur S. Wensinger. Middletown (Conn.), Wesleyan University Press, 1961, p. 17.

109 "Theater (Bühne)," *ibid.*, p. 88.

110 *The New Vision: From Material to Architecture*, translated by Daphne M. Hoffman. New York, Brewer, Warren & Putnam, Inc., 1930, p. 102.

111 "Dynamisch-konstruktives Kraftsystem," *Der Sturm* (Berlin), vol. XIII, p. 186; quoted in László Moholy-Nagy, *The New Vision*, p. 132.

112 *The New Vision*, p. 164.

113 Catalogue of Moholy-Nagy's first photographic exhibition, 1923; quoted in Sibyl Moholy-Nagy, *Moholy-Nagy: Experiment in Totality*. New York, Harper & Brothers, 1950, pp. 27–28.

114 *Vision in Motion*, p. 288.

115 Sibyl Moholy-Nagy, *op.cit.*, p. 129.

116 Quoted in German, without original source, in exhibition catalogue *Fernand Léger*, Munich, Haus der Kunst, March–May 1957, p. 31.

117 Quoted, without source, in Katharine Kuh, *Léger*. The Art Institute of Chicago, 1953, p. 33.

118 Fernand Léger, "A Propos du cinéma," *Cahiers d'Art* (Paris), vol. VIII, Nos. 3–4, 1933.

119 "My Ballet Mécanique," *De Stijl* (Leiden), No. 12, 1924–1925, pp. 141—144.

120 Fernand Léger, "A New Realism – The Object (Its Plastic and Cinematographic Value)," translated by Rosalind Gilder, *The Little Review* (New York), 1926 (Special Theatre Number), pp. 7–8. The preceding quotation comes from an article by Léger about his film in the same periodical (vol. X, Autumn–Winter, 1924–1925), in which he refers to "An important contribution due to a technical novelty of Mr. Murphy and Mr. Ezra Pound – the multiple transformation of the projected image."

121 *Ibid.*, p. 8.

122 Fernand Léger, "L'Esthétique de la Machine," *Bulletin de l'Effort Moderne* (Paris), No. 4, February 1924, p. 380; English translation by Ron Padgett, "Aesthetics of the Machine: The Manufactured Object, the Artisan and the Artist," *Art and Literature* (Paris), No. 11, Winter 1967, p. 162.

123 Quoted, without source, in Kuh, *Léger*, p. 30.

124 Andersen, "Notes on Tatlin," in exhibition catalogue, *Vladimir Tatlin*, p. 9.

125 "Art out into Technology"; English translation by Keith Bradfield, in exhibition catalogue, *Vladimir Tatlin*, pp. 75–76.

126 "Letatlin," *Vechernaya Moskva* (Moscow), April 6, 1932, no. 80 (2507), p. 2; English translation by Keith Bradfield in exhibition catalogue, *Vladimir Tatlin*, pp. 78–80.

127 *Rimbaud: Complete Works, Selected Letters*, translation, introduction and notes by Wallace Fowlie. Chicago and London, University of Chicago Press, 1966, pp. 56–57.

128 Note in Ernst's diary for 1935; quoted in *Max Ernst*, edited by William S. Lieberman. New York, The Museum of Modern Art, 1961, p. 18.

129 "An Informal Life of M. E. . . ." in *ibid.*, p. 8.

130 Alexander Calder, "Mobiles," in *The Painter's Object*, edited by Myfanwy Evans. London, Gerald Howe Ltd., 1927, p. 63.

131 *Calder, an Autobiography with Pictures*. New York, Pantheon Books, 1966, pp 126–127.

132 *Ibid.*, p. 127, p. 130.

133 Statement in "What Abstract Art Means to Me," *The Bulletin of The Museum of Modern Art*, vol. XVIII, Spring 1951, p. 8.

134 "Mobiles," *op. cit.*, p. 67.

135 *Self Portrait*, pp. 389–392. Although Man Ray has stated (questionnaire, July 18, 1966, Collection files, The Museum of Modern Art) that the original conception dates from 1923, the drawing (formerly in the collection of Tristan Tzara) is dated 1932, and *Object To Be Destroyed* was first exhibited in the *Exposition Surréaliste*, Galerie Pierre Colle, Paris, June, 1933.

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137 *Time* (New York), December 7, 1942, p. 61; *Current Biography*, vol. IX, September, 1948, p. 248.

138 Quoted in Theodore Huff, *Charlie Chaplin*. New York, Henry Schuman, 1951, p. 253.

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162 Nam June Paik, unpublished essay, "Rondo Electronique," 1968.

163 Reproduced in Lebel, *Marcel Duchamp*, plate 97.

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The literature on the history of technology and on various aspects of the interrelationship among machines, society, and the arts is vast. Many of these books and articles have been consulted in preparing this exhibition and its catalogue; references to specific sources will be found in the notes. The brief list below includes some useful basic books, most of which contain comprehensive bibliographies, and a few publications that have offered especially illuminating insights.

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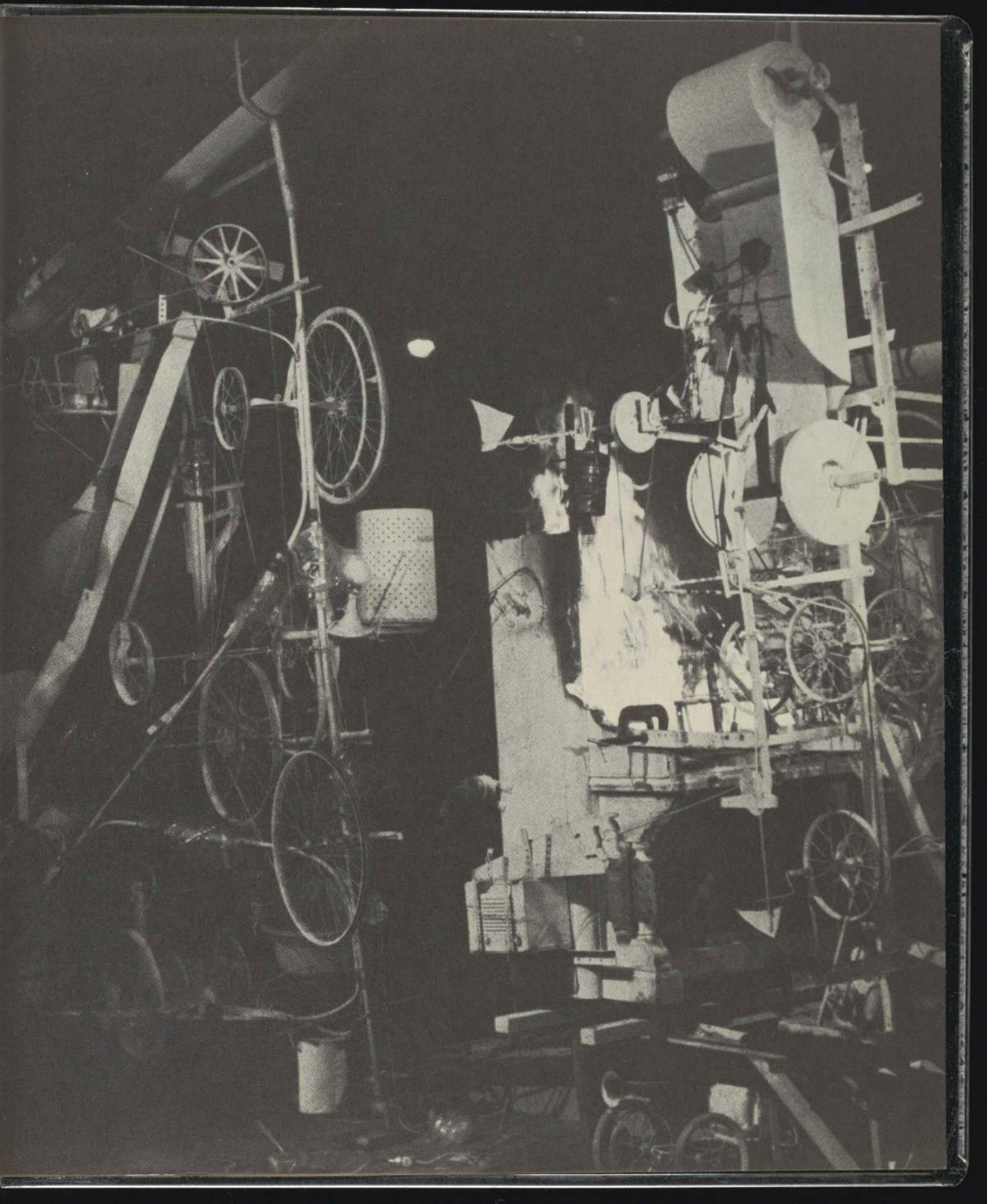

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