

ABRIDGED

DESCRIPTION

OF SEVERAL PIECES

OF HOROLOGY,

Which were approved by several Academies, and which were invented or made by Hubert Sarton, Horologer Mechanic, inhabitant of Liege, at the entrance to Pont-d'Isle, and during the *Saison des Eaux*, in Spa.

Two Projects have been added; one, a new machine for extracting coal; the other, a reconstruction of the famous Machine of Marly.

ANNOUNCEMENT

One finds in Liege and Spa, at the house of HUBERT SARTON, a most complete assortment of all types of watches, in the latest taste, gold and silver watches of any kind, plain or enamelled, simple and repeaters, also with alarms, marking the names and days of the months and those of the moon; watches which one does not have to wind; watches with stop seconds for observations, with which one can stop the seconds hand without suspending nor harming the running of the watch; watches with the horizontal escapement and metallic regulator, to prevent the variations which the diversity of temperatures can cause; watches with only one hand for the hours and the minutes, with regulators with elastic suspensions to prevent or guarantee its pivots when dropped; all kinds of coach watches, etc.

One also finds there a complete range of clocks, from the simplest to the most complex; richly decorated clocks, with gilded bronze figures; musical clocks, playing many airs on flutes, with accompaniment; clocks known as regulators, going one year without being wound, and having a pendulum of nine rods, in brass and steel, laid out so as to correct the effects of temperature, and whose hand marks the degrees of heat and cold; clocks with several dials, on which one sees the difference between true and mean time; small regulators with weights suitable to be placed on a bureau or a chimney, with or without ringing; travel clocks and watches, striking the hours and quarters, repeating them at will, with alarms; universal clocks where there are several dials, including one which is mobile, displaying the time in the principal cities of the world, manual dials for the equation of time, suitable for regulating and checking watches and clocks by the passage of the stars and the sun through the meridian line, with a printed guide which explains its use, etc.

The same mechanic undertakes the execution of any kind of piece of mechanics, and forwards abroad.

He also manufactures, for amateurs and the curious, firearms of any type, that is to say rifles or guns, in the latest taste, with one, two or four shots; also air rifles, etc., of which he joins with their beautiful and perfect execution the greatest safety of the canons.

I

MANNER OF USING THE

MANUAL DIAL

FOR THE EQUATION OF TIME

To use this dial, it is necessary to observe that there is a difference between the hour which is marked by the Sun on a sundial or a meridian line, and the hour which a good clock or a well regulated watch indicates. The unequal movements of the Sun causes a difference between these two indicators each day, that astronomers have calculated in the tables of the equation of time. But it is tiresome to consult them often, because one finds them too complicated and too difficult for ordinary use; nevertheless it is necessary to regulate one's clock or watch, if one wants to gain all possible utility from it. Most people who acquire them imagine that having set them right once, it is no longer necessary to adjust them again, to obtain a constant exact running from them. Others, having set their watch in conformity with a meridian line two or three times, claim that it goes exactly like the Sun. But all and sundry are mistaken by requiring a going in conformity with these two different indicators; because the movement of the Sun is variable, sometimes it advances, sometimes it retards. On the contrary, clocks and watches, made up of toothed wheels and pinions, go uniformly and can only mark an always equal hour. It is this hour that is called the mean hour, which is in conformity with the meridian line only four times in the year: on April 15th, June 16th, August 31st and December 24th.

It should be noted that here I exclude clocks and watches with the equation of time. They mark the mean hour and the true hour of the Sun at the same time, but their mechanism is complicated and their effect is not very exact, so that one usually gives preference to simple watches for daily use.

However, a watch set to the mean hour will not be able to follow the hour of the Sun, each variable day, as it is easy to be convinced by consulting tables or this Manual Dial for the equation of time.

By means of the following operation, made on this Dial, a seconds clock being well regulated and set right on such day that one wants one year, will meet exactly with the Sun on the same day one year later; but on all the other days of the year there will be a difference more or less. Here is what it will be. Let us suppose that I set right, according to a good meridian line, a well adjusted seconds clock on the 15th of April, when the Sun only differs three seconds from the hour of the clock. Each day it will gradually fall behind the Sun until the 15th of May, when it will be behind by four minutes seven seconds. And from the 15th of May it will be behind less and less until June 16th and 17th, when it will start to advance on the Sun until July 28th, when it will five minutes fifty seconds ahead. But then this advance will decrease imperceptibly until 1st September, when one will find it behind the Sun by twenty-three seconds. This delay will gradually increase until 1st November when it will be sixteen minutes twelve seconds. Then it will start again to decrease until December 25th, when the clock will advance forty-five seconds, and will continue to advance until February 10th, when it will be fourteen minutes fifty-three seconds. Then it will decrease until April 15th, the day on which the clock should differ only three seconds from the Sun.

By making this observation, one will be easily convinced that the movement of the Sun is variable, and that a clock or a watch can only follow it artificially. And so, to regulate a clock or a watch according to the passage of this star on the meridian line, it is necessary to make the operation indicated by the tables of the equation each time, by following the variations of the Sun. These tables, as I have said above, are too complicated to be of ordinary use, since

they require a calculation and an annotation each time they are consulted, in order to remember on what day one set his watch to the time of Sun, how much difference there was then, and how much there is currently with the hour of this star. Without this he cannot proceed with certainty to advance or to delay his clock or his watch to be perfectly set to the true hour.

But without needing to search or calculate, or to resort to the tables of the equation of time, or to meridian lines, the *Manual Dial* devised by Sr. Sarton can easily be used as an infallible guide, not only for the advance or the delay, but also to know the daily variations of the Sun and the difference each day between the true hour and the mean. It can be used for all years, being calculated over an annual average between leap years.

This *Manual Dial* is composed of several circles, and in particular of one which represents the minutes. There are two hands, one of which is of brass and the other of steel. The first indicates by its point, on the circle of the minutes, the daily difference of the true hour with the mean, and consequently the variation of the Sun. The second hand, which is of steel, is used to extract these variations without research or calculation. The months which are divided into days, are marked each one on a small line, and are divided into six periods, numbered in sets of five, until the last of the month. The brass hand has a slope on each side, forming a true line which comes exactly to the center of the dial, and which must be directed to the number of the day for which one wants to know the variation of the Sun; and this is marked by the point of the same hand on the circle of the minutes. For example, put the sloping side of the brass hand on 1st January and its point will mark four minutes and a half of delay, which is precisely that of the Sun on this day. (Note that it is always necessary to start to count from the point of 60.) From the 1st turn the sloping side of the hand to the 5th and the point will mark six minutes nine seconds of delay. On the contrary, put it at 1st December and the point will mark ten minutes and a half in advance. From the 1st pass to the 5th of the same month and you will find it nearly nine minutes in advance. This example is enough to indicate the way in which one must use this dial. I will detail below the use of the steel hand, and I observe above all, that when one wants to check a clock or a watch already adjusted according to a good meridian line, it is necessary to disregard the variation of the Sun; and this one can be done by the following process.

First put the brass hand of the *Manual Dial* over the day of the month, which will mark by its point on the circle of the minutes the delay or the advance of the Sun then, and consequently it will be the difference of midday of the Sun with the midday of clocks or watches. Then at the same time consult a meridian line at the time of midday, and make the hour of your watch conform exactly, but with as much advance or delay on the Sun as the brass hand indicates to you on the *Manual Dial*; then your watch will tell you the mean time. Thus when the midday of the Sun advances, that of a clock or a watch must be late; and on the contrary, if that of the Sun delays, that of the clock must be in advance. I supposed here that the clock or watch is already adjusted; but if, on the contrary, one wanted to regulate it, one would proceed in the following way.

It is necessary to put a clock or watch on mean time (on October 6th for example) after having observed on the *Manual Dial* that on this day the Sun has advanced nearly twelve minutes. Consequently, at the moment of the passage of the Sun on the meridian line, one will set the midday of the clock or watch nearly twelve minutes late compared with the midday of the Sun. Then, to see whether it is regulated, one will wait a few days (for example until the fourteen of the same month), having consulted the *Manual Dial* on which one will lead the brass hand to October fourteen, one will see that its point marks nearly fourteen minutes in advance. However, if the clock or watch is well regulated, it is necessary that its midday is late by almost fourteen minutes on that of the meridian line; and if it is more or less, it is proof that it is not regulated, and that it requires to be adjusted (with the pendulum if it is a clock and with the balance spring if it is a watch). In setting however, use a wise proportion between this adjustment and the difference. Such is the manner of checking and of regulating either a clock, or a watch with the *Manual Dial*.

The steel hand is used to disregard all variations of the Sun to make them follow a well regulated clock or watch, and to put it to the time of the meridian without being obliged to resort to it each time. This is the manner of using it.

One will put (on 1st January for example) one's clock or watch right with the Sun; that is, the two middays quite in conformity, and at same time one will turn the brass hand of the

Manual Dial to 1st of January and put the steel hand on the 60 of the minutes circle. If one wants then to set it to the time of the Sun (the 5th or the 10th or the 15th is not important) it is only necessary to turn the brass hand (but without touching that of steel) from 1st January, where it was, over the current day. These two hands will work together by their friction, and what the steel hand marks on the circle of the minutes, will be precisely what the Sun will have done since 1st January until the chosen day. This operation presents the exact abstraction of the variation of the Sun between these two times. Then five or ten or fifteen or twenty days afterwards, if one wants to know how much one must advance or delay his clock or watch to put it in agreement with the hour of the Sun, it will be necessary to fix with one hand the brass hand over the day of the month on which it had been placed above, then put the steel hand on the number 60, after which one will again turn the brass hand to the current day, while the steel hand turning with it will indicate the quantity of minutes with precision that you must set the Clock or watch in advance or late, so that it is in agreement with the hour of the Sun. One example appears to be enough to explain the way in which one must proceed each time one wants to make clocks and watches follow the true hour of the Sun, etc.

II.

Description of a Large Clock

This Clock is surmounted by the figure of the Sun, which rises and set exactly at the hour compared to the duration of the days and nights. It makes its revolution in 24 hours, divided into 24 meridians, and indicates the true hour of this Star from its rising until its setting, and its passage on the meridian line with precision, and also its various elevations. One sees there the duration of the days and nights for each principal place on the Earth, each sign of the zodiac with its degrees, the Equinoxes, the Solstices, and consequently the start and the end of each season.

This Clock also shows the various phases of the Moon, marking its age, and making its synodical revolution in 29 days, 12 hours and 44 minutes.

It beats seconds. The movement of the mark in the center of the dial is by an isochronous escapement invented by Sr. Sarton, who had the satisfaction of seeing it approved by the Imperial and Royal Academy of Brussels in 1783. (See the Approval, N^o. I below, page 7.)

The same clock has the equation of time in it, marking the hour of true or apparent time by one hand, and the mean or equalized hour by the others. It sounds the hours and the half hours. The movement for the ringing, like that of the rest of the works, has a double pulley weight of twenty pounds, and has only three feet of descent for six weeks duration. The movement does not stop while being wound.

The fork which maintains the vibrations, has the property to be able to put the clock's escapement exactly right without interrupting the movement. The vibration is of ten lignes, measured from the center of the bob, of which six are for the constant arc.

A universal calendar presents the days of the week and the date of the month. Whether it has 28, 29, 30 or 31 days, the effect is done by a hand which goes from the last to the first of the following month by itself. It does not err in leap years, having moreover a very curious and so devised calendar, that it could work exactly for ten thousand years, if the metals and other bodies were not prone to the devastations of time.

This is done by means of four dials, each one of which is divided into ten equal parts, each having ten digits. The first moves one tenth part of each year, making its turn in ten years. Then it makes the second advance one tenth part, which turns once in a hundred years. The same operation is done for the third, which completes its turn in a thousand years and thus to the 4th which finishes its revolution in ten thousand years.

Sr. Sarton adapted to this clock a compensation regulator (see the item *Regulator* below, page 6) and a *Chronometrographic* dial of his invention. The latter enables one to note the duration of an observation at will, by indicating with precision the hour, the minute and the second, without requiring any care other than a moment of attention at the beginning and the end of the observation. (See the approvals at the end.)

The dimensions of this clock are 2 1/2 feet high and 1 1/2 feet wide. It is of a pleasant form and can be placed on a table. And though it has only one face, one can see the mechanism of all the parts through glass on the front and on the other three sides.

In spite of the number of effects which this clock produces, it is not difficult to repair or clean. And is not prone to any variation, because all the effects of the ringing have no communication with the movement, and one can at will produce them by the means of a crank key which fits to the square of the hand of a particular dial, whose every turn amounts to twenty-four hours. By this means if the clock has remained without being wound, one could give new life to all its effects at exactly at the point from which it deviated, without fearing any disturbance; and by the same means one can also make it act out, in a very little time, all the effects which should take place only during the space of ten thousand years.

This piece of horology was first made by Sr. Sarton in 1773, for His Royal Highness the Duke Charles of Lorraine, etc., and is in the catalogue of the invaluable effects which decorated his cabinet. It is still running at the author's.

III

Society Clock.

This clock, which obtained the approval of the Royal Academy of Sciences of Paris in 1778, for being well executed and well built for its effect, was also part of the invaluable pieces of furniture in the cabinet of the late Duke Charles of Lorraine, etc., and a similar one is still currently at the author's. It has the property of showing the precise hour and minute from several points of view and in various places of an apartment at the same time, by moving its dial horizontally on a circular line and by describing it, in three equal movements, by half of the circumference within the space of one minute. The dial stops for a few seconds at each point, to give the opportunity to recognize the points indicated, and having described the half-circle it returns in the same direction by retrogressing at similar intervals. One can accelerate or slow down its movement at will and stop it by the means of a push piece without changing the movement of the clock which goes eight days without being wound.

IV.

Watch with Spontaneous Movement.

This watch, which is wound by only the movement that it receives while being carried, was also subjected to the judgment of the Academy of Science of Paris (in 1778) which declared that the author had cured very well the disadvantages and variations caused in other watches of this kind by the winding mechanism; and in praising the construction, it considered it to be it worthy of its approval, as being ingeniously arranged to wind itself while being carried.

V.

Moving Clock.

This clock, whose movement is of a new construction making use of the pendulum itself, was also placed in 1778 in the splendid cabinet of the late Duke Charles of Lorraine, etc.

VI.

Clock in Equilibrium.

This clock is made up of a brass verge, mounted on a pivot, and forming a double lever, at one end of which is the movement of a watch which traverses a circle in a twelve hours, and by this means uniformly marks the time on two dials, carried by the two ends of the lever and making their revolution around the common center in twelve hours. This piece was one of curiosities in the cabinet of the late Duke Charles of Lorraine, etc., for whom the author then made his *Manual Dial of the Equation of Time* (see page 2 above) as simple as useful to regulate and check clocks and watches, and to recognize at a glance the daily variations of the Sun without needing to resort to sundials for this.

VII

REGULATOR.

This regulator, invented by Sr. Sarton, is suitable for all kinds of observations where the most scrupulous exactness is necessary. It marks the hours, minutes and seconds with the highest degree of accuracy by its new isochronous escapement. The accuracy of this regulator comes from the fact that it constantly preserves equal movements of vibration, and that it keeps itself vertical, though the wall or the case where it has been placed had suddenly got out of order by more than one foot from the perpendicular.

This regulator has a weight and goes for one year without needing to be wound. The pendulum, being composed of various metals, is not prone to any variation, or rather it is compensated exactly, so that the variations of the atmosphere cannot disturb it. (See the Approval of the Imperial and Royal Academy of Brussels, N^o. II, page 7.)

This compensation for the effects of temperature on metals is operated by the position of these metals with regard to the bob. It is fixed there by a steel verge and a very extraordinary lever which makes it rise and drop exactly in proportion to lengthening of the brass and steel subjected to the influence of the temperature. It is what preserves the bob at an exact and constant distance from its point of suspension all the time. The movement, which is done by the aforesaid metals lengthening or shortening by the amount of cold or heat, makes a hand turn, which indicates the various degrees of temperature on a portion of a graduated dial fixed to the body of the regulator. It is a natural thermometer, of which the effects are produced only by the action of the temperature on the assembled metals.

VIII.

Clock with Spring.

This clock, that the author displayed in 1783 in the salon of the Emulation Society of Liege, is isolated and moves by itself, without any external communication. It is attached at the end of a steel verge, forming a pendulum with correct seconds, minutes and hours, on a knife-edge suspension. The bob contains the entire mechanism of this piece, which is of great utility for astronomical observations, and more especially because it can be transported from one place to another without the movement of its hands being disturbed. One has only to suspend it in the place where one wants it and give it motion like an ordinary pendulum. It always finds its vertical, once put into motion, and maintains its oscillations with the vibrations of the seconds hand with the highest degree of accuracy. It needs to be wound only about every eight days, and one can do it without fearing to alter its movement.

N^o. I.

EXTRACT of the Memorandum of the Imperial and Royal Academy of the Sciences and Humanities of Brussels.

Meeting of January 24th, 1783.

The commissioners named for the examination of the new escapement presented by Sr. Sarton, Horologer Mechanic to His Highness the Prince-Bishop of Liege, having reported to the Academy that they have examined this object, and that this artist had gone to one of them with the movement of a clock, to which he had applied his escapement, which instead of pins has triangular teeth at each side of the limb, whose tops are finished with the circumference of the same radius as the center of the wheel; an expedient by which the drops and the pallets of the anchor are always equal, without any recoil or shock which can deteriorate the isochronism of it. The Academy, having seen this report, can only approve of this new escapement, which it believes deserves a distinguished place among the inventions of this type. It believes it is very suitable for astronomical observations and to improve marine watches, and can only give high praise to its author, who is also known very favourably.

Made in Brussels, on January 28th 1783.

J. DES ROCHES, Perpetual secretary.

N^o. II.

EXTRACT of a report submitted to the Imperial and Royal Academy of the Sciences and the Humanities of Brussels, on the construction of a compensation regulator, presented for its examination by Sieur Sarton, Horologer Mechanic of S.A.C. the Prince of Liege, etc., Member of the Emulation Society of the same city.

We the undersigned Commissioners named by the Academy of Science at Brussels, to examine the *Compensation Regulator* that Sr. Sarton submitted to its examination and its judgment, and which he set up in our presence, let us state that we have thoroughly examined all the mechanism, as well as the principle on which it is built.

For a long time the variations that cold and heat produce on various metals have been observed, and the relationship has been determined with much precision. In horology it has been especially usefully, for the uniform measurement of time, the observations and experiments which physicists made for this purpose, and the most skilful artistes of this century who worked with the desire to build *astronomical clocks*, able to compensate for the different expansion of metals by heat, and to thus obtain in all the variations of cold and heat, a uniform movement of the pendulum and equal oscillations. Of all the clocks of this kind which have been invented until today, though all built approximately on the same principles, and with the same metals, steel and brass, that of Sr. Sarton appeared to us to deserve to be preferred because of its great simplicity, and the ease with which it can be regulated by the observer to the highest possible degree of accuracy, without anything disturbing the work, and without stopping the movement of the pendulum.

This invention proves that Sr Sarton has clear ideas of what he undertook to do, and that he has the principles of good mechanics. We believe consequently that he deserves the praises and the approval of the Academy and the most distinguished encouragements from all those who are interested in the progress of the Sciences and the useful Arts.

Made in Brussels, on November 5th, 1788.

The Abbot MARCI, Provost. The Abbot KNIGHT. The Abbot MANN.

This report was read to and approved by the meeting of the Academy on November 10th, 1788, and I certify this extract is in conformity with the original and the judgment of the Academy.

The Abbot MANN, Perpetual secretary.

Memoir on a New Observation Watch,

Invented by Mr. Sarton, Horologer Mechanic to His Highness the Bishop-Prince of Liege, member of the Emulation Society in the same city, etc., announced by the author at the public meeting of the aforesaid Society, held on February 18th, 1788.

One knows that it is often of the greatest importance to know precisely the duration of a phenomenon, of an astronomical passage, a chemical operation, a physical experiment, a military advance, the manoeuvre of a vessel, a horse-race, etc.

One has wished for a long time, on these occasions, to have watches which, using a mechanism and a particular indicator, mark in a fixed and invariable way the beginning and the end of these observations, and to be able to ensure at a glance, without any research or calculation. But up to now one had managed only to use seconds watches with which one stopped the movement at will. One could thereby make sure of the moment when the event had started, but it was impossible to determine the duration of it. Or, if one wanted to mark the end of it, by only stopping this movement then, there no longer remained any indication of the start.

It must have been observed with attention and retained exactly, which is often very difficult and prone to error; more especially as the observer is inattentive and occupied with his purpose. Or if one holds the movement of these watches in suspense until the beginning of the observation, it results that one cannot know the hour of its beginning or its end. And besides, each time that causes a delay in the hours and minutes, so that after having observed with such a watch, one is obliged to resort to a meridian line or another regulator to set it right. In order to avoiding these disadvantages, watches were invented which one stopped only the seconds hand, without stopping those of the hours and minutes. But this means was still insufficient for many purposes. First it has the disadvantage of misaligning the seconds with the minutes, and then it fills its purpose only for the duration of a revolution of the seconds hand. So that if one wants to measure the time of a longer observation, one has to stare continuously at the watch and to note the revolutions of the seconds hand; thus the attention of the observer must be on the watch and the purpose of the observation.

The insufficiency of all these methods made me determined to design a watch which, without exceeding the size and form of ordinary watches, by means of a new mechanism and a particular indicator, which, without affecting the running of the watch at all, can keep an exact note of the duration of an unspecified observation, by indicating the hours, minutes and seconds which filled the interval of the observation, from its beginning to its end, without it being necessary to stare at the watch, and not being obliged to pay attention to it. It is only necessary to start the movement to the indicator at the beginning and to stop it at the end of the observation, which, being able to last several hours, leaves the observer the time to be occupied with other matters, with the assurance that the indicator of his watch will show him with accuracy the hour, minute and second during this interval, and keep the demonstration going as long as he deems appropriate, the watch continuing nevertheless to mark its hours and minutes normally without any intermittency.

REPORT of the Commissioners named by the Emulation Society, established in Liege for Sciences and the Fine Arts.

We undersigned Commissioners, named by the Emulation Society to note the properties and the use of a new *Observation Watch*, invented by Mr. Sarton, declare that the experiments that he made with it at a General Meeting of the Society, and then repeated in our presence, appeared very satisfactory to us and in conformity with the statement of the report. We believe consequently that this useful invention is made to honour its author, and that he deserves the approval of the Company.

Made in Liege, February 20th, 1789.

L.F. DE SAIVE. F. VILLETTE. DEPAIX TREFONCIER.

I declare that the report above was approved by the Emulation Society, and that it is in conformity with the original. In witness whereof I sign this certificate.

REGNIER, Perpetual Secretary.

PROJECT

For a New Machine for Extracting Coal.

One reads in the Gazette of Liege of March 29th, 1776, an offer was made by the mechanic Hubert Sarton, to build in large the plans and models of a new machine of his invention, able to extract coal and all other minerals at some depth, without horses and with more celerity and much less expense than by ordinary means. Though this machine deserved an honourable mention on behalf of the late Mr. Morand, in his great work on pit coal, the lack of concern of the Government and the attachment to the old routines caused them to neglect the offer of the inventor, who renews them today. To convince the experts of its utility, he offers to prove his machine by means of an allowance.

PROJECT

For Rebuilding the Famous Machine of Marly.

Louis XVI having proposed a price for the repair or a new construction of the Machine of Marly, the mechanic Hubert Sarton contributed to it in 1784, by a report accompanied by a model of fifteen feet, which was deposited with the Academy of Science in Paris. It is known that this famous machine, built to provide water for the needs and embellishments of Marly and Versailles, was invented by Rennequin, inhabitant of Liege. The mechanic H. Sarton, also an inhabitant of Liege, facilitated emulation, always believing this machine could be much simplified, and consequently much decreasing the maintenance costs without decreasing the quantity of water which it must provide. When it was strong and new, and the Seine was rather high, it raised, according to the scientist Belidor, 779 cubic fathoms of water to the basin of the aqueduct in 24 hours, 476 feet above the level of the river. Today it gives hardly half as much, and it heads towards its total destruction. It cost more than eight million to build, and since its construction ten times as much to maintain and repair it. Its output does not answer its expenditure. Now the most advanced mechanics lets us see that the old machine is too complicated and that in its composition there is a superfluous multiplicity of wheels, levers, rocking bars, cranks, pulleys, chains, force and suction pumps, which are opposed to the action of the engine; that is, 14 wheels set in motion by running water, an always increasing resistance.

In this state, it appears that the economy requires a new building instead of more expensive repairs. The model provided by H. Sarton is of a simplicity which requires for its execution, according to his estimate, the sum of two million at most, including the buildings in which it will be housed, and two hundred thousand francs for maintenance and annual repairs including the wages of the machinists, guards, workers, goods, etc.

In LIEGE, Published by J.A. LATOUR
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[Undated, but 1789]