

# ANDROIDS



*the Jaquet-Droz automatons*

Scriptar ~ F.M. Ricci









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LES AUTOMATES  
*du célèbre Droz.*



# ANDROIDS

*the Jaquet-Droz automatons*

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*We wish to thank the Art and History Museum of Neuchâtel for its precious co-operation.*



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## Foreword

One fine day in October 1823, a Parisian opening his copy of the then-popular news sheet "Le Diable boîteux" (The Limping Devil) would have come across a somewhat breathless and admiring exhortation to go off and discover three unique youths currently in Paris. "Made of copper and cardboard, or of wood" it was written. But even if they were not of flesh and blood, they most certainly seemed to be alive.

One of these youngsters would artfully write in elegant script what you asked him to... Leaning over his table, another would painstakingly trace, with wondrous emphasis and subtle shading, most talented drawings. The third, a girl, would play charming if somewhat dated melodies on a bellows-operated organ. "Time goes on, all things change, the paper's correspondent noted, but they are, and they do, ever the same thing."

How many intrigued Parisians went to see *The Writer*, *The Draughtsman* and *The Musician* is not known. But more than two centuries after their birth, their adolescent bloom hasn't faded a whit. For this enduring youth, they owe eternal thanks to their creators, three incredibly inventive and immensely talented sons of Neuchâtel: Pierre and Henri-Louis Jaquet-Droz and the master mechanic Jean-Frédéric Leschot.

*The age of such intricate mechanical wizardry may have passed but our automated civilization certainly owes these precursors far more than it realizes.*

*As the curator responsible for the Jaquet-Droz and Leschot automatons, I can most emphatically vouch for their genius. It behoves us today to treasure and to preserve it faithfully. In the fall of 1977, therefore, the Neuchâtel Museum undertook a complete restoration of *The Musician* and a thorough refit of *The Writer* and *The Draughtsman*. This painstaking task was but the technical prelude to the inauguration of a superbly appointed room providing them with a setting worthy of their uniqueness.*

*I can only express my deep satisfaction and joy at the thought that our efforts have spurred others to devote a book to them. I trust that its message, more so even than *Le Diable Boîteux's* report, will carry their charm and their artistry far and wide. For truly they deserve no less.*

Jean Pierre Jelmini  
Curator of Neuchâtel Art and History Museum



## Introduction

Nature in many countries generated legends to which old rites are still linked: festivities with lanterns, noises made to chase away evil spirits, traditions whose origins are lost in the mists of time. There are other regions, often more rugged, where the legends are about the people who made them. The spirit of the place is a creative spirit and the hand of the craftsman has replaced the fairy's wand. How much of legend is there in the providential meeting of Daniel Jean Richard and the horse-coper Peter? How much of a gap separates myth from reality in the conversation between the dealer in horses and the man depicted as a pleasant young blacksmith who was to decide the destiny of a whole country's craftsmen and industry? Isn't he a worthy subject for a fairy story, transforming as he did the "montagnon" (inhabitant of the Jura mountains), who was quick-witted no doubt, but ignorant of worldly things and of learning, into the farsighted promoter of the watch industry in the Neuchâtel mountains? Isn't it extraordinary that a single gesture laid the foundations of what was later to become the world's capital of watch production?

One miracle leads to another and we can ask ourselves what spirit breathed on Pierre Jaquet-Droz, another inhabitant of the Mountains, so

that, besides the fabulous clocks which amazed the swells of the time and courts as prestigious as that of Spain, he began to create automatons, those people who come to life, draw, write, breathe and play music. Unreal creatures before whom we who live in a technically oriented and technology-worshipping civilisation are still stupefied.

What was the impulse that was so strong in Pierre Jaquet-Droz, this Neuchâtel "proposant" (candidate pastor), that it led him to give up his future ministry in order to take up a career which would make him equal to the most famous watchmakers, engineers and inventors of his time?

Several of his biographers tell us of his philosophy studies at Basle and of his meetings with the eminent mathematicians the Bernouilli, but there is no explanation of how he came to take up clockmaking and then moved on to automatons. Who taught him to handle his tools? Who influenced his mind? We will try and add our stone to the edifice of this history which is still in the making...

Pierre Jaquet-Droz: his age, his training, his ideas, his meetings - the philosopher, the mathematician, the watchmaker.

In 1711 Antoine Thiout published his treatise on watchmaking in which he summarised what was known in his time of the relatively new art of watchmaking. He set out diagrams of watches and clocks and showed drawings of escapements - the heart of the watch - and of all the instruments used by the craftsmen of the time.

About 15 years later, Jean André Le Paute, watchmaker to the king in Paris, also wrote a book on the same subject. In this one finds advice on the making and finishing of watches as well as drawings of large and small clocks, abstract calculations which were generally above the heads of workmen of the time, a design for two clocks with one wheel, etc.

These two works were read widely. In any case,

towards the middle of the 18th century, watchmakers did not have a real theory of their craft at their disposal. Even in the recognised centres this often amounted to uncertain groping in the dark, shored up with reasoning that could lead craftsmen astray, badly served as they were by their rudimentary tools. However, many masterpieces were made in this era, which is all the more to their creators' credit.

A man of genius was needed to set watchmaking on solid foundations. It was in these circumstances that Ferdinand Berthoud's book appeared with its modest title "Essays on Watchmaking". Well versed in mathematics, blessed with a happy spirit, with a penetrating mind, hardworking, indefatigable in research, he had no equal in the accuracy of his experiments and the soundness of his reasoning. He was the first to put the calculations required for their work within the reach of "provincial" craftsmen. Moreover he found the most practical ways of compensating for the effects of heat and cold and perfected the running of watches by making detached escapements with springs or balance springs, whose regularity and accuracy were to be perfected over the next two centuries. The principles and the ways of making isochronous balance springs were also invented by him. All in all, his plans and his calibres as well as all the parts which he made served as models for many years. These were astounding discoveries for those times and came from an inventive and fertile mind. They dragged watchmaking from the narrow sphere where it would perhaps have remained without the help and the insight of this man from Neuchâtel, who had become a Parisian and who finally published six volumes, with the admirable aim of instructing his fellow watchmakers. It is in this "technological" context that the mechanical genius of Pierre Jaquet-Droz was born.

#### Pierre Jaquet-Droz' training

*In the deeds of the Company of Pastors of*

*Neuchâtel dated June 1740 there is the following entry:*

*"Mister Pierre, son of Abraham Jaquet-Droz, of La Chaux-de-Fonds, having been examined in languages and philosophy and the Company having been satisfied by his replies and his testimony, has been accepted as a candidate pastor."*

*Later, in the same register, there is a single line: "Has given up the study of theology."*

*Between these two entries it is easy to imagine the first awakening, the development and the maturity of a scientific mind. Here was a process of maturing in which Pierre Jaquet-Droz, at first concerned primarily with spirituality, turned towards more mundane and practical objectives. Instead of being an unknown pastoral minister, he was to become a clever engineer and make his mark on Neuchâtel watchmaking, causing its fame to spread far beyond the frontiers of his small country, like that of the already widely known Geneva industry.*

#### Apprenticeship

*Many questions have been asked about the watchmaking and engineering apprenticeship of the young Pierre Jaquet-Droz. There are a number of things which we still don't know. For example, we do not even know the profession of his father, Abraham Jaquet-Droz. At most we can deduce that he was a well-to-do farmer who was sufficiently affluent and enlightened to steer his son towards higher studies...*

*Following his return from university - later we shall see the influence which his time in Basle had on Pierre Jaquet-Droz - he lived in a watchmaking environment. Family settlements, gifts, descendants and various documents have indicated that the businessmen, watchmakers and craftsmen of talent in La Chaux-de-Fonds constituted a group and were linked by bonds of friendship where they were not related. Pierre benefited from his contacts*

with the Sandoz, Josué Robert, the Brandt-called-Grieurin fathers, mothers and sons. Besides, he had already been able to watch with interest the work of one of his sisters who worked at watchmaking at home.

Pierre Jaquet-Droz in Paris

In the work entitled "Les étrennes historiques", dated 1862, the Abbé Jeanneret, very probably basing his evidence on a document produced by Phinée Perret of Le Locle at least forty years earlier, mentions that Pierre's first master was a "bad workman" employed by Josué Robert, living at Le Pont, a country property north-east of La Chaux-de-Fonds.

In turn Phinée Perret tells us that Pierre spent some time in Paris perfecting his craftsmanship and theoretical knowledge. Nothing, he adds, accounts for the rapid progress in watchmaking work here as much as the journeys made by the first watchmakers to this capital and centre of the arts.

Other works also mention that the King's watchmaker Josué Robert, relation and friend of the family, probably guided his first steps and influenced the career of the future engineer. But there is little definitive information on the seven years - 1740-1747 - of Pierre Jaquet-Droz' apprenticeship.

However at the end of this period his name was suddenly brought to the attention of his contemporaries when the Governor of Neuchâtel, representative of the King of Prussia, Monsieur de Nathalys, came with his attendants to admire a clock made by Pierre Jaquet-Droz on the occasion of a hunt at his country seat.

He was to return more than once to the workshop at "Sur le Pont". It should be noted that this visit up to a point marks the end of his period of apprenticeship and at the same time the appearance of the first fine works made by him, successes which were not entirely independent of



Pierre Jaquet-Droz (Oil portrait by Emmanuel Witz).

the cabinet-makers and bronze-founders of Paris, as - between 1747 and 1750 - Pierre Jaquet-Droz regularly visited the City of Light to order cases from its excellent craftsmen, and even from celebrated artists, which would be worthy of the fine mechanisms he had created. This didn't prevent him from marrying the daughter of his local supplier, who was also a researcher and inventor.

Incidentally, it is possible that Phinée Perret confused various facts connected with Pierre Jaquet-Droz' stay in Paris and the theoretical knowledge which he could have acquired during his apprenticeship; it is also probable that his alert mind was able to benefit from his subsequent travels.

#### Setting up

On 25th October 1750, Abraham Louis Sandoz-Gendre, civil lieutenant and maker of clock cases, gave his daughter Marianne in marriage to Pierre Jaquet-Droz. (He had been named "extra judge" in June and then counsellor of the bourgeoisie in July of the same year).

He was 28 years old; he set up house and installed his workshop at "Sur le Pont". His first child, a daughter named Julie, arrived on 25th July 1751. On 13th October 1752, his son Henri-Louis was born and, finally, his daughter Charlotte on 25th May 1755.

This last childbirth left his wife very weak and she never recovered. Every apparent improvement was followed by a relapse and she died surrounded by her family on Christmas morning. The youngest of the children did not survive her mother for long, dying on 3rd February 1756 at the age of eight months.

Honoured by his fellow citizens, who had already elected him to public office, and having achieved considerable professional success, though this was still in its early stages, fortune had smiled on Pierre Jaquet-Droz. But now he had paid a heavy

tribute to fate.

In a normal reaction to such deep sorrow, he buried himself in his work, researched unknown systems and entered his first period of gestation, which led him to create the magnificent clocks which brought about the famous journey to Spain. In the meantime Pierre Jaquet-Droz adopted Jean-Frédéric Léschot (1746-1824) whom he instructed in his profession, while his own son Henri-Louis studied in Nancy. Employee, then partner, Léschot continued his master's work until 1824, the year of his death.

#### Lord Keith

At this point a character appeared who had a strong influence on events, particularly those of a commercial nature, which concerned Jaquet-Droz and his future ventures. Lord Keith, had succeeded Monsieur de Nathalys, who had died in 1754, as Governor of Neuchâtel, representing Frederick II of Prussia, sovereign of this Principality.

The Scottish nobleman was an unusual personality. Lord Keith, Hereditary Marshal of Scotland, one of whose ancestors founded Marshal College in Aberdeen in 1593, was the eldest son of William, Lord Marshal of Scotland, born about 1685 in the county of Kincardine. After an excellent education he became captain of Queen Anne's guard and fought with distinction under Marlborough.

In 1715 he placed himself on the side of the Stuarts and made Scotland take up arms. A price was put on his head and he had to go into exile. Taking refuge first in Spain, he later rejoined his brother who was in Prussian service and formed a friendship with Frederick II, who always regarded him with great esteem. The King of Prussia entrusted him with several diplomatic missions including the government of Neuchâtel; then he took advantage of his alliance with England to ask for the rehabilitation of the Marshal of Scotland, which he obtained. So Lord Keith saw



spring, Morteau, Arbois, Lyon, Valence, Montélimar, Nîmes, Montpellier, Béziers, Narbonne, Perpignan, Barcelona, Saragossa amongst others marked the stages of the long but trouble-free journey to Madrid, which they reached 49 days later.

Their reception by the nobleman Don Jacinto Joveri, personal friend of the Lord Marshal, their settling in, the menu for their luncheons and dinners, the meeting of these Neuchâtelois with fellow countrymen, watchmakers working for Lanthéoum, a Madrid customer whom Pierre Jaquet-Droz (who produced other things as well as clocks) already knew - all this has been related in detail by the biographers of the master, thanks to the diary carefully kept by Sandoz-Gendre, from which many quotations are to be found.

Let us note - apart from the discovery of the tomato, the cucumber and other exotic foods by our travellers - the numerous visits which they paid to towers, castles and churches equipped with monumental and astronomic clocks and even automatons.

While waiting to be received by King Ferdinand VI our watchmakers in Madrid looked over their works again, cleaning them, winding the Stork Clock, the Negro Clock, the Shepherd Clock, the organs, the bird-organs and the repeater mechanisms, and repairing the clocks belonging to leading people...

Ferdinand VI was sick and the Queen was dying. Her funeral took place in the last days of August 1758 and it was only a week later that Jaquet-Droz was received by His Majesty the King and showed him his works... The meeting was a success but although the sovereign, whose condition had worsened, went each evening to set the clocks going in the palace chamber of which he alone had the key, he delayed giving his answer. In addition the stay, however pleasant, was becoming drawn out.

Winter was approaching and at the end of November Jaquet-Droz received a promissory note for two thousand gold pistoles. He could now think

about returning to his country, fully rewarded for his work and his patience.

The young watchmaker Jacques Gérril stayed on with Lanthéoum, while the return journey started on 23rd January 1759. Two months later, on his return to the Neuchâtel mountains, Jaquet-Droz was not only the most esteemed person in the region but his reputation had also crossed other frontiers, bringing in orders and tidy sums of money and making the local watchmaking industry very well known abroad. Respect, honours and work followed, but also political responsibilities which we will not dwell on here.

“Jet d’Eau”

Overwhelmed with work, Pierre Jaquet-Droz engaged a tutor named Duplessis to whom he entrusted the education of his children. Between 1760 and 1773 there is little information about the professional activity of the master watchmaker, although we hear a great deal about him in connection with public life, in which he had become very active.

But work continued and the workshop at “Sur le Pout” had become too small. He therefore moved to “Jet d’Eau”, a building situated at the place where the Prefecture of the Mountains is to be found today at La Chaux-de-Fonds (opposite page). And then came his illness. In May 1760, as a result of overwork, he had a nervous breakdown, described by Gagnebin, doctor at La Ferrière (the first Jura village to the east of Neuchâtel) as “painless lethargy”... from which however he quickly recovered.

However this period was important: it is certainly from this time that the regular discussions between Pierre Jaquet-Droz and his friend Dr. Gagnebin started up again. We know that apart from the philosophical and scientific discussions which they had, they went through various publications such as “Nouvelles récréations physiques et mathématiques” by Monsieur Guillaud of the literary Society of



*Besançon, published in Paris in 1769, in which the description of systems hitherto unknown were to be found. There were so many subjects for discussion and so many digressions in which the two fertile minds must have rebelled.*

**Influence of the Bernouilli, the Gagnebin and of Jacques Vaucanson on the construction of the Jaquet-Droz automatons**

*We find, in the registers of the faculties of theology and philosophy of the University of Basle, entries in the name of Pierre Jaquet-Droz dated 7th January 1738. His meetings with famous professors and notably the Bernouilli date from then. This family, illustrious because of the series of first-class geometers it produced, originally came from Antwerp, but in the 16th century the wars of religion had driven it to emigrate to Basle where it rose to the highest positions in the Republic.*

*The Bernouilli were already very famous people when Jaquet-Droz arrived at the faculty of philosophy of the College of Erasmus, but with regard to their influence on the construction of the automatons or on the idea that perhaps germinated in the mind of the future watchmaker engineer, it is worth taking one very significant fact into account: in the archives of the Canton of Basle, in the "Straf- und Polizeiakten" Schausstellungen 1667-1865, texts have been found which prove that in 1709, 1716, 1724, 1738 and 1743 constructors and wandering performers asked the Basle government for permission to give public shows of plays and unusual automatic machines. The authorities several times entrusted the two professors Jean and Daniel Bernouilli with the task of examining the mechanisms and preparing a report. We can therefore deduce that they were already familiar with these kinds of mechanism.*

*We can also assume that Daniel Bernouilli, as a physicist, must have been interested in these mysterious mechanical and watchmaking contrivances much earlier and that in at least one of the analyses he was helped by Pierre Jaquet-Droz, who was probably placed under his instructions in 1738 and 1739. From there to admitting that Daniel Bernouilli influenced his pupil not only on questions of philosophy, which is obvious, but also in scientific investigation and the different methods of carrying it out, is just one step more that we are tempted to take.*

#### **Vaucanson: artificial life**

*The influence of Jacques Vaucanson on the life of Jaquet-Droz has also been mentioned. This eminent engineer and inventor, born at Grenoble on 24th February 1709, had from an early age shown a particular aptitude for his art. In his extreme youth and using rough tools, he had already succeeded in producing a wooden clock which kept exact time. This success served to increase his enthusiasm. His urge to study the exact sciences took him to Paris and, on seeing the statue of the flautist in the Tuileries gardens, he had the idea of making an automaton which played tunes. He succeeded, and when one knows that this masterpiece was finished in 1738 and shown in the same year at the Academy of Sciences where it excited the admiration of all, one can understand that there was plenty there too to stimulate the imagination of a Pierre Jaquet-Droz.*

*This automaton was followed by other more complicated ones like the tambourine and flute player but above all the famous duck, which imitated all the movements of a living creature, including that of eating... and digesting. The story goes that when Vaucanson went to see the automatons and was unable to understand how the limbs worked before he had examined them, he said to Jaquet-Droz: "Young man, you're beginning where I've ended..."*

*Vaucanson had used almost the same mechanical system as Jaquet-Droz; but he never went to the same lengths as his famous junior in exploiting all the different possibilities...*

#### **Jaquet-Droz and Dr. Daniel Gagnebin**

*There is much to be learned from the writings of the banneret Samuel Osterwald on the subject of the Gagnebin. For instance, they were modest scientists, according to his description, and scholars of the solitary pioneer type, working more for love of science than for fame. However, their natural history collection was famous and visited by numerous foreigners.*

*Pierre Jaquet-Droz' friend Daniel Gagnebin had been a doctor and captain in a French regiment. He had become very interested in watchmaking and had been very helpful to the La Chaux-de-Fonds craftsmen. Osterwald wrote about him: "He invented a machine specially designed to prick with the greatest exactitude the cylinders or rollers required for chimeing clocks, he made artificial magnets, learned about the phenomena of electricity from his own experiments and also took up optics."*

*After his visit, Horace Bénédict de Saussure talked most of all about Daniel's brother Abraham. For example, he noted that his collection, which he called his "habitation", looked like Noah's ark... "It's an example", he wrote, "of a confusion of half-pressed birds, of pinnates, of shells, of fossils, in the middle of which there are puppets, dolls and ugly artificial flowers, while the Master, dressed as an old French nobleman, shows you these things all jumbled up".*

*The reference to puppets and dolls is not without interest for us and the question which has always been asked, and with reason, is whether Daniel Gagnebin didn't play a direct part in the construction of the automatons of Jaquet-Droz. Before the trip to Spain he had already recommended the use of artificial magnets of his*

*own manufacture to bring about certain special effects in the automata clocks shown to the King of Spain.*

*At any rate it is almost certain that the surgeon was involved in the conception of the automatons' limbs and notably in the Musician's dexterity, in her nimble fingers, perhaps in her breathing and her gaze; in short in all the movements which surprised the spectators of the time and which still fascinate us...*

*Daniel Gagnebin was also, there's no doubt, one of the originators of the artificial limbs, which he probably thought up with Jaquet-Droz and had made by Leschot and which are written about abundantly in old works and more especially in the book entitled "Le monde des Automates" by Alfred Chapuis and Géhis, in the chapter covering automatism in orthopaedics.*

*Essay on the origins of the automatons of Jaquet-Droz*

*Such were the ways in which the thoughts of the Bernouilli and the Gagnebin converged to make possible the materialisation of a dream and the translation into reality of creative ideas.*

*Some people profess to see in the automatons of Jaquet-Droz the whole humanist theory of the 18th century and a fabulous culmination of all its culture, tendencies, points of interest and passion for the physical, surpassing with the three figures (the Druggist, the Writer and the Musician) everything that had been done before of this kind, and which has never been equalled since, except perhaps with the machine tools of our century, where one finds the same combinations as those perfected by Pierre Jaquet-Droz, his son Henri-Louis and his partner Leschot. On the subject of the Musician, the only doll in the world that breathes (sharing our life, appearing to take breath from the same air as us), it has often been asked if, like the future Eve of Villiers de l'Isle-Adam, instead of carrying on a heavenly dialogue, she*

*wouldn't offer herself through her high-pitched music to lovers lost in unreal pleasure or even revive in Pierre Jaquet-Droz the immortal memory of his young wife lost for ever...*

*Perhaps our pragmatic engineers have been seduced by the myth of Pygmalion or haunted by the dreams of Condillac imagining that his statue was alive?*

*We feel it is desirable to demystify the automatons or at least the story of their invention and construction. The Jaquet-Droz and Leschot families were already rich, established and famous when they worked out the plans, imagined the effects that could be achieved and constructed these marvellous automatons.*

*As a result, why not simply admit the need that people have to improve on what they have already done, like a bet taken on and won by someone with a competitive spirit, which was as much the impulse behind the construction of Ducommun-called-Boudry's famous "apostles" clock as behind all the inimitable masterpieces of watchmaking that followed.*

*But then, is there much point in eliminating myths? Whether it be that of the friendly blacksmith of La Sagne or of the brilliant creator of the automatons of La Chaux-de-Fonds, still to be seen today at the Historical Museum in Neuchâtel? Rousseau, Voltaire, Anderson, de Saussure and many other famous people have spread the word about the Neuchâtel mountain craftsmen and their works. Osterwald the banneret had sometimes been their salesman! Apart from his publishing activities, he had a shop where books, luxury clocks and watches as well as snuff-boxes with clockwork singing birds were sold to important people of the time. Pierre Jaquet-Droz had imagination and ambition... It's not impossible that this analyst of life in the Principality of Neuchâtel, who described it better than anyone else, asked Jaquet-Droz to do something never done before... Not just to do as well but to do better than the best so far, to find*

better solutions than they had to the difficult and inevitable problems of artificially copying life, to go much further in giving a human appearance to automatons which had been so much admired and which were very fashionable at the time.

Thanks to his comfortable circumstances Pierre Jaquet-Droz was able to dedicate himself to his research in the mechanical field and together with his friends obtain the maximum from his knowledge and experience in order to achieve

spectacular results. While it's certainly true that the Jaquet-Droz automatons do not exactly copy the processes of nature, the harmonious working of the bones and sockets and of the human body, they do however give a perfect imitation of the effects.

In addition, contemporary opinion went far further than simply finding these objects of curiosity.

People had ideas for other developments: using combinations of caws, chains and rods to help reproduce certain documents and to copy craftsmen's movements, thereby freeing the workers from certain tasks and from monotony. All this came to a head with the publication of a work entitled "L'isographie" which was often consulted at the beginning of the 19th century and provided very useful information to help improve a number of techniques.

The automatons, as we have already indicated, brought about considerable progress in mechanical engineering, which is at the centre of all industrial production and heralded the dawn of the machine age. Vaucanson had also set an example by installing his machines in French factories.

When Jaquet-Droz' little clockwork family was exhibited for the first time, it already represented a synthesis of ideas and the arrangement of certain elements in a way never known before.

Logic, continuity and coherence. The works of Descartes, the writer, exhibited in Vienna in 1760, had been overtaken and so had the wonderful toys made by Vaucanson and previous achievements like the clockwork-powered wooden pigeon of

Archytas which could fly, the automaton of Albert Le Grand which opened the door of its cell and made noises to welcome the person who entered it, the iron fly of Jean Miller called Regiomontanus, the heads of the Abbé Mical and so many other objects described by writers and poets of every age since Antiquity; it is certainly true that the artificial imitation of life seems to have always been one of man's principal subjects of interest.

### Jaquet-Droz' business

To understand what follows it is worth returning briefly to the organisation of Jaquet-Droz' business. Between 1760 and 1767, Pierre Jaquet-Droz' son Henry-Louis and Jean-Frédéric Leschot were students together and together they were initiated into the profession of mechanical engineering.

In 1767 Henri-Louis Jaquet-Droz was 15 years old. He was then sent to Nancy where he was put in the care of the Abbé de Servan who taught him mathematics, physics, drawing and music. On his return two years later, Leschot had a share in the Jaquet-Droz business and the three began to work together. The first represented science and the inventive mind, the second the clever hand of the craftsman and the third artistic taste. In 1773 the Draughtsman and the Writer were completed, as was confirmed for example by a letter from Suzanne-Louise Nicolet, friend of Jaquet-Droz, to her brother who was a tutor in Utrecht and who is quoted in various works. This letter says:

"I don't know if I told you about the works of Monsieur Jaquet-Droz which have caused such a stir. I can't tell you how beautiful they are, but amongst them there is a draughtsman who draws different things and a writer who writes what one dictates without being touched..."

This letter is dated 19th October 1773. It also mentions that the Jaquet-Droz son would be leaving the following day for England with his works and with four employees. On 20th October 1773 Henri-Louis did in fact leave for London

where he set up a branch of the business which opened in January 1774.

#### First exhibitions of the automatons

*"We saw the noblemen of neighbouring countries and the cantonal magistrates with their families, the French ambassador himself was there incognito", recalled Isaac Droz in a letter in July 1774 to Monsieur de Lentulus, governor of Neuchâtel, who was in Berlin at the time. The automatons were exhibited at La Chaux-de-Fonds in the drawing-room of the Jaquet-Droz' house. Soon they left this town - or rather village - for Paris where they first made an appearance in January 1775.*

*On the 25th of that month they were mentioned in the following terms in "the political and literary newspaper covering the principal events at all the courts and literary news":*

*"The creator of these works is Monsieur Pierre Jaquet-Droz, native of Neuchâtel in Switzerland. He is to be found every day at the Hôtel Lubert, rue de Cléry, in the mornings from 11 o'clock to 2 o'clock and the afternoons from 5 o'clock to 9 o'clock. The first places cost six livres and the second three livres."*

*It should be noted that the prospectus distributed in Paris mentions that the entrance is covered and you cross two large courtyards where carriages wait: "liveried servants would not be admitted, even for payment..."*

*That same year the automatons were shown in London.*

*From Paris, which seems to have been their home base, they made their appearance between 1775 and 1783 in Holland, in Flanders and in Northern France, accompanied on their travels by Leschot or by another employee. Contrary to the legend, Louis XV - known as "The Beloved" - never saw the automatons, which arrived in Paris after his death. However the Draughtsman drew the portrait of the dead monarch.*



*Jean Frédéric Leschot.  
(Oil portrait by Grosclaude), property of the Société des Arts  
of Geneva.*

*Queen Marie-Antoinette and her followers, Louis XVI and numerous courts and sovereigns were able to admire the Writer, the Musician and the Draughtsman. The story is even told that Leschot, overcome with emotion before Marie-Antoinette when announcing the portrait of King Louis XVI, reversed the cams which controlled the automaton's hand and another drawing appeared - one called "My doggie" - which caused general consternation.*

#### *Return to the mountains*

*In 1785, Jaquet-Droz' little clockwork family was exhibited for charity, first in Geneva, then at La Chaux-de-Fonds, in aid of the hospitals in these two cities. At the same time, on 24th September 1785, Henri-Louis became a member of the bourgeoisie of Geneva, as did Jean Frédéric Leschot some time later.*

#### *The business prospers*

*What happened to the business during this time? Henri-Louis was running the London branch where they made handsome pieces for export to China. He often made the journey between La Chaux-de-Fonds, Paris and London, while Pierre didn't go to London until 1776. The business moved to Geneva in 1784 as Henri-Louis Jaquet-Droz could not endure the English climate any longer. However, in May 1783, in order to maintain a presence in London, he set up a new business in the British capital in association with Henri Maillardet, one of his best Neuchâtel employees. The situation in 1784 was the following: the parent company at La Chaux-de-Fonds was fully occupied; in 1782 a company named Jaquet-Droz et Leschot was founded in Geneva (it will be recalled that Leschot was already associated with the business at La Chaux-de-Fonds); in London there was Jaquet-Droz et Maillardet. Their outlets were China, the Middle East and India as well as the courts and most important personalities of Europe. The apogee*

*of the business came during the years 1786 and 1787. The beginning of its decline was two years later, in 1788 and 1789.*

#### *The automatons*

*The situation was as follows: in 1786 Henri-Louis was the owner of the Draughtsman and the Musician. In 1787 Pierre handed over the Writer to him. And by 1789 the automatons were no longer included in the inventory of the business! This is nothing less than a sign of the rapid collapse of a business which, at the time when the exhibition for charity had taken place in Geneva and La Chaux-de-Fonds and after ten years of the automatons' travels, had been at the height of its artistic and industrial fame.*

#### *Collapse*

*The association with Maillardet in London was soon brought to an end because of insufficient business and then in 1790 Pierre Jaquet-Droz died, in Bienne where he had retired. He was buried in the city cemetery where the Technicum is to be found today: a worthy monument to his genius... Henri-Louis died in 1791.*

*While the Jaquet-Droz' business was liquidated by a close friend of Henri-Louis called Ami Isaac Dasser, the collapse of the famous firm of Cox, which allowed its bills to be protested, was another serious blow. (This London company had large offices in the Far East and played an important role in the history of Swiss watchmaking, notably in the distribution of Swiss products.) The remaining partners, Jean Frédéric Leschot and the Jaquet-Droz family, had to bear respectively one quarter and three quarters of the losses, in proportion to their shareholding. Jean-Frédéric Leschot, after taking over the business, had to struggle in very difficult circumstances. The former employees, specialists in making the singing birds and the marvellous jewels which came from the Jaquet-Droz workshops,*

survived with difficulty, sometimes taking round and exhibiting "curiosities" from town to town. But interest in these objects had largely disappeared with the Revolution and the wars.

It is interesting to note that amongst the employees cast adrift there was a man named Jacob Frisard, of Villeret in the Bernese Jura, who was still making singing birds in 1793... In 1809 he and his wife put on an exhibition of curiosities in Zurich where they showed clocks with automatons. In between, in 1807, Jean David Maillardet was exhibiting automatons in France. In 1809 he showed the same pieces in Geneva, though without much success. The publicity was badly organised and taste had changed. Between 1804 and 1807 Leschot had sold mechanisms to Jean David Maillardet, though he was not paid. Later on he accused him of presenting the inventions of Leschot and Jaquet-Droz as his own work.

#### Further travels of the automatons

It is worth recalling the story of Maillardet's automatons which finished up by being sold by auction at the beginning of March 1847 at Valangin. The two families of automatons - those of Jaquet-Droz and Maillardet - had travelled all over Europe and caused very understandable confusion amongst the public...

What happened to the masterpieces of Jaquet-Droz during this time? In a letter dated 29th April 1806, Leschot confirms to Messrs. Lorimier in Paris, who were looking for automatons to buy for their gallery, that the ones in Monsieur Droz' drawing-room had been sold 18 years earlier to Messrs. Gendre Frères, a French firm in Madrid. We know, the letter adds, that the pieces are in bad condition, abandoned in various Spanish towns... this company's fortunes and activities having been seriously affected by the war.

The sale to Messrs. Gendre Frères is confirmed by a document in the possession of Messrs. Vacheron Constantin & Cie, Geneva. The deal had been



Henri-Louis Jaquet-Droz  
(Miniature by Louis Arlaud)

concluded on 20th October 1787 and the pieces had been sold for 41,000 French livres. In addition to the Musician, the Draughtsman and the Writer, there was a group called "La Grotte" which represented several lively scenes in a pastoral setting.

In 1806 these pieces were somewhere in Spain...

In 1809 Napoleon's armies entered Saragossa. Art lovers among Napoleon's officers brought back the best known works to their country. Others were to do likewise at a later period in history. It was under French military "protection" that the three automatons came back to France. (La Grotte seems to have completely disappeared).

In the 1823 edition of the "Encyclopédie des gens du monde", volume II page 577, we find: "Monsieur Joseph Droz, mechanical engineer of the Monnaie in Paris, exhibited three automatons: one which writes, one which draws and one which plays the piano..."

There is no doubt that these are the pieces brought back by the French armies. In fact, it is not only the similarity of the trio which proves it but the fact that after having been at the Château de Matignon sur Bayonne, the Jaquet-Droz clockwork family was repatriated to Paris. It is therefore reasonable to assume that its restoration was entrusted to the best mechanical engineer available there, at the Hôtel des Monnaies. It is curious that the clever craftsman "anxious to share in the glory of Jaquet-Droz" as an anonymous author said at the time, was also called Droz. Having removed the rust from the mechanical parts, he put the automatons on show at a house situated where the Boulevard Montmartre crosses the rue Richelieu.

In 1825 the automatons appeared at the Paris Exhibition. In 1828 they were at Voghera, then at the Duke of Parma's court. At the beginning of the 1830s they were exhibited at Le Locle, in 1833 they were in Geneva where the "Journal de Genève" talked about their trip to Italy and gave the names of their new owners - Messrs. Martin and

Bourquin - who kept them until 1840.

From Geneva the Writer "sent" a letter to the widow of Monsieur Leschot who came with her daughter to see the three clockwork children. Her daughter made them new costumes in keeping with the fashion of the time. In 1834 it was back in Neuchâtel and then there is a gap of more than 50 years!

Where were the automatons? Monsieur Auguste Bachelin wrote in 1888 that the writer still existed and was somewhere in Russia. In reality, the three automatons - to which a fourth had been added, a porter towing a heavily loaded carriage which had been constructed by the collectors Bourquin and Martin - continued their endless journey throughout Europe under the management of these two collectors. Various landmarks: Cologne in 1880 and Dresden in 1881, etc.

In 1883 Mr. Martin offered everything for sale for the price of 15,000 marks. Or possibly for hire to travelling showmen. Nobody took up this offer, according to the "Neuchâtel Museum" in 1894. A year after the announcement of the death of the Martin grandfather his widow said she was prepared to sell them for 150,000 francs!

"Will no official voice be raised to demand the return to this country of the masterpieces so dear to us?" asked the article which appeared in the magazine mentioned above... After laborious negotiations which continued intermittently for nearly ten years, Madame Martin passed the three automatons on to Mr. Carl Marfels of Berlin, a famous collector who entrusted their restoration to a mechanical engineer named Froelich.

#### Public subscription

In 1905 exhibitions, designed above all to influence public opinion in favour of the automatons, were organised at Le Locle, at La Chaux-de-Fonds, then at Neuchâtel. Following negotiations started by a delegate of the History Society of the Canton of Neuchâtel, Monsieur Marfels in turn decided to

*resell the automatons.*

*1906: the Writer became spokesman for his brother, the Draughtsman and his cousin, the Musician, when he wrote the words "We will never leave our country again". The public and the authorities of Geneva, Neuchâtel and the Confederation undertook to purchase the little family. In 1907 the Geneva Arts Society organised an exhibition in the great hall of the Athénée featuring the automatons of Jaquet-Droz and Leschot. Watches, clocks and regulators of the same era were also exhibited. The automatons then visited Bienne, Lausanne and once again Berlin. After the First World War when Marshal Joffre paid a courtesy visit to the authorities of the canton of Neuchâtel, the writer paid homage to him by writing "Glorie to Joffre, Foch and Clémenceau".*

*Since then many people famous in the worlds of politics, science and showbusiness have come to admire the three automatons. In 1932, during the watchmaking crisis, La Chaux-de-Fonds organised an exhibition in order to try and get business going again and the three automatons were put on show. It was a success. The following year the operation was repeated and the exhibition was named the "First Swiss Salon of Watchmaking". There were many foreign visitors, many future purchasers... The automatons had contributed, if only in part, to the revival of business.*

*For the tenth anniversary of the exhibition "Montres et Bijoux" in Geneva, a whole collection of automatons was assembled for an exhibition: there were more than 300 exhibits, old and new, and the three automatons of Jaquet-Droz had the place of honour. It was an unprecedented success, in fact so much so that the organisers had to extend it by a week.*

*In 1954 the three clockwork figures crossed the frontier again on their way to Paris for the exhibition "Horloges et automates" organised at the "Musée du Conservatoire national des Arts et Métiers" on the occasion of the International*

*Congress of Chronometry. They were to be found beside the dulcimer player which is known to have belonged to Marie-Antoinette!*

*In the spring of 1961, in response to the wishes of "Watchmakers of Switzerland" the automatons were sent to Boston USA, but each piece in a different plane in order to spread the risk.*

*The three little figures attracted a crowd to the city's Science Museum such as had never been seen before! Then to the Smithsonian Institute in Washington. Afterwards they returned to Switzerland and, in 1964, during the "Hong Kong Swiss Watch Fortnight", the Writer and the Draughtsman took the plane from Zurich to the Far East. The two figures were received by a large crowd in the city where they were surrounded by armoured cars for protection: at over 190 years old they were still true stars!*

*It is not surprising that after so many journeys and so many adventures and in spite of the care that has been taken of them, they are tired now and sometimes ill; like the Musician who needs a serious operation... to rejuvenate her.*

Roland Carrera

Neuchâtel: from Roman Gaul to the King of Prussia and the Helvetic Confederation

*The Gallic territory of Neuchâtel, occupied by a Celtic branch (the Belgæ), was situated at the borders of the Sequani and Helvetic countries. At the same time as the Kingdom of the Burgundians, of which it was part, it passed in turn to Roman Gaul, the Sequani and the Merovingians. Once it had come into being as a country, Neuchâtel soon joined the Holy Roman Empire. When Charlemagne's empire was split up Neuchâtel remained part of Burgundy. Ulrich of Vinelz (in the Canton of Berne, on the shores of the Lake of Bièvre) was the first member of the House of Neuchâtel in the year one thousand. His descendants took the title of Lords of Neuchâtel about a century later. There were five generations of them before the Countess Isabelle succeeded on the death of the last male of the House. The succession then passed to the Fribourgs, the Hochbergs and the Orleans-Longuevilles, before a dispute broke out between the pretenders at the end of the 17th century. There were not less than fifteen of them, Latin as well as Germanic. The choice, which was between the two last, the Prince of Carignan and the King of Prussia, was made in favour of the latter and Frederick-William I became the sovereign of the Principality of Neuchâtel and Valangin in 1713. In 1740 Frederick II succeeded him, then Frederick-William II (1786-1797), Frederick-William III (1797-1806 and 1814-1840), the two periods being separated by French domination and the reign of Marshal Alexandre Berthier. Helvetic admission in 1814, combined with Prussian dependence, constituted, until the Neuchâtel revolution of 1st March 1848, the last act of this series of suzerainties before the territorial and political fate of the Republic and Canton of Neuchâtel, twenty-first state of the Swiss confederation, was sealed.*

## The Bernouilli - men of learning, philosophers and mathematicians

The first of the Bernouilli to become a famous scientist, Jaquet Bernouilli, was born in Basle in 1654 and taught mathematics there from 1687 until his death in 1705. Together with his brother Jean and to the great admiration of the European scientific world, he developed in the *Acta Eruditorum* of Leipzig the marvellous potential of differential calculus, of which only the general principles and algorithm had been indicated by Leibnitz, with his penetrating and multifarious genius. A collection of his complete works appeared in Geneva in 1774 under the title of "Jacobi Bernouilli Opera". It consisted of two quarto volumes. However, the work for which he will perhaps go down in history is the one in which he laid the foundations of the mathematical and philosophical theory of probability. His nephew Nicolas Bernouilli had it published after his death, under the title of "Ars Conjectandi" in Basle in 1713. It is in this work that the theorems which bear his name and deal with the laws of probability - resulting from the repetition of events appear and on which all the practical applications of the theory of chance rest. His brother, Jean Bernouilli, born in Basle in 1667, took over his teaching work and continued it until his death on 1st January 1748. Jean Bernouilli's work was also collected together and published in Geneva in 1742 in two quarto volumes. Endowed with a mathematical intelligence that was perhaps even more acute than that of his brother, he was ranked by his contemporaries with Newton and Leibnitz and is regarded as the true inventor of integral calculus. As a result of the progress in mathematical sciences, his work is only of historical interest.

Nicolas Bernouilli, the nephew of the two brothers, combined the study of geometry with that of law and attracted attention with a thesis on missing persons in which he proposed to apply the

calculation of probability to this difficult question in jurisprudence. At this point another of Jaquet-Droz' teachers appears, since there is reason to think that he was in contact with Jean Bernouilli; this is Daniel Bernouilli, one of Jean's sons, who was born in Grenage in 1700 and who died in 1782. He maintained the family reputation during the 18th century and was a worthy emulator of the Clérands, D'alamberts and Heulers. He was honoured ten times by the Paris Academy of Science and his dissertations appeared in its collection as well as those of Berlin and St. Petersburg. His father and his uncle had supported the school of Leibnitz and had subsequently been formidable adversaries of Newton's doctrines, which the English geometers had all supported. But Daniel followed the development of theories in opposition to the geometers of his time by working out the theory of the world based on Newton's gravity. A clever physicist as well as a deep-thinking geometer, his abilities in both these fields were put to work in his great treatise on hydrodynamics, published in Strasbourg in 1738, the year that Jaquet-Droz arrived in Basle. Like most other members of his family, he studied the mathematics of probability and it was he who, in the transactions of the Academy of St. Petersburg, put forward the paradox which became famous under the name of the "Problem of Petersburg", and who worked out the theory of moral hope to resolve it. The process of inoculation gave him another opportunity to apply the theory of probability and he had a number of lively differences with D'alambert on this subject. It would be possible to list a whole crowd of other less well-known geometers from the same family. The last to make a reputation for himself, at least abroad, was Daniel's son, who lost his life bathing in the Nera in 1789.

## The Gagnebin and Osterwald the banneret

If you talk about the Gagnebin you have to include the banneret<sup>1</sup> Frédéric Samuel Osterwald, who was well known in the Neuchâtel region. He published a work entitled "A description of the mountains and valleys of the Principality of Neuchâtel and Valaugin", which originally appeared in the "Journal hévétique" in 1764 and then as a book in 1766, with various additions and corrections. This book was republished in 1861 by Victor Benoît and finally by the printing house of Courvoisier of La Chaux-de-Fonds in 1913, with a full introduction and numerous illustrations, most of which were taken from old engravings of the time. Osterwald's work resembled what today would be called a reportage. It went into great detail and constitutes the only important document of the 18th century which covers both the economy and the industries of the Neuchâtel mountains. Osterwald wrote extensively. In passing one might add that he was related to the great theologian Jean Frédéric Osterwald whose Bibles in their original edition are much sought after by bibliophiles. He was commissioned to write the article on Neuchâtel in the "Encyclopédie" of Diderot and was a man of considerable culture and talent. He was also so eloquent that the people of Neuchâtel called him "Bouche d'Or" (golden mouth). Osterwald was therefore one of the most prominent people of Neuchâtel. Furthermore, in his capacity as banneret, he was head of the militia and of the bourgeoisie, belonging to what at the time was called the "Quatre Ministraux" which was in a sense the executive of the town. In June 1769, with his son-in-law Jean Elie Bertrand and two other members of the bourgeoisie of the city, he founded the Typographic Society of which he was one of the leading lights. Later on he had to resign his post of banneret because this society was commissioned from abroad to print a work entitled "Systems of Nature" whose

atheistic character caused a scandal in the principality. We know that this scandal attracted Voltaire's attention and that he wrote an ironic letter about it to Frederick II of Prussia, but finally the excitement died down after several years and Osterwald joined the town council again and was reinstated as Master of the Bourgeoisie. He also recovered his rank of banneret.

(1) Master of the Bourgeoisie, member of the Town Council and honorary standard bearer, head of the militia.

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*The Writer*

## *The Writer.*

Among the known writing automatons, only that of Frederic von Knaus (which still exists at the "Gewerbe Museum" in Vienna) is earlier by some fourteen years. Most remarkably, this latter is capable of writing a long text. It should be pointed out, however, that its mechanism is not placed entirely inside the automaton's body, but in a large sphere, thus avoiding several difficulties which had to be overcome by Pierre Jaquet-Droz. It was Jaquet-Droz the father who took the lead in the construction of the Writer's mechanism. He had conceived it at a time when his son Henri-Louis was still adolescent; but he was already assisted in his researches by Jean-Frédéric Leschet and several capable workmen.

This small person, a child of barely three years, is seated on a stool in the style of Louis XV. He holds a goose quill in his right hand, while his left presses on the small mahogany table. His eyes follow the letters traced out; his attitude is attentive; his gestures a little jerky, but none the less natural.

Description of the mechanism: *The Writer's mechanism is extremely complex; he is the most complicated of the three automatons. For his*

*construction Pierre Jaquet-Droz had to solve some very difficult problems, particularly that of housing the complete mechanism within the body of the child, and controlling the movements of the wrist by the elbow and arm.*

*Two sets of gears can be discerned. An ingenious system releases them alternately, without any pause, until the final full stop which immobilises the whole.*

*The first mechanism, contained in the upper portion of the body, turns a long vertically pivoted cylinder, consisting of three sets of cams; each one of these has the task of setting in motion the levers intended to provide the movement of the wrist in the three fundamental directions.*

*The pen moves not only in a horizontal direction but also vertically. It is thus able to trace the letters with thick and thin strokes.*

*At each turn of the cam a letter is formed. It is at this moment that the second mechanism comes into operation, to communicate upward and downward motion to the cam shaft.*

*The length of movement is defined by interchangeable steel pegs, arranged around a disk placed in the lower portion of the mechanism. There are forty of these, each occupying an angular space of 9°. Each peg causes the cam shaft to take up a certain position corresponding to one letter, or a particular manœuvre (new line, take up ink, etc.).*

*It is thus possible to set the mechanism so that the automaton can write any text, up to a maximum of forty letters or signs.*

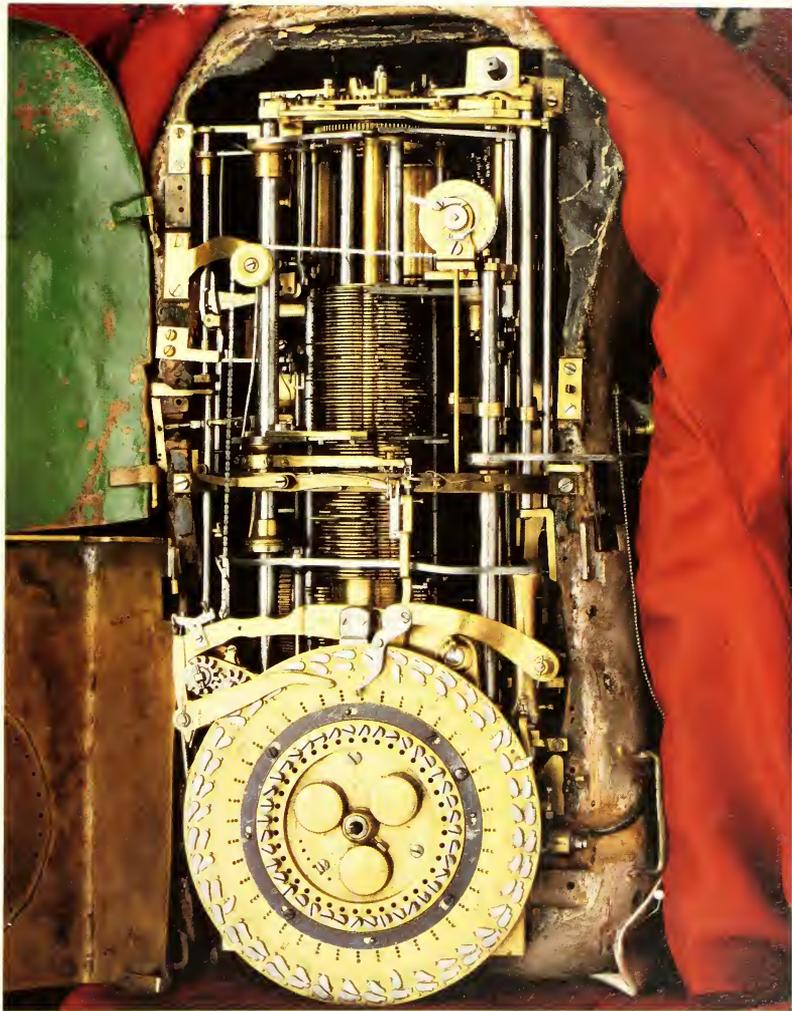
*Many other parts of the mechanism could be described. Let us mention, among others, that which moves the head and eyes of the automaton, and that which determines the distance that the table is shifted, so that the letters are aligned properly, side by side, whether they be wide or narrow. Let us also mention the arrangement which moves the dot on the i to make the final full stop, and locks the machine.*



Les automates  
Jaquet Droz  
à Neuchâtel



*Jacquet Droz mon  
Inventeur*



*Es lebe die Stadt  
Albrecht Duerers.*



Gloire à Wilson  
Loch et  
Clemenceau.





*The Draughtsman*

## *The Draughtsman.*

*This delightful child is very similar in appearance to the preceding one, but its attitude is slightly different because the paper is not moved during the operation.*

*The Draughtsman was chiefly made by Henri Jaquet-Droz, always with the valuable assistance of J.-F. Leschot and that of three other extremely skilled workmen, in a relatively short time between 1772 and 1774.*

*Description of the mechanism: The work of the Draughtsman is more spectacular than that of the Writer. One is always struck by the dexterity and accuracy with which the automaton draws a profile or a subject with extraordinary attention to detail. Its mechanism is, however, much less complicated than that of the Writer.*

*As in the preceding automaton the mechanism comprises two parts. The first, contained in the upper body, sets off a cylinder with three sets of cams, having an average diameter of 80 mm.*

*Much larger than those of the Writer, these cams allow a better finished and finer drawing to be obtained, with much larger amplification as well. At each turn of the cam a fragment of the drawing is executed, then the secondary mechanism,*

*released by the first, raises the whole set of cams in such a way that the three levers of the arm are positioned on the three following cams.*

*Next, the second mechanism restarts the first which controls the execution of the next portion of the drawing, and the work proceeds until the twelve cams in the set have functioned. The drawing is then completely finished, and the stack of cams delicately returns to its initial position while the whole mechanism comes to rest.*

*Three interchangeable sets of cams, which date from the time of manufacture (1774), allow four drawings to be traced. The portrait of Louis XV and the drawing of "Toutou" each use only six cams, so that one set of cams is sufficient for both.*

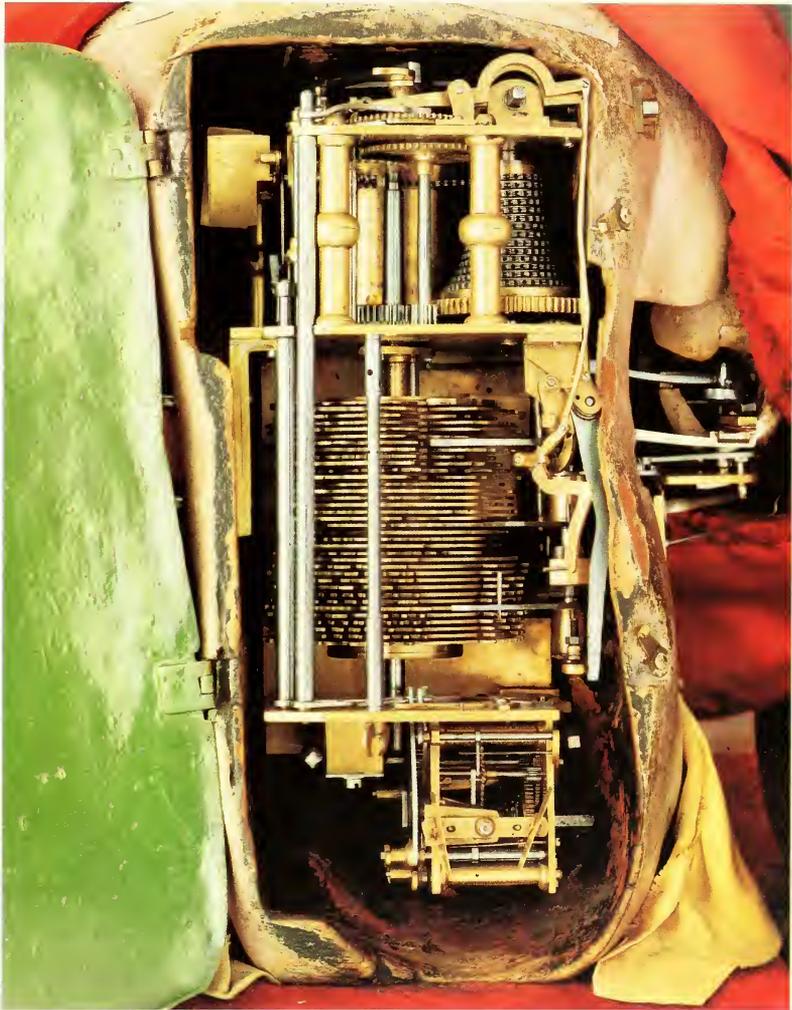
*During the pauses intended for changing the position of the cam stack, the Draughtsman blows on his drawing to clean it of all dust. For this purpose a bellows, placed in the head of the apparatus, is compressed sharply at regular intervals.*





















*The Musician*

## *The Musician*

*Pierre Jaquet-Droz, his son Henri-Louis, Frédéric Leschot: three mechanical geniuses created a stupendous object. In spite of modern investigative techniques it is still difficult to describe precisely what the original design plans of the Musician were.*

*However, the temptation is great for a restorer to enter into the spirit of the three inventors, and follow in their creative steps for a while.*

*One has to admit that a reconstruction of the intellectual path followed by the designers of the automaton can only be hypothetical.*

*It would seem that the mechanical design of the instrument rested on the preliminary determination of the circular arcs of the keyboard (in such a way that the movement of the arms and hands could easily be adapted) and on the definition of the musical possibilities of the instrument.*

*The melodies transcribed on the cylinder were composed as a function of the keys, since the Musician can only play notes or chords positioned immediately under her hands.*

*For the construction of the steel cams, Pierre Jaquet-Droz and his collaborators determined the position and movement of the hands on the keyboard. The driving mechanism of the cylinder followed, with all the other mechanisms, to perfect the illusion which all automatons must have.*



# Première Mélodie

A handwritten musical score for a piece titled "Première Mélodie". The score is written on six systems of grand staves, each consisting of a treble and bass clef. The key signature is one sharp (F#) and the time signature is common time (C). The notation includes various rhythmic values, slurs, and dynamic markings such as *mf* and *f*. The piece concludes with a double bar line and a fermata. Below the main score, there are two sets of empty grand staves.



# Deuxième Mélodie

A handwritten musical score for a piece titled "Deuxième Mélodie". The score is written on eight systems of two staves each, using a grand staff format (treble and bass clefs). The key signature is one sharp (F#), and the time signature is 3/4. The notation includes various musical symbols such as notes, rests, slurs, and ornaments. Fingerings are indicated by numbers 1-5. Ornaments are marked with a star symbol (\*). Dynamic markings include *pp* (pianissimo) and *f* (forte). The piece concludes with a series of sixteenth notes that fade out.



# Troisième Mélodie

les croches inégales

The musical score is written in G major (one sharp) and 3/4 time. It consists of seven systems of staves. The first six systems each contain a piano part (treble and bass clefs) and a violin part (treble clef). The piano part features a steady eighth-note accompaniment, while the violin part plays a more melodic line with various ornaments and dynamics. The seventh system shows the piano part continuing with a tremolo effect, while the violin part concludes with a final melodic phrase. The score includes various musical notations such as slurs, accents, and dynamic markings like 'm' (mezzo-forte) and 'p' (piano).



# Quatrième Mélodie

Les croches inégales

A handwritten musical score for a piece titled "Quatrième Mélodie". The score is written in G major (one sharp) and common time (C). It consists of seven systems of two staves each (treble and bass clef). The notation includes various rhythmic values, including eighth and sixteenth notes, often beamed together. There are several dynamic markings such as *mf*, *f*, and *ff*, and articulation marks like accents and slurs. The piece concludes with a double bar line and a fermata over the final notes. The handwriting is in ink on aged paper.



# Cinquième Mélodie

A handwritten musical score for a piece titled "Cinquième Mélodie". The score is written on seven systems of two staves each, with a treble clef on the upper staff and a bass clef on the lower staff. The key signature is one sharp (F#) and the time signature is 3/4. The notation includes various rhythmic values, slurs, and dynamic markings such as *mf*, *mfz*, and *mfz*. The piece concludes with a series of sixteenth notes in the right hand that form a triangular shape, tapering to a final whole note chord in the left hand.

8. 48.



Explication des Accrochements et des Signes

Signe  Pencil Tremblement Tremblement appuyé Tremblement continu

Effet 

Signe  Tremblement suivi d'un Saut de Gaspar Slur montant Slur monté et descendant

Effet 

Signe  Trille arpégée Appoggiature courte Appoggiature longue

Effet 

Il faut préciser - à quelques exceptions près - que "la Musicienne"

joue les accrochements presque toujours avant le temps











## *Description of the Workings of the Musician*



The mechanism of the musical instrument  
*If the virtuosity of an interpreter depends essentially on his personality, on his ability to bring out the beauty of chords, rhythms and melodies, the quality of his instrument nevertheless constitutes an appreciable element. The Musician is sufficiently gifted to be capable of comparison with a virtuoso, and she merits an instrument worthy of her skill.*

*The tuning of the pipes and their resonance are not alone in determining the musical richness of the instrument: all the mechanical elements, the keys, the operation of the bellows, contribute equally.*

### **The keyboard**

*The 24 wooden keys are secured on brass mounts, which pivot around a long hinge fixed into a frame. Return springs allow the keys to rise when they have been released by the Musician's fingers. Under each brass mount, a screw presses on a pilot (a wooden peg terminated by a metal peg)*

*allowing the strength of the notes to be adjusted. When a finger presses on the key, the pilot finds itself in a small hole in the wind chest, and about to open the valve. The air, which is permanently under pressure in the wind chest, then enters the corresponding pipe. The note is played.*

### **The bellows driving mechanism**

*This mechanism provides the alternate operation of the two bellows which force air into the wind chest. The gears pivot in a frame consisting of three plates supported by twelve round pillars. Two barrels in tandem, 90 mm in diameter, are connected to fuseses by chains, and thus provide the motive effort. Two springs of impressive height (55 mm) and 0.70 mm thick, are contained in the two barrels. The remainder of the gear train is formed by four gears (wheels and pinions) and a worm on which a fly speed control is frictionally mounted.*

*On the arbor of the third gear, at the extreme left of the plate (photo page 71) a crank and lever give an alternate movement to an arm which raises and lowers the two bellows; in this way air is provided without any interruption.*

### **The arm and forearm**

*The arm fulfils no mechanical function, but responds to the particular care of the designer in respecting the anatomy of a human being taking the necessary pose to play on a keyboard with the fingers. The angle formed between the vertical position of the body and the arm is 45°.*

*The elbow in its anatomical form is eliminated in such a way as to allow the forearm to pivot and to install the bell cranks and rods (see photograph of the elbow, page 72).*

*The forearm slopes down slightly as far as the wrist; this latter presents a negative angle with respect to the horizontal line of the keyboard, the jointed fingers being bent up. This position is perfectly similar to that of a virtuoso, and differs*

only by reason of the rigidity of the wrist; thus the fingers bend from the end of the phalanges and give the illusion of suppleness. This technique of playing was used currently by harpsichord players of the XVIIIth century. The whole of the arm, bent forearm and fingers measures 50 cm, a dimension which admirably respects the proportions of the human body. The forearm is of wood, hollowed out, which allows the mechanism actuating the fingers to be housed within it. Mounted on a shaft provided with two large steel pivots this forearm turns when pursuing the movements controlled by followers which "read" the central cams; it moves in a radius of 30 cm from the point of rotation to the extremity of the fingers; the angle of movement is 20°.

The mechanical composition of the forearm  
The mechanism housed within the hollow forearm comprises five square-section rods whose two flattened extremities are pierced. The rods each pivot on a pinned stud; this latter is held on a bell crank and pivots like a hinge. On the other branch of the crank, a similar stud provides the pivot point of the rod connected to the cam follower. The rods ensure the transmission of the movement caused by lifting the cam followers, via their pivots. (photo page 72). When the cam followers (or levers) are lifted the first set of rods is lowered; this lowering movement is transformed, via the bell cranks and studs, into a rectilinear motion of forward and back to the articulated phalanges via the cranks within the hand; pressure of the fingers on the keys is thus rendered possible.

#### The hand and its mechanism

The man in the street often marvels at the hand of a craftsman or an artist. Similarly, one can only admire the hand of the Musician and be charmed by the illusion which it creates, without being tempted to illuminate its mystery, or decipher its motion. If the body, elbow, arm and forearm are

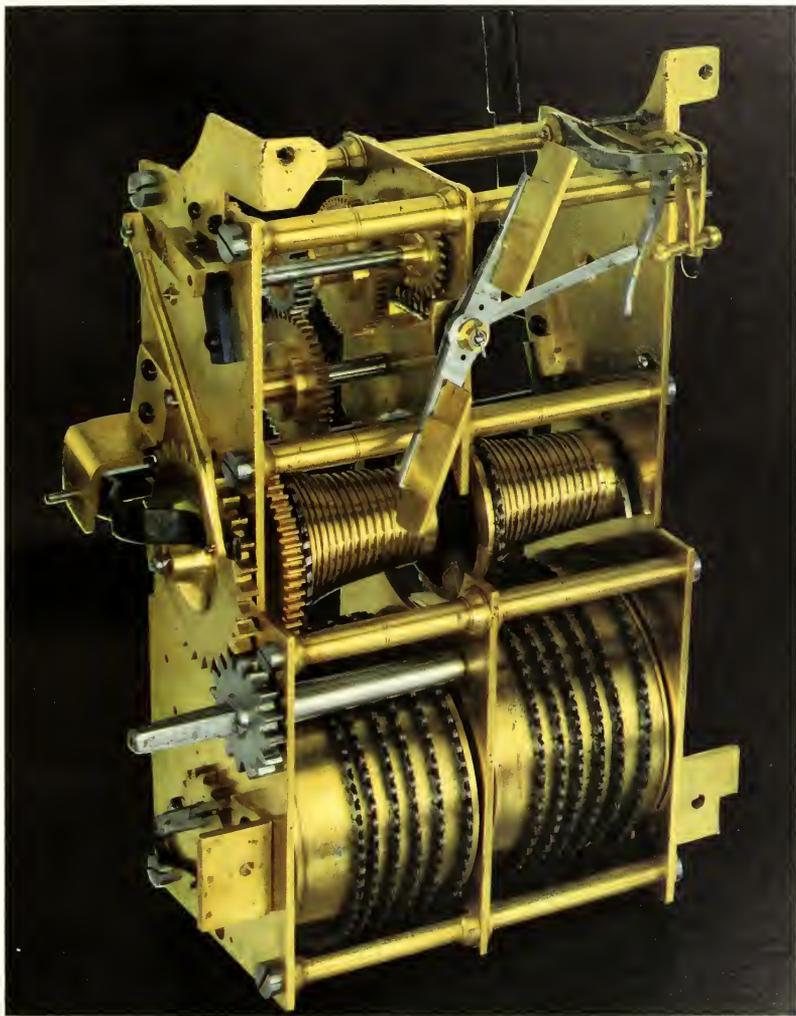
the controlling organs, the hand is the true working element on which all eyes converge. The agility of the fingers, the precision of playing the music, the light touch on the keys for certain melodies, possess a special beauty. Pierre Jacquet-Droz and his son have thus immortalized one of the finest of human acts, man's creativity in its concrete form. It is within the interior of the palm of the hand that the mechanism reveals its extreme complexity. Four fingers, the index, middle, ring and little finger, form a discreet assembly, while the thumb is independent (photo page 73).

A brass support screwed to the upper part of the hand receives the hinge on which the cranks pivot. The crank is connected to the rod in the forearm by a stud, while the second part is formed into a brass shank, which just presses on a steel wire fixed to the finger. When the rod in the forearm is set in motion, the crank pivots and presses on the steel wire on the finger, while a return spring makes it take up its initial position when the rod is no longer moving.

Accuracy of manufacture is vital to achieve the rapidity of return of the fingers when the cam follower is no longer lifted. One can never admire enough the relative length of the rods which assure the movement with all its rapidity. There is no need to stress the perfection of this mechanism, let it only be added that each finger has its own hinge, of which one part is attached to a plate secured to the interior of the palm.

#### The mechanism of the body

The photograph on page 75 shows the whole group of mechanisms assembled and restored; they constitute the body of the Musician; in front the "life mechanism" behind, on the left, the mechanism of the curtsy, and on the right, the cylinder driving mechanism; finally, above, the cylinder with its pins is the "musical heart" of the Musician. At the centre, brass vertical levers rise up to the head, so as to transmit the various



*Bellows driving mechanism of the organ*

movements. If, as Baudelaire tells us, "perfumes, colours and sound echo one another," no one can remain insensitive to this symphony of parts, this architecture of cams, this poetry of mechanism, to these fairy colours rediscovered, thanks to the restoration. However, beyond mere contemplation, the impelling need for knowledge leads us to investigate still further the workings of the Musician's body.

The cylinder or the "musical heart"

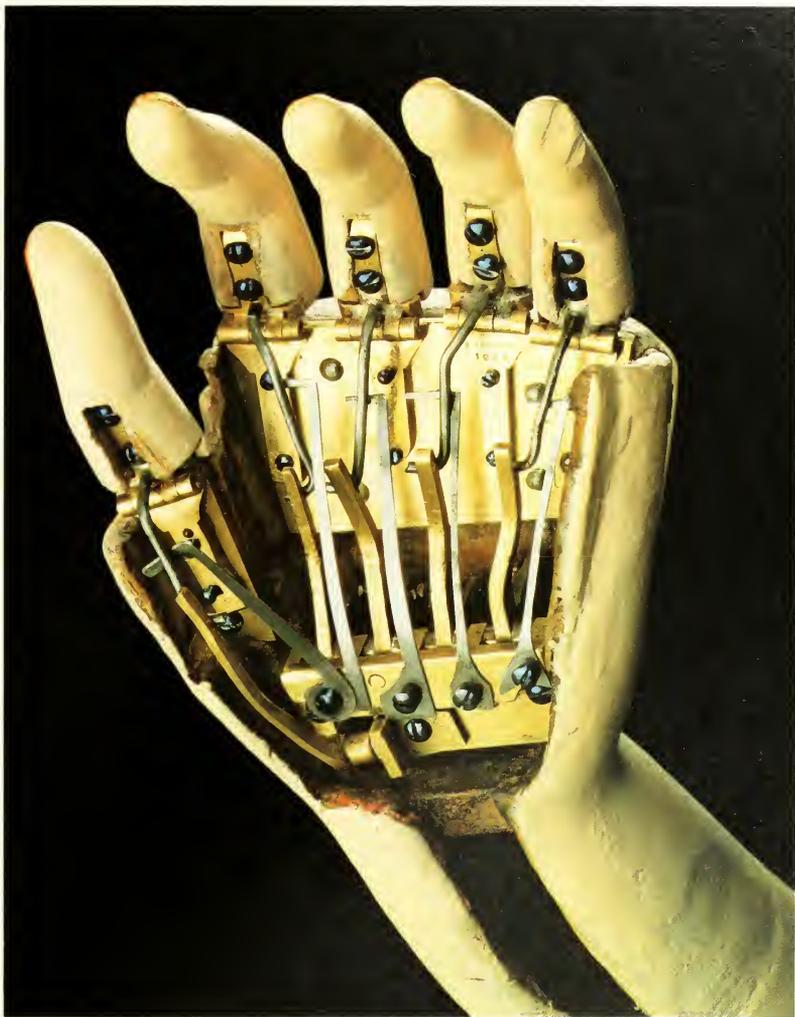
Made of brass, it carries at its centre a set of ten steel cams on which two followers bear, also of steel, which can be seen in the photograph on page 77 and which control the side movement during the course of rotation of the cylinder (design A, page 74). In this photograph, one can distinguish in outline another circular cam, this one of brass, with its profile in relief, on which rests a steel roller secured to a lever; this mechanical feature provides lateral rotation of the head during the musical programme; at rest, this is derived from other levers housed within the "life mechanism" which are actuated to give similar movements.

The cylinder, hollow within, is planted with 25 rows of pins around its circumference, on each side of the central cams, making a total of 50 rows. By shifting the cylinder laterally the melody can be changed by means of a large horizontal brass shaft and the star; this is a system fitted on the driving wheel which permits automatic changing. On the top of the cylinder can be seen the ten followers connected by rods to the Musician's fingers.

On the extreme right will be seen a very large toothed wheel, and a number of circular brass cams fixed to it. By turning on its axis, this wheel drives the cylinder, and controls, by means of four cams, another series of animation movements of the Musician during the musical programme. One can appreciate the subtlety of the design because Jaquet-Droz has given to his automaton different attitudes at rest, during the execution of the



*Elbow of the Musician. The photograph shows the relay rods that are necessary for the working of the fingers*



*Hand mechanism after restoration*

*melodies, and finally during its curtsy.*

*The large toothed wheel is driven by an arrangement similar to that of the bellows, also provided with two fusees and barrels in tandem, the train of gears ends with a fly. Uniformity of the motive force is absolutely essential here if one is to achieve perfect rotation of the cylinder, that is to say, a harmonious tune without jerks. It is this regularity which also determines the natural and regular animation of the head and eyes during the musical programme.*

*Let us point out in this connection that the steel levers which "read" the brass disks, converge on the same stems from which the rods rise up towards the bust head, and eyes.*

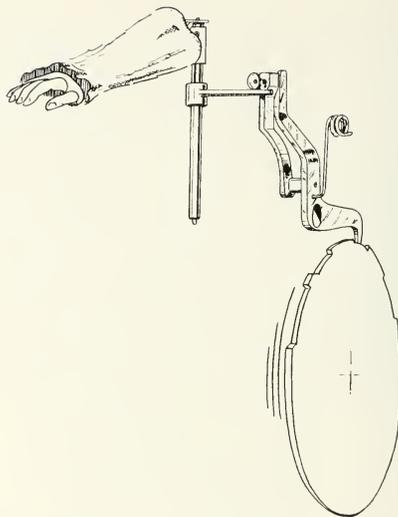
*The steel cams or central levers, the pins and followers*

*Rotation of the cylinder enables the followers, provided with steel tips, to be lifted by the pins, (design B, opposite) and the central levers to turn the two forearms to right or left.*

*The curtsy mechanism*

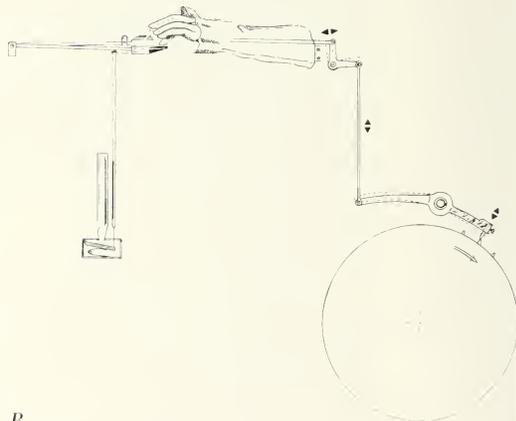
*Placed below the principal mechanism, the curtsy mechanism is released at the end of each tune. It has the peculiarity of being the only one to have a toothed barrel. On the other hand, its composition is similar to the others: three gears and a worm provided with a fly provide the drive to the five circular cams that can be seen in the front of the photograph on page 76.*

*The rocking levers press on the cams to follow their profile faithfully. The cam followers are connected to rods, transmitting the motion to the organs concerned. Thus, the Musician, when making her curtsy, is not content merely to incline the bust, but also turns her head to the left while lowering it, turns her eyes to the left and right, and up and down. Without this particular provision the masterpiece of Jaquet-Droz would lack a most important element: humour. Thus, the Musician seems*



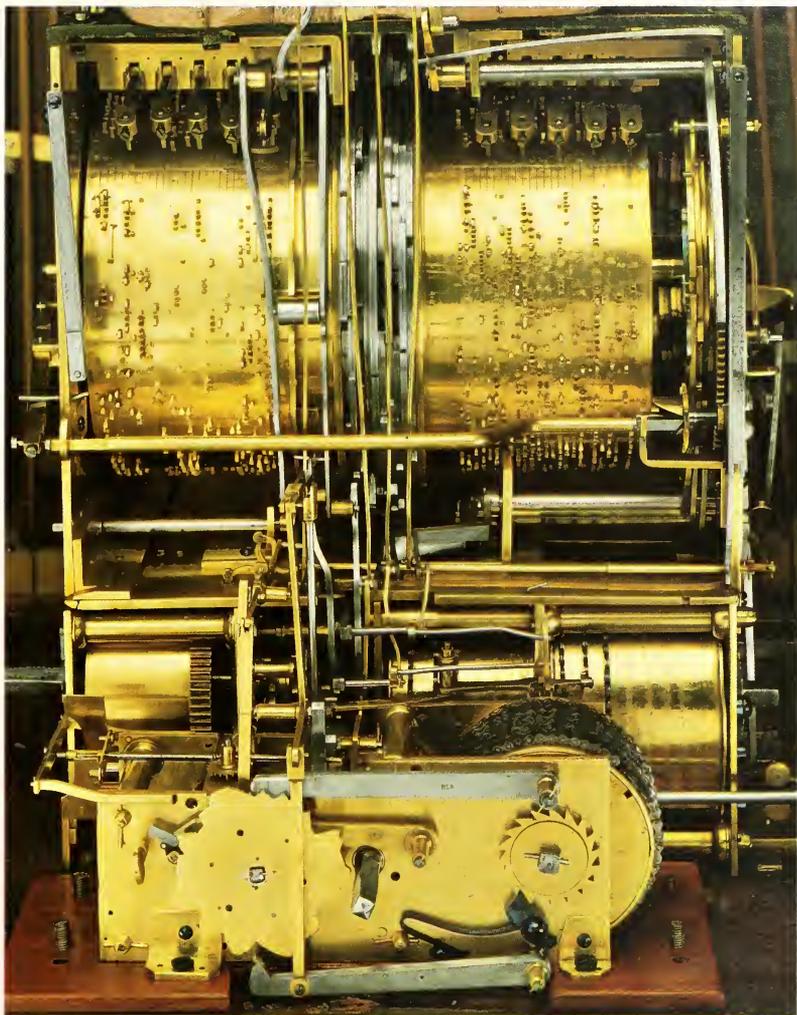
A

*Lateral movement of the arm, starting from the circular cam*



B

*Relay movement starting from a lifted key*



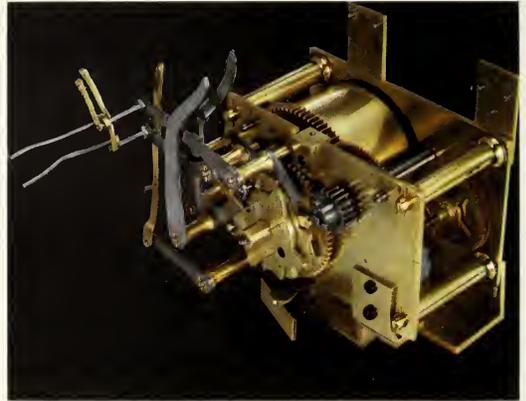
*Body mechanism of the Musician*

to take on an amused air when she makes her curtsy. The profile of the circular cams is much more accentuated than the cams of the life mechanism; the speed of rotation is rapid, in order to render more accurately the motion of a curtsy, which takes 7 to 8 seconds.

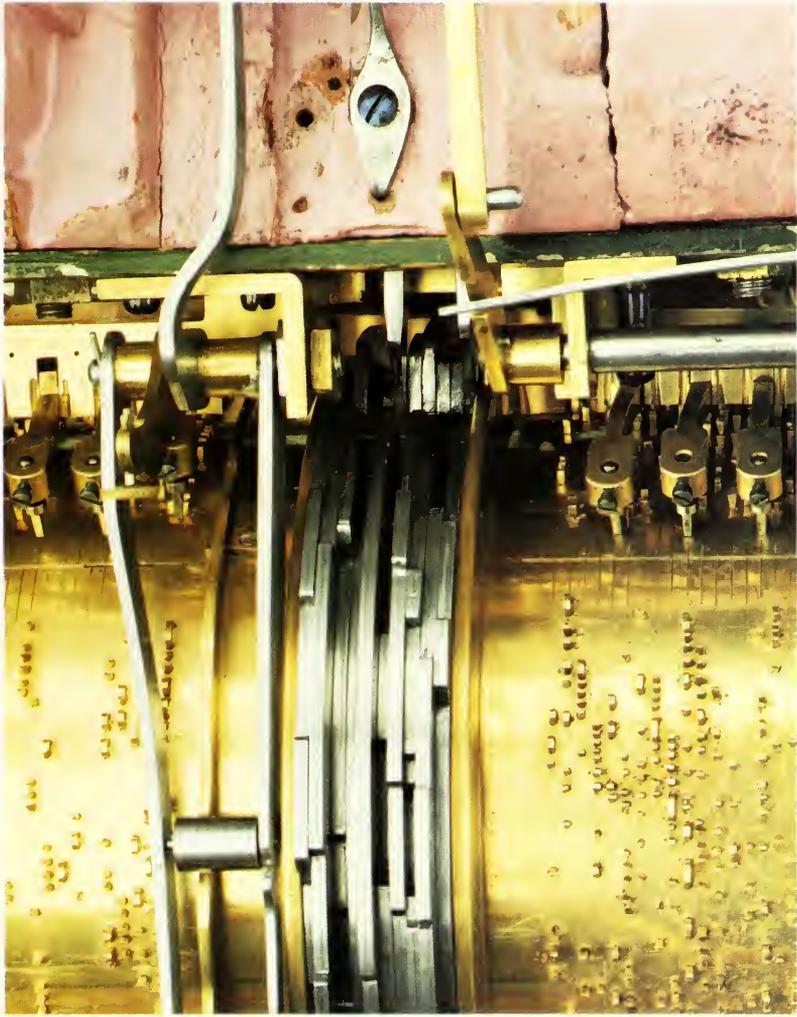
This mechanism is very powerful, since the cams and their levers must not only lift the long push rods intended to pivot the bust, to which they are secured, but also provide the simultaneous functioning of other organs. Quite a considerable force is thus necessary to rock, progressively, half the body; the bust regains its upright position by the action of two powerful blade springs placed near the hinge pivot, for one part, and on an automatic train brake for the other.

#### The life mechanism

This is so named because it assures in a totally independent manner the movements of breathing, the eyes and the head. A demonstration usually began with the releasing of this mechanism so as to arouse the spectator's interest. The very slow and regular animation caused by the wheels and levers with their demultiplication gives the impression that the Musician is waking, and preparing its audience to receive the musical message. It is one of the most sophisticated mechanisms by virtue of its design, and also because its operation lasts more than an hour and a half. Conceived with astonishing perfection, this mechanism makes the Musician the only automaton to possess a supreme gift, breathing; in other words life itself. In the photograph on page 79, representing an exploded view, one can distinguish the different parts of the mechanism; in the centre a barrel and fusee with five other gears pivoted between two plates; outside these (above in the photo) can be seen the four cams and two steel levers which animate the eyes (two for raising and lowering, two others for the left to right movement); at the bottom of the photo, a double brass cam with



Curtsy mechanism of the Musician.



*The cylinder or "musical heart" of the Musician*

*three levers intended to make the Musician "breathe".*

*One will note that among the four circular cams giving mobility to the eyes, only one has teeth; this ingenious system functions as a restraint, changing the position of the cam relative to the others. In three-quarters of an hour the movement of the eyes is never the same, making it appear perfectly like a human being.*

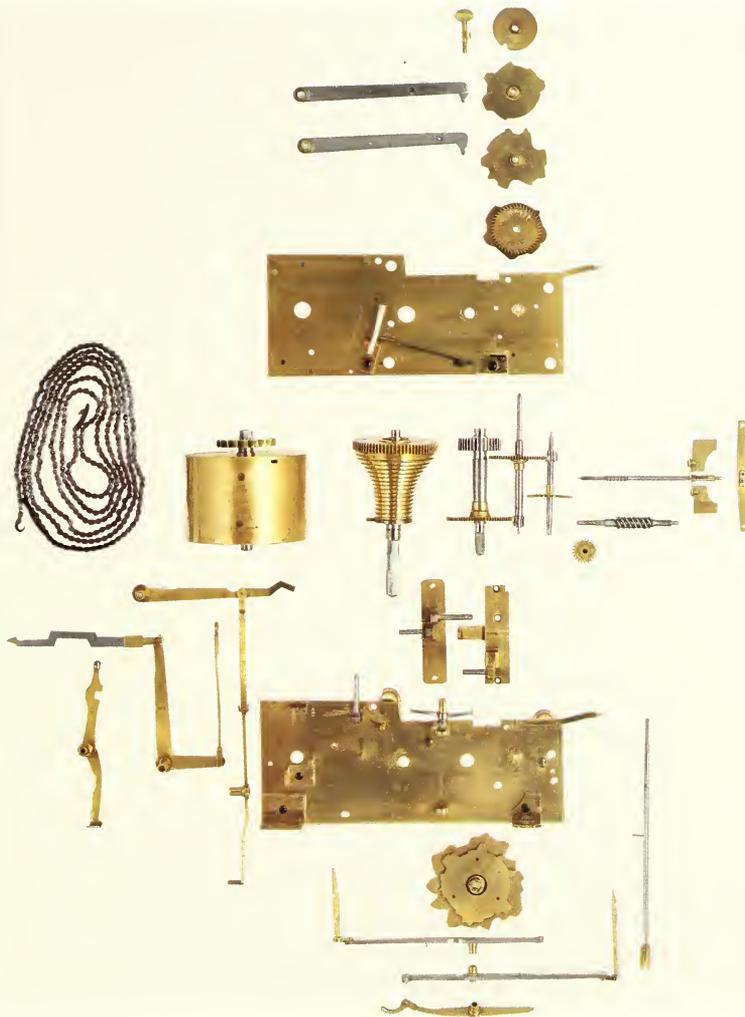
**The mechanism of the head and bust**

*All the movements produced by the various mechanisms are transmitted to the head by rods and relays which cross the bust. One terms "relay" a square of brass on which a stud is fixed; on this a crank rotates and transmits the motion to an organ (see this page); in the photo can be seen the coil springs which are completely anachronistic, having been added during the course of restoration.*

*The eyes are held between mounts and pivot on prongs held in position by a retaining spring. Their mobility is provided by levers connected to rods; one of the longest of these guides the two eyes, connected by a transverse link rod, simultaneously from left to right.*



*Rods and relays terminating in the bust and head mechanism, before restoration.*



*All the parts of the life mechanism of the Musician*



## *Restoration and technology*

*"Science reassures, Art disturbs".*

*There is no better maxim by which to illustrate the wonderful Musician of Pierre and Henri-Louis Jacquet-Droz; the questioning which it inspires finds its answer in both disciplines. For once one can admit that Science is put to the service of Art, in order to arouse and drive the imagination towards the infinite; but also to constitute the reassuring element where reason recovers itself. If the spectator, admiring the Musician, receives her proper image and finds himself disturbed, it could be that the same phenomenon occurs in the case of the restorer... Alas, if ambiguity exists, it must disappear. Thus, the attitude of the restorer must in no way be modified as to the methods of restoration employed, even if the irresistible charm comes from this doll, whose musical talent is only equalled by her beauty. Only the impressions produced by the functioning of the mechanism, the delicacy, the suppleness, the precise movements, the virtuosity, the worldly gestures, the apparent feminine fragility, the slow and regular breathing, the musicality of her instrument, must retain the attention of the restorer.*

in order that he resuscitate them, while respecting the finer points. The attitude of the restorer depends essentially on his conception of the trade which he follows. It is claimed, wrongly, that the success of a clockwork restoration or of an old mechanism is due entirely to a group of technical and very strict rules, or else to almost "magical" hands. This very elementary statement cannot suffice. The truth may be found in one rule, from which all the others are derived: the restorer must behave as an aesthete. If confronted with an objet d'Art, in order to evaluate the beauty, the restorer tries to understand the intention of the creator, he must also be able to grasp the problem posed by the genius of the designer. In both cases an almost scientific investigation is vital. This conception offers the double advantage of artistic contemplation and knowledge. From this, the object defines itself and allows the restorer to plan his restoration as a function of the history, of the date, of scientific discovery, of techniques applied necessary to the construction, and finally the artistic style of each object. Having the spirit of these elements of appreciation, he is compelled to be faithful, to respect the mechanisms in their integrity - at risk of seeing their specific character changed inexorably. To this must be added the constant anxiety to preserve whatever is possible, to restore the damaged parts, to remove marks or damage perpetrated by less scrupulous repairers, and to complete, according to necessity, lost or incomplete mechanisms. It then becomes clear that modern technology and materials must be eliminated; that the choice between an invisible or a visible restoration is clear, while the craftsman must strive not to betray the artistic and scientific expression of the creator.

This is the great historical problem which faces every restorer: many parts of the Musician had been remade in 1905 (they carry this date). These pieces are already evidence of an epoch and have not been made in the style of the

XVIIIth century, but according to the techniques of the beginning of the XXth. Confronted with this dilemma the restorer was obliged to seek advice. An interesting conversation took place between the keeper and restorer, a dialogue from which sprang the most desirable solution. Monsieur Jelmini chose to remake the piece according to the style of 1905, a date later than the acquisition of the Musician by the Museum of Neuchâtel. This decision respects, in effect, the flow of history and the evolution of restoration technology during the course of the centuries. Only parts dated 1905 were re-made in this style, while the others were made according to the style of the XVIIIth Century.

Such a conception of restoration, five years ago, would have appeared out of place or incongruous. But change, albeit slow and gradual - is beginning to take place. It seems that the restorer of old mechanisms and clocks is coming into his own again. Confusion and haste are yielding to thought. Intervention with mechanisms is becoming more respectful and less foolhardy. The aesthete of mechanisms, without actually winning, is making his voice heard. The restorer is no longer attracted by modern materials, reputedly more solid but anachronistic, at the expense of the materials used at the time of manufacture; in the midst of these restraints, the art of the restorer has a free hand.

If all the very technical aspects of a horological or old mechanical restoration have stimulated much debate, they have had the merit of provoking the most fundamental of thoughts. Even some reputedly unshakable ideas, after much later exchanges, have subsequently been abandoned in an attempt to follow this constant evolution. Other restorers claim to have defended the purity of design for all time, omitting to take into account the efforts of those who have defined it and applied it well before them, and who brought it to them... But what does it matter, since the objects and their creators benefit

thereby, to the great satisfaction of the public. More than ever the success of the Musician's restoration depends on the aesthetic behaviour of the restorer. More especially as the perfect functioning of the different mechanisms constitutes the fundamental element likely to promote the illusion and the emotional shock of the spectator in front of the "Eternal Ece". In recounting the history of her restoration we invite the reader to discover this art, so strange because it permits "the resuscitation of an automaton". More rational spirits will be able to satisfy their curiosity by reading the descriptions relative to each mechanism.

#### The discovery of defects

Anyone hearing the Musician play could have been pardoned for thinking that she was suffering from some "cerebral absences". Her instrument was not the reason, except for a few defective adjustments of the controls and keys. Her annoying habit of trailing her hands on the keyboard was leading to loss of accuracy and interruption, a fault due to being able to disconnect the fingers at times. Her tiredness affected her memory to the point where she forgot to play certain notes. The melodies were losing their sense and musical nature. Furthermore her disinclination to curtsy, to anyone familiar with the charm of the Musician, was no less surprising. Her gaze, customarily clear and modest, was growing dull; an insidious squint was disfiguring it, her irregular breathing denoted an apparently insurmountable lassitude, the proud tilt of her head was revealing a disturbing weakness. Furthermore she was content to play inaccurately, at the price of a certain effort, two melodies, disdaining the other three. Had Time overtaken her so inexorably?

This was to put in doubt the genius of her creator, and also to forget that she was an automaton, and that automatons are immortal.

The mechanical analysis and taking down of the Musician

Once her clothes had been taken off, there was easy access to the three mechanisms which animated her. Each one of them sometimes operated simultaneous functions.

The first that could be seen provided the breathing, eye movement, and the head movements. The second, by far the most important, controlled the lateral movement of the forearms, and the fingers' playing. The third, housed beneath the second, allowed the Musician to carry out her curtsy. These three mechanisms were interconnected by various levers. Finally the fourth, housed in the base of the instrument, operated the bellows alternately in order to force air into the set of pipes. After having separated the Musician from her instrument, the levers which linked the mechanisms were disconnected. First the breathing mechanism was lifted from its fixing to the base by four screws. Then, after taking out the hinge pin which secured the head on a pivoting vertical column, it was lifted off. Then the trunk was separated from the body by taking out the pin from the bearing. It remained then only to unscrew the sixteen lugs which fixed the two mechanisms to the base.

Lifting off the cover of the instrument revealed the mechanism of the keys, extended by the wooden pins which control the valves admitting air to the pipes. The twenty-four key supports are each provided with a return spring and pivoted about a long hinge. The springs being disconnected, each pin could be extracted. The brass mounting where the key supports were fixed was taken off.

Returning to the instrument base, with the base lifted up, the coupling between the wind-chest and the bellows was unscrewed; with these two elements dismantled, it remained only to lift off the set of pipes.

The furniture was ready to be restored by the cabinet maker. The clothes were cleaned and set in order.

The rational explanation of defects  
*The imperfection of the Musician's musical repertoire was explained by defects in her mechanisms.*

*The cylinder planted with pins constituted the essential mechanical component; bent pins, those missing, or broken, had to be corrected.*

*No burr could be allowed to remain, to facilitate "reading" by the beaks or follower levers. Since each pin defined a note, the sustained effort needed to obtain an appreciable result may be appreciated. Moreover, the wheel train driving the drum had to be restored so as not to cause any hesitation, or jumps in the execution of the tunes. The pivots having been polished, the pivot poles corrected, the steel de-rusted, dressed and burnished, the brass was carefully cleaned, and the surfaces treated in order to give them back their original appearance; finally the screws needed to be impeccable.*

*The complexity of the hand mechanism demanded perfect condition, because without this organ of executing orders received, no precision of play would be possible. Numerous defects had to be corrected: damaged finger hinges, overstressed return springs, excessive friction in the components where they rub against each other, broken or damaged studs being among the elements to be corrected in order to give back the Musician's fingers their dexterity.*

*The defective synchronisation between the hand positioning and the keyboard prevented the fingers from running over the keys properly. This alignment, made possible by reason of the circular cams whose circumferences presented hollows and rounds, had to be precise, no misalignment between the fingers and keys could be tolerated.*

*The Musician's most serious fault had the effect of producing two contradictory movements. When one or several fingers pressed a key, the lateral movement was already made, thus causing a*

*Bellows gearing mechanism before restoration*



stoppage due to wear of cams. Their remaking demanded extreme care, because it was vital to respect scrupulously their dimensions, taking wear into account... The real complexity lay in the final adjustment. Certain notes had a duration which was clearly variable: the tunes require that during the movement of her hands, the Musician should let them glide over several keys, (effectively pressed, but for a brief moment) before positioning them to play other longer notes. All these shades of interpretation, and the richness of play depend upon the execution of these cams and their adjustment. Wear of certain components of the mechanism was altering the motions of the head and eyes, the curtsy and the breathing.

#### Restoring the keyboard

The chief work consisted in adjusting the "attack" of each key with the adjusting screw so that the note was executed, even with a minimum pressure by the finger. As a consequence it was vital to eliminate the numerous blobs of solder, and remake the screw, often held by glue. Cleaning the keyboard and the elimination of friction by dressing the components, determined the proper functioning of the latter. Tensioning of the keys' return springs had to be carefully done, so as not to create mechanical resistance during pressing on the one hand, and on the other hand to ensure the key returning correctly.

#### The restoration of the bellows driving mechanism

The detail of the photograph on page 34 shows the condition in which the mechanism was found. Damaged and rusty screws, wear in the fusee grooves, defective shape of the pivots in their holes diminished the mechanical efficiency. Bushing these holes with material of the same period, bushing the pivots, correction of the screws was the essential part of this restoration.

Connection of the two bellows to the driving lever



*Wear of the teeth caused by a super-abundance of oil in the gears of certain wheels necessitated their being remade. It would be superfluous to describe the making of a wheel or pinion in full detail, apart from mentioning that the milling cutter necessary to cut the teeth was first of all manufactured so as to imitate perfectly the curves of the old wheel teeth. Trial of the gears having been done, it was then possible to clean the pieces, and proceed to the checking of the powerful springs. Re-assembling the plates followed. This mechanism, once restored, was housed in the base of the instrument, the two bellows secured and connected to the driving lever as shown by the photographs on page 85. After having replaced the plate holding the instrument, this was turned over, which allowed the set of pipes to be installed, after they had been restored.*

*The restoration of the set of pipes This had been overhauled by Mr. Von Beck, an organ builder who was entrusted with tuning the set of pipes, remaking the wind chest, some valves and certain pilots.*

*It only remained to try the keyboard, and play the scale listening attentively to the strength of each note, imagining the pressure of the Musician's fingers. However, some time elapsed before this event which depended upon the restoration of the mechanisms animating the hands and arms.*

*Restoration of the forearm and hands The photograph on the opposite page shows the condition in which the arms of the Musician were found. The delicacy of the hand demanded particular care from the restorer, the elimination of rubbing, and perfect lubrication. The pieces were taken down and each one carefully checked. After being soaked in a bath consisting of water, spirit of soap and alkali, the pieces were rubbed and rinsed, and then immersed in alcohol to eliminate all humidity. Those which were damaged by time*

*were polished and burnished with the aid of shaped burnishers. Damage to screw slots was removed with a slightly oiled burnisher. All anachronistic screws were remade according to the style and pitch of the period. The studs for the bell cranks were re-polished, holes checked, and corrected according to their needs. A minimum of play is tolerable in order that the "instructions" can be executed promptly. The arm was separated from the rest of the body by unscrewing the supports which retained it. After unpinning, polishing the arbors, rods, studs, bell cranks and hinges, final cleaning was done and subsequent reassembly after checking. The hands of a woman betray her age; those of a virtuoso are often insured for enormous sums. The Musician could no longer put up with the excessive coating due to fire layers of paint deposited on her fingers. Rediscovering the original tint, the pattern of each finger, the slight bend at each joint, the thickness and length of the nails so delicately proportioned, is like cancelling out the ravages of time and catching a glimpse of eternal youth, in the springtime of life that no autumn will disturb. The attention devoted to these details is justifiable when one thinks of these hands trilling over the keyboard under the glare of spot lights.*

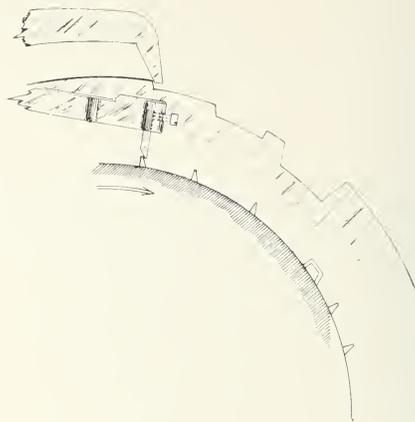
*The restoration of the cylinder, or "musical heart" The restoration of these mechanisms undeniably constituted the most delicate work. It was, in fact, inadmissible that the Musician should execute her melodies incompletely. If it was relatively simple to "make the Musician work" it was much more difficult to give her back her full powers. This accounts for the absolute inimportance of the cylinder and its pins and the central cams. In the course of dismantling in 1969 and 1969 the pins were replaced. Traditionally, the pins of musical boxes are retained by enclosed wax. If this technique presents no problem for a conventional cylinder it was not the same for the one with which*



*Hand of the Musician before restoration*

we are concerned. It should always be possible to dismantle the central cams secured by small tabs screwed on the cylinder; alas, in the course of the last restoration (1968) the retaining wax spread, thus gluing the tabs and the screws. The principal difficulty consisted in disengaging these without allowing the pins to become unglued. Once freed, the cams were restored to allow correct movement. The inclines preceeding or following the "peaks" (opposite design) had to be corrected. Certain sectors of the cams, excessively worn, were remade, in this case building up being neither desirable nor possible. In the course of partial reassembly trials of the ten cams were made one by one; it was checked that the rises corresponded properly to the movement towards the right of the right hand, and to the left of the left hand, checking above all if a certain position of the follower on a peak of the cam corresponded properly to a group of notes on the keyboard. This work was done for each hand, and for each tune, 24 corrections of the cams were necessary, 30 or so broken pins were replaced, (photo 1, opposite page) and anachronistic studs changed (photo 2, opposite page).

These "materialised" musical notes were levelled and the followers polished. As in the greater proportion of the mechanisms, plates damaged by scratches, or even the marks produced by vice-jaws were treated by polishing and burnishing, the surface taking on its original appearance; rusty and damaged screws were burnished and blued as in the original (photo 3, opposite page). It would be superfluous to mention all the damage, anachronisms or blunders which had accumulated in eliminating certain subtleties. One example, among others, suffices to evoke the type of indelicacy which reveals above all a total lack of respect, a mechanical absurdity: in order to create more space, that is to say lateral play of the cylinder axis, someone had pushed an ordinary nickel pin under the bridge, not realizing that this gave rise to a far



Defect due to a simultaneous movement



1. Cylinder keys before restoration  
2. Studs that were later replaced



3. Condition of the screws and surfaces before restoration  
4. An incorrectly placed screw can produce a devastating effect.

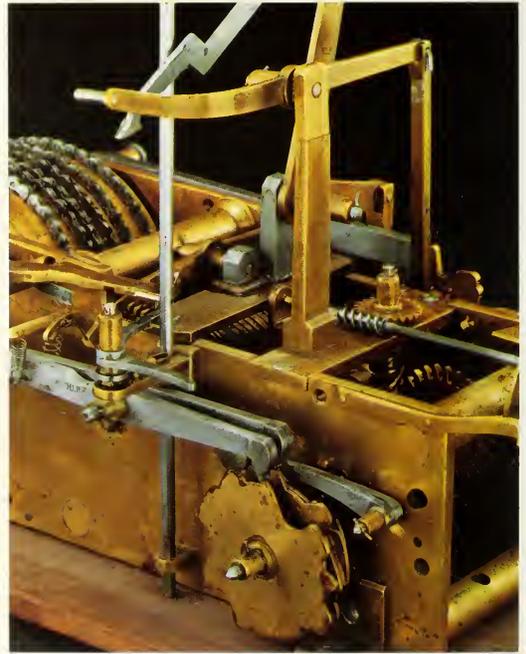
*more serious fault.*

*The restoration of the vital element of the Musician, which determines in some measure its musical gifts and playing technique, always observed the same rule: respect and faithfulness. Photograph 4, on page 89, shows the devastating effect that a badly placed screw can produce.*

*The restoration of the curtsy mechanism  
This mechanism, being damaged by wear, has consequently undergone restoration; remaking the release system and the brake, also the bridge carrying the pivot bearing of the fly.  
Split cams, rusty and pitted levers, worn studs, followers, and gears, have been remade or repaired. The mechanical efficiency being thus improved, the Musician has regained her suppleness, and the vivacity of her curtsy.*

*The restoration of the life mechanism  
As the opposite photograph shows, this mechanism has been particularly ill-treated by the passage of time. Certain cams were no longer being driven by their arbors, others were disconnected and no longer worked.  
Most of the eye movements and those of the head were suppressed. The teeth of the wheel engaging with the worm were remade, since the clearance of the gear was far too great.*

*The restoration of the body and face  
Two centuries of wandering on the roads of Europe and the rest of the world, before a marvelling and sometimes demanding public, will naturally alter the freshness of the complexion of any artist.  
During her creator's life-time the Musician made some most brilliant appearances; one will pardon her now for lingering in places where etiquette was not particularly respected. The many journeys, often in precarious conditions, over poor roads, the precipitation between each "concert", the diversity of the spectacles in which she took part, the different*

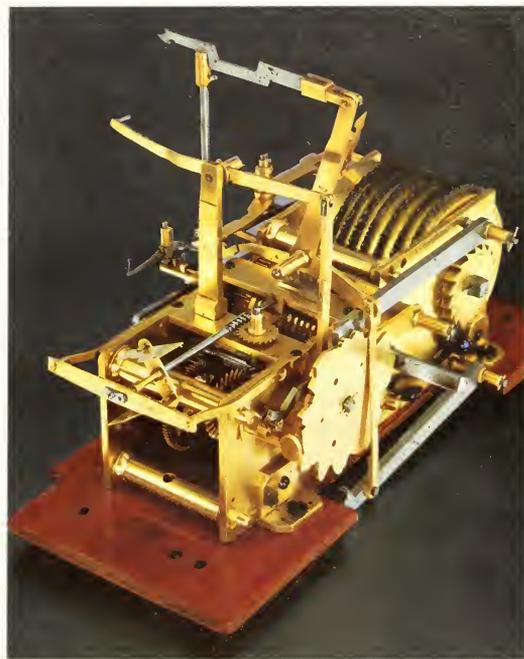


*Life mechanism before restoration*

type of public which she met, largely explains the twelve coats of paint which covered her face. The coats of colour take one back through the ages. Pale pink on the first layer, where the cracking, scratches and brush hairs joined together in promoting wrinkles of age, passing via mauve tints, and yellow tones, to find at last the coloured palor of the original layer: an entire life devoted to music unrolled before us. The fair grounds, the circuses, the Napoleonic armies, and finally the salons of the bourgeois and of the well-to-do, two centuries of history. Successive removals of layers of paint, carried out in collaboration with Monsieur Rosario Gandolfo, have made it possible at least to eliminate the pastiness of the face. The dimples, the finely formed nostrils, the meeting of the lips and their shape, the size of the chin, all the details of facial sculpture have re-discovered their youth. The remainder of the body, hidden by the dress, has only been superficially cleaned so as to leave historical evidence of the layers of paint covering all the wooden parts.

The restoration of the cabinet work  
Several splits damaged the base of the instrument as well as the stand. Monsieur Schneider, a cabinet maker of Neuchâtel, has entirely restored the diamond marquetry and the base, completing the missing mouldings and re-varnishing the whole of the cabinet work.

The final mechanical assembly  
This began with connecting the cylinder to the driving mechanism: using the screwed fixing lugs, the curtsy mechanism was secured. These three mechanisms, forming an important unit, were mounted on the base and secured by the sixteen lugs. As the photograph on the opposite page shows, the levers of the three mechanisms were connected on their respective studs, with the aid of pins. It was then

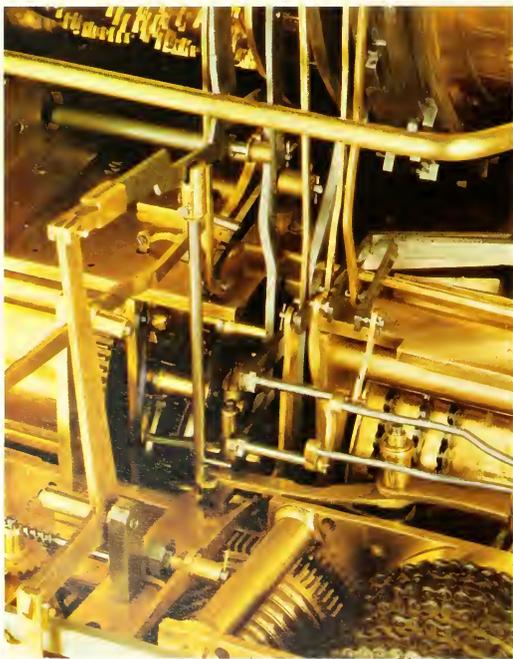


Life mechanism, entirely restored and ready to be connected

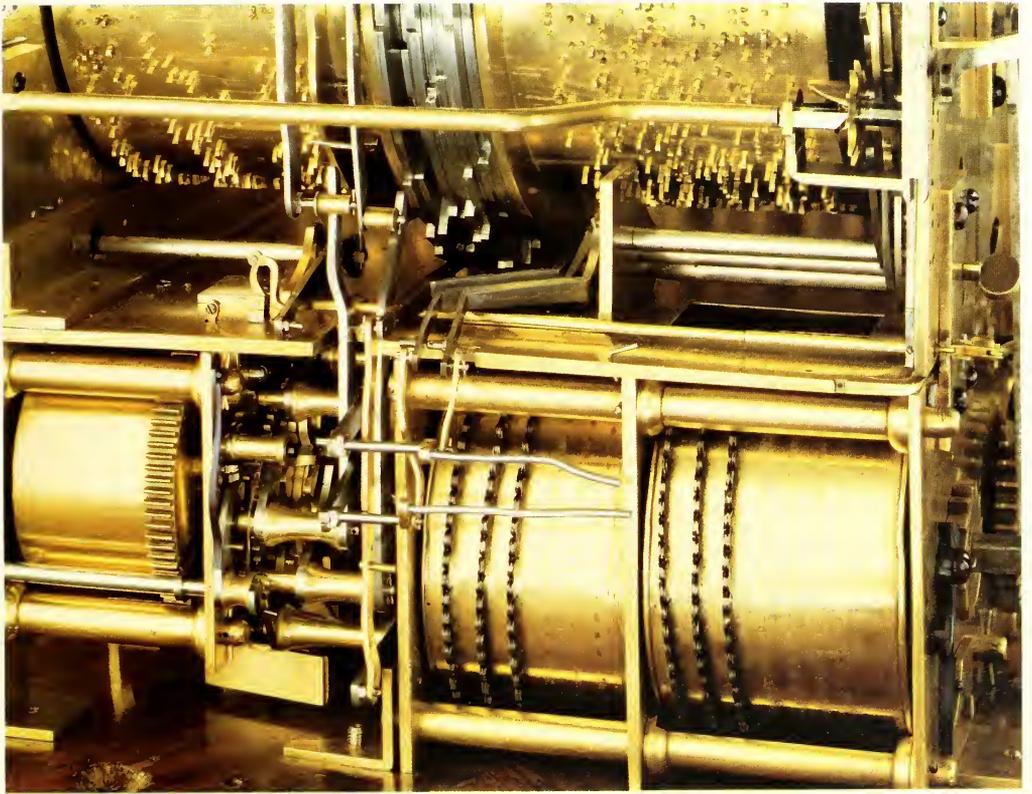
*possible to mount the arms and their supports, as well as the positioning springs, and to carry out several trials of rotating the cylinder, and adjusting the levers; then the bust and head were positioned, connecting the actuating rods to the relays and studs. The life mechanism was fixed at the end, and the last rods connected there (photo below). Finally the instrument was placed in front of the hands, checking each note for each hand, and this procedure was repeated for each of the five melodies.*

#### *The resurrection of the Musician*

*"Resurrection is quite a natural idea; it is no more astonishing to be born twice than once" (Voltaire)  
The work of putting together nearly five thousand pieces, after restoring them one by one, can only be truly appreciated at the moment when the Musician springs into life. I should like to thank all those who by their advice and help have contributed to this work. In so doing they are partly responsible for the preservation of a great heritage which also proclaims the unfailing value of the artistic professions.*



*Dominique Loiseau*



*Assembly of the three mechanisms*













# MUSIQUE A LA COUR DE LOUIS XVI

*score and music  
of the Jaquet-Droz automaton*

I should like to express my deepest gratitude to J.P. Jelmini, Keeper of the historical and art Museum of the city of Neuchâtel, for his enthusiastic collaboration; Catherine Michaud, musicologist, who made it possible for me to outline the five musical expressions of the Musician; Catherine Caumont, clavichordist, for enriching the wisdom of our android with contemporary talent; Joel Charroux, musical-instrument restorer, for allowing us to use his Gaveau spinet; and finally Yves Bocquet, who gave the Musician a number of pages of 18th-century music, thus providing worthy support for the "old-style" notation of the five melodies recorder by Catherine Caumont.

It is thanks to the combined help of these lovers of beauty that today we are able to relive a musical experience which began more than two centuries ago.

Olivier Roux

## The repertoire of the Musician

Listening to the repertoire of the Musician for the first time inspires conflicting emotions.

One is struck by the homogeneous, almost monotonous style, a phenomenon probably due to the fact that the instrument has only one organ stop and lacks diversity of expression (which only developed later), and that its pallet is short, as in most mechanical instruments of weak volume, that is to say, limited to 24 notes - 12 in the left hand (accompaniment), 12 in the right hand (voice).

By listening more carefully, it is possible to detect a certain variety of form, even though each "piece" is composed on the principle of the accompanied monody.

Is this a sort of collective game in which five composers all took a hand?

We are reminded of what was once called a "garland", a collective literary form, adopted in music.

However, it is probably more reasonable to assume that the sole composer is indeed Henri-Louis Jaquet-Droz, who was subjected to French and Italian influences during his musical initiation in Nancy at the age of 15 in 1767.

Although he was an amateur musician, one must nevertheless grant Henri-Louis Jaquet-Droz the benefit of a fairly complete musical education. Around 1774, his father wrote... "Henri-Louis is in London, composing operas...".

It is also worthy of note that among the possessions Henri-Louis left behind were a pianoforte, a viola, a cello, a violin, etc.

### Musical commentaries

The five airs are strophic, in two strophes or in da capo, in the Italian style; they contain important ornamental and notational elements pertaining to the variation.

In principle, the widely decorative melody of the right hand is accompanied by the bass (left hand) and is based

## Première Mélodie

The image displays a handwritten musical score for a piece titled "Première Mélodie". The score is written on ten staves, each consisting of a treble clef staff and a bass clef staff. The music is in a single system, with the right hand (treble clef) playing a highly decorative, melodic line and the left hand (bass clef) providing a simple, rhythmic accompaniment. The notation includes various ornaments, such as mordents and grace notes, and rests. The piece concludes with a double bar line and a fermata over the final note. The handwriting is elegant and characteristic of the 18th-century style.

upon an alternating harmony between the tonic and the fifth of the chosen key (A major). This accounts for the style and character of each melody, but also allows for various ornaments which produce a certain diversity.

The ornamentation reflects both the practice of the eighteenth century French clavichord school as well as the already deepseated habits of the gallant style. In other words, besides irregular notes, it contains trills.

This somewhat disconcerting style of composition is without doubt linked to the date when the automaton was constructed. Does it represent the search for a proper mixture of styles in order to attain a greater richness or variety, or is it simply a lack of precision?

### Analysis

#### Air No 1 - Strophic

Two themes for two strophes separated by a cadence on the fifty degree of the key.

Refinement in notation: each theme is followed by a second motif leading to the cadence, thus dividing each piece into two parts, both being binary thematically.

The popular character of this music is striking. The trumpet-sounding bass reflects a definite knowledge of French music, the organ notation of which derived from the important school of wind instruments in the eighteenth century.

#### Air No 2 - Strophic with refrain

One theme per strophe. The first strophe is reduced to the theme of the exposition. The second, more important strophe, is very lyrical in character. The refrain is differently ornamented in the repetition. The trumpet-sounding bass underlining the theme and the refrain are more varied in their melodic line in the middle strophe, but more monotonous rhythmically. This eight-like notation reminds us of the technique proper to the pianoforte where each note is consistently repeated to compensate for the dryness in tone.

These facts indicate that Henri-Louis Jaquet-Droz must have been familiar with the school of clavichords and pianofortes, Grimaldi (1706) being the first one known to us.

#### Air No 3 - Rondo in variations

One theme for three strophes. Strophic with a refrain, the theme is presented three times. Between the refrain and the third presentation of the theme, the composer inserts an element of divertissement.

## Deuxième Mélodie

The musical score for 'Deuxième Mélodie' is presented in two systems, each with a treble and bass staff. The music is in 3/4 time and A major. The first system consists of two staves of music. The second system also consists of two staves, with the second staff ending in a double bar line and a fermata. The notation includes various ornaments, such as trills and grace notes, and dynamic markings like 'f' and 'p'. The bass line is characterized by a steady, rhythmic pattern that resembles a trumpet or organ accompaniment.

#### Air No 4 - Strophic (cf. 1)

One binary theme per strophe. The second part of the theme corresponds to the variation of the first presentation; it is not a different element. This second part is a coda in typically Italian vocal style.

The same notational system is used in the bass as in the preceding airs.

#### Air No 5

Da capo Italian style, with the repetition being ornamented in the French style.

In each part the theme is binary (French tradition).

#### Is the Musician musical?

The answer is yes - in a double sense.

First of all because we see her actually "touching" the keyboard of the organ with her hands, a rare ability for a robot.

Secondly because she faithfully reproduces the style of performance of the period, which is of course essential. But before we consider her musical talents and examine the question of her touch, it is important to situate her in relation to the family of organs and to retrace schematically the life of her interpreters, who were hardly known but who nevertheless embody a realm of music to which we had lost the key.

I am alluding here to the hidden part of her genius, the pointed cylinder concealed beneath her dress, which is a true musical memory.

According to reliable records, the mechanically operated tubular bells in the steeples found in France at the beginning of the fourteenth century were the first physical evidence of musical notation in relief on wrought iron cylinders.

As for the mechanical organ made of wooden cylinders, it is mentioned apparently for the first time in the accounts of Philippe le Bon, Duke of Burgundy. From 1458 to 1467 he accorded a pension to Jan Van Steenken, "Meester van orgelen spelende by hen selven" (master craftsman in organs which play by themselves), with the stipulation that the duke should see and have an option to purchase every instrument which he built.

Finally, we cannot ignore the social and musical role played from the sixteenth to the nineteenth century by the immense family of mechanical instruments (automatic chimes, chime pendulums, spinets and clavichords with keyboards and cylinders, bird-organs, pendulums with organ stops,

## Troisième Mélodie

Les croches inégales

The musical score for 'Troisième Mélodie' is written in a system of two staves, likely treble and bass clefs. It features a complex rhythmic pattern with many beamed eighth notes, characteristic of the 'Les croches inégales' style. The notation includes various ornaments and slurs. The piece concludes with a final cadence on a single staff.

church and room organs) the essential functions of which are now fulfilled by the radio and gramophone which provide music in the home without the physical presence of the musicians.

But even though the Musician is a member of the family of mechanical organ instruments or those with flute-stops, its mechanism, which is much more complex than that of its older or younger brothers, in no way prevents it from attaining a clarity of sound and a velocity comparable to instruments with a less complicated mechanical system, for example the bird-organ.

No wonder the latter "sings" so cheerfully, since there are only 3 mechanical transmissions, limiting movement and not allowing for inertia. In other words, very little distortion occurs in this type of instrument between the "reading" of the airs and their performance. On the other hand, the Musician requires 7 relays from the cylinder to the actual sound, which involves considerably more movement (3/10 at every relay) and creates a certain dullness, on account of considerable distance between the reading keys, the pick-hammers and the sound; hence the difficulty of keeping this mechanical wonder in tune.

#### Speaking frankly

If in our book Dominique Loiseau has had the opportunity of vividly portraying the trials and tribulations he encountered, and the solutions he adopted in order to "cure" the Musician of the numerous ills with which she was afflicted when she entered his "clinic", this was not the case with the organ doctor, Franz-Joseph Van Beeck, organ and piano builder, on whose behalf I speak here.

He was faced with an instrument which had suffered, as had the Musician, "years of irreparable outrage...", and in addition he was hampered by many enigmas which required decoding and for which he did not have the necessary keys.

#### Restoration - ineptitude

F.-J. Van Beeck states that not only had the instrument undergone several transformations in the course of the years (of which I am also convinced), but also that it was "restored" by some of our tinkering ancestors in the nineteenth century who were singularly lacking in the necessary skills.

Much closer to our times, so-called "specialists" have succeeded in further blurring the dim traces which even the shrewdest Sherlock Holmes in organology already had trouble in discerning.

## Quatrième Mélodie

Les notes enjambées

The musical score consists of ten systems of music, each with a treble and bass staff. The music is written in a style characteristic of early 20th-century French organ music, featuring complex rhythmic patterns and melodic lines. The first system is marked 'Les notes enjambées' and includes various musical notations such as slurs, accents, and dynamic markings. The score concludes with a double bar line and repeat signs.

We have indeed discovered, among other monstrosities, once the organ had been taken apart, that the cover of the blowing apparatus had been glued with ordinary glue. This would explain the multiple air losses. As for the original springs, these had been replaced by a piece of old rusted bed spring, no doubt in a valiant effort to copy the original!

It goes without saying that I would not relate these facts if I had no evidence of them.

The air pressure, measured with a water pipe (a special apparatus used by the makers of pneumatic instruments to verify their air pressure), was then only 20 cm<sup>3</sup>, compared with 50 cm<sup>3</sup> today.

The cover used for the closing and articulation of the valves was stiff. The mouths of the pipes had been "harmonized" with a cutting knife. The result was a total disparity from one pipe to the next. It looked like a large family in which no two children belonged to the same father or mother.

Finally, as far as important modifications are concerned it is most probable that the organ stop originally included a set of extra fifths for which space had been provided in the sideboard. But since no one decided on this addition during the restoration, we are left today with an instrument having only a double series of 12 pipes, of which 20 are open, the 4 lowest tones being obstructed.

#### A question of ethics

A set of deteriorated organ pipes presents only two alternatives: rebuild a set and accept the risks of infidelity this entails, which amounts to depriving the automaton of its infant soul, or adopt the solution of Messrs. Jelmini and Van Beeck, which is to leave the instrument in its present condition.

While the latter choice involves the risk of inflicting on our contemporary ears the irremediable "authentic" damage to which the instrument was subjected, it offers, on the other hand, the immense advantage of conserving the original poetic aura of *The Musician*.

## Cinquième Mélodie

The musical score is written for two staves, likely representing the right and left hands of a piano or organ. It consists of 12 systems of music. The notation includes treble and bass clefs, a key signature of one sharp (F#), and a 3/4 time signature. The melody is characterized by frequent sixteenth and thirty-second notes, often beamed together. There are several instances of triplets and complex rhythmic patterns. The score concludes with a double bar line and a small 'c.c.' marking at the bottom right of the final system.

## Introduction to the record

*Conspiration des Allégements et des Signes*

The score is written for Signe (treble clef) and Toffet (bass clef). It consists of three systems of music. The first system has four measures with dynamics: *Sineci*, *Trémollement*, *Trémollement épais*, and *Trémollement continu*. The second system also has four measures with dynamics: *Trémollement suivi d'un 'Bouc de Jeune'*, *Trémollement*, *Trémollement suivi d'un moment*, and *Trémollement suivi d'un moment et descendant*. The third system has two measures with dynamics: *Trémollement épais* and *Appogiature ovale*, followed by a measure with *Appogiature ovale* and a final measure with *Appogiature ovale*. The score includes various musical notations such as slurs, accents, and dynamic markings.

*Il faut préciser à quelques exceptions près que de l'histoire*

*faire les accords presque toujours en accord de temps*

Five sets of empty musical staves, each consisting of a treble clef staff and a bass clef staff, arranged vertically.

## Side A

I. A melody, as "played" by the Musician on the day of her arrival in the workshop of Dominique Loiseau.

Two preliminary remarks:

a) this recording was taped on a mini-cassette recorder and does not pretend to compete with the sound of a high fidelity recording.

b) The excessive speed of the "movement" of the music was inevitable since the general mechanical condition of the instrument and the robot was so poor that at normal speed no sound would have been emitted.

If we dared submit such a recording to the demanding ears of our contemporaries, it was to illustrate in the form of musical flashes the long and arduous adventure which culminated in the restoration of The Musician.

This recording, therefore, gives us an idea of the void from which the patient was finally to escape.

Many thanks to Mr. Roland Carrera who was kind enough to lend us this valuable document.

II. Recording of the 5 airs which the Musician actually plays.

## Side B

III. Airs No 1 and 2 played by Catherine Caumont on a Gaveau spinet, copy of a 1912 Dolmetsch instrument.

IV. Airs No 3, 4 and 5 performed by Catherine Caumont on a Polymood Keyboard synthesizer.

# AUTOMATONS I



BY P. AND H.L. JAQUET-DROZ  
An air played by the automaton before its  
restoration, July 1978.  
The five melodies played by the automaton  
after its restoration,  
January 1979.

470 68.10 168-01-1

NEUTRALISATION DER VERFAHREN  
ANFÜHRUNG, ERHÖHUNG VORBEREITEN

Music lovers who follow on the scores the five “treasures” of the Musician, will notice that Catherine Caumont takes a few liberties with the text. As a contemporary performer, she acts in complete understanding of what was customary in the eighteenth century, when “taste” demanded a minimum of know-how.

There is no need for her to reproduce exactly the playing of her young ancestor, nor to compete with her, but rather to give us one of the many possible interpretations. Finally, in order to vary the sounds and still in a non-imitative spirit, we used two contemporary instruments: a spinet and a synthesizer.

Notice that the third melody sounds like an organum of the Middle Ages, whereas the fourth and fifth melodies are closer to the vox humana.



