COUNT RUMFORD: A Science Dramatization (July 2003)

REVISED

<u>Personae Dramatis</u>:

Count Rumford: Don Metz

Madame Lavoisier-Rumford: Helene Perreault

Karl Theodor: Gerry Smerchanski

Pierre de Laplace: John Murray

Humphrey Davy: Evan Janzen-Roth

Signor Artaria: Peter Heering

John, Son of Lord Germaine: Cliff Dann

Narrators: Cathrine Klassen and Peter Loly

Narrator A
<u>Introduction</u>

Good evening. ladies and gentlemen...Tonight we will try to capture the complex personality of Benjamin Thompson, known as Count Rumford. He was born in poverty in 1753 in Concord, a small town in Colonial Massachusetts. Knighted by the time he was 30 years old, he became Count Rumford, General of the Army and minister of public works in Bavaria before he was 40. Rumford was also a famous scientist, versatile inventor, public benefactor, and a clever spy. He was very interested in scientific ideas, mechanical devices, in experiments involving heat, light, and gunnery. He made original contributions to each of these.

In the 18th century there was a big gulf between the natural philosophers and the artisans and the inventors. The natural philosophers considered the artisans crude and ill-educated, while the inventors scorned the natural philosophers as impractical dreamers. One of Count Rumford's real contributions to the development of science was his realization that the practical devices and improvements could stem directly from basic studies of pure physics. We see him turning his attention to the fundamental laws of nature, time and again, in ways that also were directly applicable to everyday life.
Our little science drama will be presented in four short scenes.

The **<u>first scene</u>** is set in Woburn, Massachuset, circa 1775, at the beginning of the American revolution. Benjamin Thompson is 22 years old, already a major in the New Hampshire Militia, and married to a much older and rich widowed landowner. .

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The **third scene** is set in 1792, in Munich at the palace of the Elector, on the evening of Sir Benjamin Thompson being elevated to Count Rumford.

The **fourth and last scene** takes place 15 years later in Paris, at the villa of Madame Lavoisier, in January of 1807. Here we meet the celebrated mathematician and physicist Laplace in the company of Madame Lavoisier-Rumford and the young chemistry lecturer Humphrey Davy.

SCENE 1: Woburn, Mass., 1775, the American Colonies

Narrator B:
The year is 1775, the beginning of the American revolution. Benjamin Thompson is 22 years old, already a major in the local militia and married to a much older and rich widowed landowner. He spies for the British and is making arrangement to leave for England. As a method of communication he uses "invisible ink" to write his reports about the activities in the Colonies to General William Howe in Boston who in turn sends them to Lord Germaine, the Colonial Secretary in London. BT is in his study composing what is now his famous report "Miscellaneous Observations upon the state of the Rebel Army" which covered a wide range of information of military and political affairs. .

Benjamin Thompson (BT)

Young Major Benjamin Thompson is finishing a report, written with invisible ink, to be sent to General William Howe, the commanding officer of the British Army in Boston. BT is sitting at his desk, writing and intermittently reading from the text.

.."Miscellaneous Observations upon the state of the Rebel Army". I think, that sounds just right.

I have to finish this tonight and send it immediately to General Howe in Boston. I will use my new chemistry trick. Chemistry is truly wonderful.

He looks at the letter and then to the ink he uses.

Just the right concentration of tannic acid.

He scribbles something on a piece of paper, lets it dry, looks at it and says:

And ... a touch of Sulphate of iron. My dear little Sarah will be amused at my new game, and after treating this letter as prescribed. only General Howe will be able to read my secret message about the movement of the rebel troops.

He reads what he wrote, then goes back to his report

I hope I will be able to put the British at ease concerning the capability of these so-called rebel "Riflemen". I am afraid, even General Howe thinks of them as superhuman. Certainly, Washington has allowed rumors to spread that they and their magic rifles are invincible. They are really a wild undisciplined bunch of rebels who aimlessly roam the countryside.

He writes as he reads from his text:

"Instead of being the best marks men in the World, and picking off every regular that was to be seen, there is scarcely a Regiment in Camp but can produce men that can beat them at shooting".

I assure you that the Battle of Bunker Hill was not lost because of these "terrible guns of the rebels". Indeed, I suspect that they probably weren't even there!

Sincerely, Your loyal, and humble servant, Benjamin Thompson.

He seals the envelope and reaches for more paper.

Now I must quickly write another letter to the Rev. Timothy Walker, telling him how badly I have been treated. And, to ask my dear friend for a small favour. I must be careful to use ordinary ink here.

He writes for a few seconds and then reads from the letter:

My dear friend and companion. "I must leave my native Country for I can no longer bear the insults that are daily offered me. I have done nothing with any design to injure my Countrymen and will no longer tolerate this barbarous manner by them. I confide only in you that I must abandon my wife and my dear little Sarah, hoping that you will take good care of them in my absence. Their distressed circumstance calls for every indulgence & alleviation you can offer them". Au revoir, your dear and loyal friend Benjamin.

BT looks at his report and mutters to himself;

The magic guns of the Riflemen, ha! I have some ideas for scientific investigations to test artillery. Someday I will produce a gun that the Riflemen could only wish they had.

He smiles, takes his letters, places them in a bag, puts on his coat and leaves.

SCENE 2
Narrator A:

In 1776 Benjamin Thompson was forced to leave the Colonies. Supplying himself with letters of introduction and intelligence reports, he gained almost immediate access to the highest political circles in London. He made a great impression on Lord Germain, the Secretary of State for the Colonies. Lord Germaine became an expert on the many details and affairs of state, and Thompson was a willing pupil and used him to climb the ladder of success.

Thompson was very adaptable and quickly rose to the position of Under-Secretary of the Colonies and commanded a large income. At this time he seems to have been involved in handing over to the French British naval secrets. He also became very rich and used his leisure time for scientific experiments.

He measured the muzzle velocity of bullets and determined the recoil of guns in different situations. He invented a device for measuring the power of gunpowder which became the standard equipment for this purpose for over a century. For the latter work he was elected to the Royal Society at the age of 26.

It is 1780 and Benjamin Thompson has become the Undersecretary of State for the Colonies. Unfortunately, he made himself thoroughly disliked by those who came in contact with him because of his acquisitiveness and his arrogance. Accused of spying for the French, he takes refuge in his scientific experiments. Here we find him at the Lord Germaine's estate, just outside of London, testing his famous ballistic pendulum that measures the velocity of bullets. He is in the company of young John, the nephew of Lord Germaine

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SCENE 2: At Lord Germain's Estate, near London, 1780
Benjamin Thompson (BT)
John, a young ensign in the Royal Navy and Nephew of Lord Germain

The Ballistic Pendulum
The Force of Gunpowder experiment

BT is adjusting his ballistic pendulum as young John looks on. John arrives, in hunting gear, holding a gun

BT:

Good day John. I understand you are hunting with your Uncle, Lord Germaine.

John:

Yes, ...I thought I would leave them and see what you are doing. My Uncle says that you are setting up an experiment.

BT:

Indeed since I was a young lad scientific investigations have been one of my most agreeable past times. I see you have a hunting rifle, do you like guns?

John:

Oh, yes Sir. I like guns and am fascinated by them.

BT:

Well then, how much do you know about guns? The parts of rifle, the construction, and the physics of projectiles. As an officer of the navy you should have studied ballistics.

John:

Yes, of course Sir**.** But I am not a gunnery officer. Still, I think I remember some basic principles. I know, for example, that bullets can fly hundreds of yards.

BT:

Ah yes, but how fast does a ball, propelled from your gun, travel in that hundred yards. Scientifically, we might ask the question, what is the speed of the ball as it leaves the muzzle of your gun?

John:

I really do not know. 100 feet per second? 200 feet per second?

Rumford:

Well, let's think about this. We know from experience that cannon balls can travel 300 yards or more. Let us say about 1000 feet. Knowing the angle of the cannon, we can estimate the muzzle velocity of the cannon ball. Galileo Galilei was the first to understand this kind of motion. Do you remember the teachings of the great Galilei?

John:

I remember my instructor giving proportions and equations to memorize but I could never understand their meaning.

BT:

Well, let me show you. I have two small iron spheres. Watch as I roll one of them along the table and let the other sphere drop just as the first leaves the table...

BT tries the demonstration several times...

BT:

There..what do you conclude about the motion of the two balls, John?

John:
Oh yes! The two balls land on the level ground at very nearly the same time.

BT:

Very observant John, but what does this mean?.

John:

One ball has only vertical motion and the other has horizontal and vertical motion. The horizontal motion and the vertical motion must be independent of each other. So, as the ball moves horizontally...

BT:

Yes, what forces act on the ball?

John

Only gravity.

BT

In what direction?

John:

Downward

BT: (rolls a ball across the table)

So, as the ball moves horizontally ...

John:

It's speed will be constant as gravity only accelerates the ball downwards.

BT:

Very impressive, John. Now, let me illustrate the horizontal motion.

BT draws the horizontal motion on newsprint.

John:
And the ball accelerates downward. For each interval it must cover more space.

BT:
Good. Now let's make a quick calculation, using simple and convenient numbers, such as a height of 36 feet (*draws*). We also know that the acceleration of free fall is 32 feet/second for each second.

John:
And I remember the equation! The time of descent of the freely falling ball is given by the square root of the height divided by half the acceleration. Since the time is the same for both balls, the distance traveled is the muzzle velocity times that time. I will need my slide rule for this calculation.

BT:

Ah!! Kids today, completely dependent on a calculator. We can do this in our head. The square root of 36 divided by 16 is 6 over 4 which is 1 and a ½.. Assuming that the distance is about 500 feet, the muzzle velocity muzzle velocity is about 340 feet per second.

John:

Wow! We calculated the speed to be exactly 340 feet per second.

BT:
Not exactly John. We have several problems. How do we "exactly" measure the range of the cannonball?

John:

Well, I'm not sure.

BT:

And , what about the problem of air resistance?

John:

So our calculations are only theoretical? Will we ever be able to determine the muzzle velocity of a gun?

BT:

Actually John, I have been able to "exactly" determine the muzzle velocity of a gun, including the effects of air resistance using my ballistic pendulum. But I will save that demonstration for another day.

SCENE 3:
Narrator B:
Claiming that he could no longer resist the call to action, Thompson fled to America with the rank of Lieutenant Colonel in the British army. Much to his disappointment, he missed most of the war there.

Returning to London he found that the British had not forgotten his suspected collaboration with the French and he went to the continent to seek his fortune. He managed to present himself to the court of Bavaria in Munich as a brilliant scientist and soldier-of-fortune, accepting an appointment in the service of the Elector of Bavaria, Carl Theodor. Thompson returned to England just long enough to be promoted to full Colonel and be knighted by George III. Thompson was probably nighted because he promised to spy for Britain. Ultimately, however, he disappointed the British because he insisted that there was nothing of importance to report from Munich. His urge to get ahead in his new surroundings became more important than his commitment to the British government. Spies were then sent to Munich to spy on Thompson

Benjamin Thompson returned to Munich in 1783 as Sir Benjamin and for the next ten years the world was his. By 1792 Sir Benjamin rose from Colonel and *aide-de-camp* to the Elector, to Minister of War, Minister of Police, Major General, Chamberlain of the Court, and State Councillor –he held all of these offices at once–, in other words, he was now the most powerful man Bavaria, next to the Elector.

Between 1783-1788 Sir Benjamin studied the problems of the army and the poor and worked out the details of his scheme, and only then did he put his ideas into operation. First, there was the problem of clothing and feeding of the Bavarian army. The morale in the army was low: there was nothing to do and most enlisted men were illiterate.

Secondly, solving the problem of the social entrenchment of the large beggar population in Munich was critical. Thompson decided to set up a military workhouse in Mannheim for the manufacture of uniforms. This radical solution of the problem, of course, was unacceptable to the industrialists of Mannheim and they saw to it that Thompson did not get suitable workers.

Undaunted, Thompson thought of a plan that, in retrospect, seems daring, if not outrageous. He looked to the large beggar population of Munich for a solution. Beggars were highly organized and the police did not dare interfere. What the authorities judged as an insurmountable social problem, Thompson saw as a unique economic opportunity.

Thompson obtained the Elector's consent and with the help of the police, he rounded up all the beggars in Munich and placed them in workhouses. He proposed to feed and clothe them as factory workers, in return for their labour for the benefit of the army. For this purpose he managed to take over the Poor People's Institute. He picked New Year's day of 1790 to put his plan into operation because this was traditionally beggars' holiday in Munich.

The beggars were rounded up, placed in warm places, fed and finally, the first census was taken. However, it required several years to train the workers and establish a well-run industry.

Unfortunately, in his enthusiasm to employ the poor, he neglected to consider the enormous difficulty of providing adequate nutrition for them. He immediately undertook the first systematic and scientific study of nutrition. Moreover, he was acutely aware of the inadequacy of the artificial light used by the poor and the soldiers alike. The poor working inside large rooms, with small windows, were unable to work efficiently at arts and crafts that required careful concentration of detail.

To solve the first problem he developed his minimal requirement for sustenance: Rumford soup. Most importantly, he introduced potatoes: they were cheap and filling. Unfortunately, potatoes were not considered fit for eating in Bavaria and Thompson had to smuggle them into his kitchens and prepared only by "trusted" cooks. After the potatoes were used for several months without poisoning anyone, Thompson publically confessed their use.

The second problem, that of the quality and intensity of light, was attacked by first inventing the photometer to measure the intensity of a light source. After many experiments, he came to the conclusion that an improved version of the then used Argand lamp, using linseed oil, gave the best combination of light intensity and cost efficiency.

Finally, Thompson is the creator of one of the world's most beautiful city parks: The English Garden (Englische Garten). In 1790 he somehow persuaded the Elector that a man of his age would get more benefit and satisfaction from a magnificent park for the public than from occasion hunting excursions. He probably also reminded his Grace of the recent unpleasant treatment of Maria Antoinette and the great scientist Lavoisier in France. He wanted the lower strata of society contended and happy and insulate them from what he called the "the French infection".

In 1792, The Elector became, for four months, the Vicar of the Holy Roman Empire and seized upon this opportunity to reward his friends. He raised his faithful aid to Count of the Holy Roman Empire.

In the following scene, we meet The Elector, Carl Theodor, the newly named Count Rumford and his assistant with an assembled group of invited guests in the palace of the Elector. The date is 1792.

(Ladies and gentlemen we ask you to pretend to be the guests assembled in the palace).

SCENE 3: Munich: 1792, the Palace of the Elector

Sir Benjamin
Carl Theodor, Elector of Bavaria,
Rumford's assistant, Signor Artaria, a well-known Bavarian instrument maker in the Mannheim Academy of Sciences
The audience

<u>Demonstations</u>:

The Photometer

A Rumford Lamp

The Passage Thermometer

An Experiment to show molecular motion

Note: *Rumford should occasionally speak in French and also in English. It is well documented that his German was adequate but not very good.*

Carl Theodor:

Turns toward the audience

Ladies and gentlemen: I welcome you to this auspicious occasion. I am pleased that it was within my recently given extraordinary powers to reward some of my faithful friends and benefactors to our country.

He lifts a glass in saluting Count Rumford
Loud and cheerful applause

Sir Benjamin, in just 10 short years, you have contributed to our national welfare in many ways. Your scientific knowledge, ability to apply that knowledge to practical things, and especially your energy and will to see through major projects has changed Munich and Bavaria forever. One such project was the complete restructuring of the army, providing food, shelter and clothing for the soldiers. Your most remarkable achievement, however, was the success of organizing and educating the beggars into an important industrial force that is now able to furnish clothing and food for themselves as well as the army. And finally, Munich salutes you, Sir Benjamin, for designing the magnificent city park, known as The English Garden that will surely be a legacy to your illustrious name for all times.

Loud and cheerful applause
Turns to Sir Benjamin and says in low and weighty voice:

We, Carl Theodor, Elector at Rhine by the Grace of God, Duke of upper and Lower Bavaria, Lord Steward and Elector of the Holy Roman Empire have been pleased with the excellent personal merits of Sir Benjamin Thompson, and promote him to the rank and dignity of the Imperial Counts of the Holy Roman Empire, with the title of COUNT OF RUMFORD.

(This will be read in German first and then in English)

Loud applause. Carl Theodor turns to the audience:

Sir Benjamin chose the name Rumford, after a town of his home province of Massachusetts in the newly formed United States of America.
Count Rumford:

Thank you, your Grace. I am, as always, your servant and in your debt.

After some pause...

Carl Theodor:

This evening we have the unique privilege of watching and listening to Count Rumford and his assistant, Signor Artaria, showing and describing some of the experiments and scientific instruments he has devised in his quest to better our daily lives. Welcome, Signor Artaria.

Artaria:

Thank you, your grace. It is always interesting and exciting to work with the Count.
Sometimes, however, he overestimates my abilities to make the specific instruments he requires.

Count Rumford:

My dear Artaria, you have never disappointed me. You are a magician.

Artaria:

Thank you, Sir.

Carl Theodor:

The count and his assistant will try to explain the scientific principles behind the various instruments displayed. They will explain the workings of some of the scientific apparatus that the Count built during his stay in Munich. The Count in very actively involved in the public education of science.

He turns to the Count and his assistant and nods

My dear Count, it is all yours...

Count Rumford:

Good evening, Your Grace, my worthy assistant, Signor Artaria, and ladies and gentlemen
Before coming to Bavaria I spent some time in England as a soldier, administrator and sometime scientist. Since tonight we are interested in my scientific work I will present one successful apparatus I devised in England that will probably be used for some time. This device enables one to measure not only the speed of a bullet as it leaves the barrel of a gun but also its efficiency.

He goes to the apparatus and explains

This is a simplified version of the apparatus that is now called a "Ballistic Pendulum". With this apparatus it is possible to determine the recoil velocity of the gun and hence the efficiency of the gun.

He, with the help of his assistant, demonstrates the use of the apparatus.
Carl Theodor:

I understand that, based on this work, you were elected to the Royal Society at the age of 26.

Rumford:

Yes your Grace. I believe I was the youngest member at the time.

Takes a slight pause

In Munich I have been very productive, thanks to the good graces of the Elector. In preparation for finding the cheapest and best material to cloth the army, I built what I call a "passage thermometer".

Artaria coughs loudly

Actually, I had a great assistance from my excellent instrument maker, Signor Artaria

He points to his assistant. He acknowledges with a bow.

Artaria

I constructed the passage thermometer by blowing a long glass tube to enclose a regular thermometer (*overhead*).

BT:

I filled the bulb around the thermometer with materials and put the apparatus in hot water until the temperature reached 75^0 F. Then, I moved the apparatus to an ice bath and took the time it took the temperature to cool from 70^o F to 10^o F.

Artaria

Ah-hem. We studied densely and loosely packed materials, equal and different weights, and different materials like silk, wool, cotton, eiderdown, fur.

BT:

Ah-hem. I came to the conclusion that is was the air trapped in the cloth, fur, or feathers that was the key to the material's insulating properties.

Artaria

We immediately recognized this as an important scientific discovery.

BT:

And, I received the highest honor of the Royal Society of Great Britain, the Copley Medal.
My ultimate conclusion was the general principle that "any substance which tended to impede the motion of a fluid, be it liquid or a gas, increased the insulation property of a material". This conclusion was based on my chance discovery of what later became to be known as "convection".

In the course of a set of experiments on the communication of heat in which I used thermometers of an uncommon size ...having exposed one of them which was filled with spirits of wine in as great a heat as it was capable of supporting, I placed it in a window to cool where the sun happened to be shining, I saw something that was very interesting. I saw the whole mass of the liquid in the tube in the most rapid motion running swiftly in two opposite directions, up and down at the same time. ...Somehow some fine dust particles had found their way into the bulb of the thermometer ...the sun making these tiny particles visible, showing the violent motion of the spirit of wine. Examining the motion with a lens I found that the ascending current occupied the axis of the tube and that it descended by the sides of the tube.

Carl Theodor:

And from this one observation you came up with a principle that you call "convection"?

Count Rumford:
Well, not quite. Building on this one chance observation and being guided by it I conducted many experiments and soon I was able to state the general principle mentioned earlier.

Carl Theodor;
You must forgive me, my dear Count, but I cannot see how this principle, as you call it, helped you in making cloths with insulation.

Count Rumford:

This is quite simple, your Grace: Cloth must be so woven and made of such material that air is trapped in the interstices of the fibers to prevent the motion due to what I now call "convection currents". The material then is a poor conductor of heat and therefore a good insulator.

Carl Theodor:

I could have never seen that connection. Can you give us an example of convection that we may encounter in daily life?

Count Rumford:

Yes, your Grace. I believe you are a lover of coffee, as I am. When you pour milk into you cup of coffee and let it sit for a while the milk will eventually distribute itself evenly. Actually, your Grace, I am working on a revolutionary new coffee maker that makes use of this process.

Carl Theodor smiles and nods.

Carl Theodor

You must demonstrate this coffee maker, my dear Count.

Count Rumford:

Our next apparatus is called a photometer. Signor Artaria will explain and demonstrate this. After all, he helped me develop the photometer.

Senior Artania:

The count and I developed this simple device to measure the relative intensity of a light source, like that of a candle. When investigating the problem of illumination in the houses where people were working, we found that the lighting was always inadequate. We were looking for a light source that was cheap and provided considerably better illumination than the ordinary wax candles used.
We measured light intensity in order to improve lighting for the army and the workers. For example, if we compare two identical candles, and observe their shadows. I established a standard candle and then compared other light sources to it.

CT signals that he wants to ask a question

To illustrate how simple it is to establish the relative intensity of an unknown source we can compare this candle with the light given off by a standard candle.

Signior Artaria demonstrates and explains how the photometer works and how it can be used to determine the light intensity of an unknown source. He mentions and describes the inverse square law of radiation.

Rumford points to a lamp that he had recently designed (Overhead projection).

Carl Theodor:

I think we all agree that this is very impressive. Now, I wonder if you could tell us something about your study of nutrition

Rumford:

With pleasure, your Grace The question I asked was: What food would provide the maximum nutrition at minimum cost?

Based on many experiments I came to the conclusion that well prepared soup would be the best possible form of food for the Army as well as for the people working in the Poor People's Institute. The basic ingredients are barley, peas, and potatoes. I have found that meat is not an impressively nourishing ingredient but I admit it does provide flavor. Introducing stale bread fried crisp ensures that the soup is eaten slowly.

Thank you your Grace and ladies and gentlemen.

Rumford bows and is about to leave.

Carl Theodor:

Thank you Count Rumford. ....But do not leave us yet.
Turning to the audience:

I have prepared a little surprise for the Count. Since he is so interested in the public education of science and the application of scientific principles, I thought it a good idea to allow the audience to ask a few questions of the Count. I am certain that there are many amateur scientists among us. Here is your chance to talk to one of the world's authorities on applying scientific principles to improve our everyday life.

Loud murmuring in the audience, the audience then settles down.
An older gentleman in the audience slowly gets up and haltingly asks a question

Questioner 1:

Count Rumford: Congratulations on your being named a Count of the Holy Roman Empire.

Rumford:

Thank you , Sir.

Questioner 1:

I have been an admirer of your scientific work for a long time. I have even taught myself some English so that I can read your publications. Referring to your first demonstration, however, there is something that puzzles me: In my scientific readings I seem to remember coming across a note by the British scientist Benjamin Robins who described an apparatus in 1742 (before you were born I believe) that looks and functions much like what you called “the Ballistic Pendulum”. Yet you claim it as your own.

Noise in the audience. Rumford responds hesitantly

Rumford:

Well, he may have had the idea first but I perfected the apparatus so that it could be used in both scientific work and practical applications. For example, I was able to measure the recoil velocity of the gun and hence the efficiency of the gun. That is much more than he was able to do. But I did give him due credit for having had the idea before me. Just re-read my article.
He stops reflectively and then continues...

Besides, my membership into the Royal Society was more based on my work measuring the power of gunpowder, which I might add is still a standard. Thus the question of priority is not important here. No one at that time challenged me.

Questioner 2

A younger man with aristocratic demeanor, gets up and looks at the Count directly.

I, too, wish to say how much I admire your scientific work, Count Rumford. I grant you that your inventions and discoveries have made life more comfortable for many of us here in Munich, and indeed in many other places. But, I have it from reliable sources in London, that you have also turned your scientific knowledge to add to your personal wealth. I refer to the experiments you did, when working for Lord Germain in London, determining the moisture content of silk that you sold to the Colonies. I believe you found that dry silk accumulated about 8 pounds of water for every 100 pound exposed to moist air. This meant that you could make a neat profit, even without a markup. I think that is truly clever, ...and perhaps a little devious in taking advantage of those with less scientific knowledge.

Rumford:

Sir: May I remind you that I was very young then and full of ideas and ready for adventure. Yet, I feel that the profit I gained from this harmless little ruse ultimately allowed me, and, indeed, will further enable me, to make new scientific discoveries that will help me to improve the living conditions and ease the lot of mankind. In Munich I have enjoyed a long time of freedom and opportunity for scientific work that have brought about a significant improvement of the social conditions there. My accumulated wealth is used to further my work and make life more comfortable for the everyone.

Questioner 3:

Count Rumford: Your method of gathering the beggars of Munich was considered adventurous if not outright foolhardy. Where you surprised that your approach to settle so many people in large centres and educate them in crafts actually worked? I know my friends and I were astounded.

Rumford :

Not really. You see, Madam, in Munich, and everywhere else in Europe, it had generally been supposed that to make a vicious and abandoned people happy, it was first necessary to make them virtuous. But I thought, why not make them first happy, and then virtuous!

General applause and amusement

Carl Theodor:
Very amusing, my dear Count. We will entertain one more question from the audience.
...... Yes, Madam...

Questioner 4

An aristocratic looking lady gets up and smiles at the Count:

That is a very interesting guiding principle, my dear Count. One wanders why the Church has not thought of it first. ....My question to you is very direct and simple. What are your plans for the future?

Rumford:

Thank you madam. I have received permission from his Grace to take a long much needed vacation. I have decided to go to Italy and visit the great Alessandro Volta and study the nature of electricity. I also want to spend some time with the Gregorio Fontana, a world-famous instrument maker in Florence.

Rumford looks at his assistant :

Of course, Signor Artaria in some ways is even superior to the great Fontana.

His assistant smiles and nods.

Perhaps I will go back to England and show the English how to build efficient and clean fireplaces and kitchens, to make the air in that great city breathable again. I would also like to establish a public institution for defusing scientific knowledge and study the application of science to the common purposes of life. I also long to visit America, and especially see my childhood friends again.

I certainly want to return to Munich and continue my scientific work here. In Munich I still would like to do some experiments to disprove the caloric theory of heat. Finally, I plan to visit the French scientists Lavoisier, Laplace, Lagrange, Bertholet and others in Paris for the purpose of serious scientific discussions on heat and light.

Carl Theodor:

We would like to thank Count Rumford again. We wish you *bon voyage* and hope to see you back in Munich soon.

Loud applause..

SCENE 4:

Narrator A:
On March 16. 1793 “il Conte di Rumford” was issued an Italian passport and he left for Italy. He spent a 16 months there were he met and worked with Alessadro Volta in Pavia, and spent two months with the great instrument maker Gregorio Fontana in Florence. He studied mostly light and heat, but he also discussed the nature of electricity with Volta. In Verona he designed two large kitchens for two hospitals. When Rumfort returned to Munich in 1794, half of the population of Munich gathered in the English Garden to celebrate and pay honor to their great benefactor.

He now settled down and devoted his time to experimenting and writing scientific articles. Among these are his famous canon boring experiment and his determination of the temperature at which water has the maximum density.

By 1795 Rumford’s cold arrogance and exercise of power made him many enemies in Bavaria. He attempted to step down with dignity and the Elector granted him another leave of absence and he went to London. Here he diligently advertised the results of his eleven years’ labors in the city of Munich. Rumford seems to have extended his thoughts on the inefficiencies of the Bavarian Army to the whole of society. He spent a great amount of time designing and building efficient fireplaces in London in order to reduce the smoke in the city. While in London he also established a Rumford Prize for Natural Science for the Royal Society. Not surprisingly, the first recipient of the Rumford Prize was Rumford himself (1802).

His visit to England, however, was abruptly cut short in August 1796. He was summoned back to his military post in Munich. The French and the Austrians were at war. Avoiding entanglement with the opposing armies it took Rumford three weeks to get to Munich. He found the Bavarian Army unprepared to defend the city: The French and the Austrians laid siege to the city, The French in the West and the Austrian in the east.

The elector and his entire court fled to Mannheim. Since noone had faith in the Army to take on either the French or the Austrians, somebody whose political and military future was expendable would have to shoulder the responsibility for the predicted defeat. Thus it came about that Rumford’s enemies persuaded the Elector to give this unenviable task to the Count. The situation seemed hopeless. General Rumford drew all his men together in a garrison within the city walls.

Rumford first visited general Moreau and claimed that he had managed to persuade the Austrians not to enter the city. Therefore, he argued , there was no point in attacking Munich. For two weeks he waited in the city with his twelve thousand troops, and continued visiting each side in an effort to prevent them from entering the city. Then suddenly the French left and a little later so did the Austrians. The victory was won without firing a shot. Ironically, this was the only real military engagement General Thompson ever engaged in.

Characteristically, during the siege he used his powers as supreme commander of the Army to blow up all those buildings that his opposition erected to stop his plan to build an esplanade around the city around the Englishe Garten.

Narrator B

Count Rumford became the hero of Bavaria. He wrote to his friend Lady Palmerston:

Not only Munich, but Bavaria, and National Honor, has been preserved by my Prudent and Spirited exertions.

For the next two years Rumford worked on scientific experiments, the most important of which was the testing of the caloric theory of heat. The purpose of this experiment was to see if the quantity of heat produced was always the same, independent of how long the canon was

In spite of his fame and popularity in Munich, Rumford accumulated many enemies in high places, and in 1798 he decided to go back to London. The Elector appointed him as an Ambassador to England but King George III would not accept him in this capacity, for obvious reasons.

1799 he established the Royal Institution which was to serve the public as a center of scientific education. He hired the young Humphrey Davy and Thomas Young. The first because of his experiments on heat and light, the second because of his recent work on the wave nature of light. It is not surprising that the first Rumford prize from the Royal Society was presented to Count Rumford himself in 1802.

A stage light shines on Count Rumford and he is awarded the first Rumford Medal "For your various Discoveries respecting Light and Heat".

Narrator continues...

In 1802 Rumford returned to Munich: his friend the Elector had died and he wanted to be assured of his continuing patronage and pension from the new Elector Maximilian. Finding that all was well he visited Paris. Napoleon was very impressed with him and put him in the special care of famous scientists and mathematicians, among whom were Laplace, Lagrange, Delambre and Bertholet. This is when he met and fell in love with the widow of the great chemist Lavoisier.

He fell in love with Madame Lavoisier and spent three months with her. But he did not devote all his time to her, he continued his scientific work and studied radiation and found practical applications for his discoveries. These experiments got him involved in a full scale priority battle with John Lesley, a Scottish investigator. It is almost certain that the two men worked independently, but national honors were involved. Today, textbooks in English still only credit Leslie with these experiments, and those in German mention only Rumford

Because of poor communication during a time of wars and legal problems, it took another two years before Rumford was legally able to marry Madame Lavoisier. Rumford needed the permission of his mother to marry. Only in October of 1805 was the ceremony performed.

He wrote to his daughter Sarah in America: "I have the best found hopes passing my days in peace and quiet in this paradise of a place, made what it is by me - my money, skill and direction".

The last scene is placed in Paris, January 1807. Rumford and Madame Lavoisier-Rumford have been married for almost two years. It was a fashionable match and greetings from the nobility poured into the villa. A London newspaper reported:

Married: In Paris, Count Rumford to the widow of Lavoisier, by which nuptial experiment he obtains a fortune of 8,000 pound per annum - the most effective of all Rumfordizing projects for keeping a house warm.

SCENE 4: Paris, January, 1807, Villa of Madame Lavoisier-Rumford

Count Rumford
Madame Lavoisier-Rumford
Pierre de Laplace
Humphrey Davy

Note: M. Lavoisier-Rumford should occasionally speak in French and Rumford in English, especially when talking to Humphrey Davy.

Demonstration of the existence of "frigorific" rays (Demo)

Heat Radiation from Various Surfaces (Demo)

The Cannon Boring experiment (Overhead projection)

Diffusion of Heat Demonstration (Demo)

Madame Lavoisier-Rumford, Pierre de Laplace and Humphrey Davy are sitting in the drawing room in conversation. The famous painting of Lavoisier and his wife by David can be seen.

Shortly Count Rumford appears, clad in an early 19th century suit, but covered partly in white. He removes his white hat.

Madame Lavoisier-Rumford (MLR)

Good morning, my dear. Our guests, Monsieur Laplace and Mr. Humphrey Davy have already arrived. I see you are wearing your new fashionable suit. But, really, it isn't that cold today.

Rumford:

Rumford ignores his wife and turns to the guests

Good morning gentlemen. My wife makes fun of some of the applications based on my scientific discoveries. Perhaps with the help of my two eminent colleagues I will be able to convince her of the efficacy of my strange looking suit and hat.

Madame L-R:

It may be a good idea if I took notes later, draw some sketches so that we will be able to publish this unique scientific gathering.

Everyone laughs

Rumford:

Nice to see both of you, especially Mr. Davy, whom I have not seen since I established the Royal Institution. By the way, Davy, how is your young assistant, what's his name–Faraday I believe, coming along?

Davy:

He is very promising, someday he will be an accomplished scientific investigator.

Rumford:

Next time you must bring Mr. Faraday with you. I would like to meet him.

Turning to Laplace:

Mr. Davy has just recently been able to show that salt can be separated into metal and a gas by electricity, using the cells that my good friend Alessndro Volta developed. Davy, tell us about that.

Davy:

Yes. It seems that the great Lavoisier was right: salt is not an element. It is actually a chemical union between a metal we now call Sodium and chlorine. Sodium is not found in nature. This is not surprising because it turns out that it is very corrosive and reacts directly with water and produces an alkaline substance.

MLR:

Chlorine gas was known when I worked with my former husband. It is very poisonous. So the chemical reaction between two poisonous elements produces life-preserving salt. That is most interesting.

Everyone nods and seems astonished. MLR gets up and is about to leave.

Excuse me for a moment, I have to make sure that the maid is properly preparing our dinner.

Rumford:

Of course, my dear.

MLR leaves.

Rumford:

Rumford turns to Laplace

Congratulations, my dear Laplace, on your new title as Count of the Empire.

Laplace:

Thank you Count. But let me take this opportunity to apologize for my attack on your theory of capillary action at the Institute, the other day. We can still be friends, of course.

They laugh and shake hands. Then Rumford looks at his shiny suit and smiles.

Rumford;

I know now why we could not understand each other. Your mathematics obscured things for me and you seemed to have had difficulty in understanding my ideas which were based on observation and experiment.

Laplace:

Yes, differential equations do tend to scare people away. Perhaps the two approaches to understanding capillary action can be reconciled.

Rumford:

But I must say that working with the foremost thinkers in Europe, here in Paris, I have come to appreciate the broader implications of my experiments.

MLR returns. Overhears the conversation and interjects.

MLR:

I do not think the Count is innocent when it comes to treating the opinions of others with condescension.

The Count protests, raising his arms. MLR looks at her husband

I have heard you say, my love (in French), many times that “I am never wrong–I know everything”.

General laughter

Rumford:

Well, I must admit I have been wrong on occasion, I recall making a mistake in October of 1805. But, I am not wrong about the efficacy of this suit and this hat.

Points to his white hat

Of course, I put on my suit for the purpose of starting a conversation about the theory of heat.

Laplace:

It certainly has the makings of a conversation piece.

Davy:

This is a lovely house, Madame. As I was coming in I noticed the fireplace and the kitchen.

MLR:

Thank you, Mr. Davy. The Count has been busy “Rumfordizing” our large house. I must admit, I am the envy of my friends to have the world’s foremost authority improving my heating, lighting and cooking facilities.

Rumford:

I am usually happily engaged in my work improving the living facilities as well as setting up experiments.

He looks at his wife, and forces a smile

But I also use these activities as an excuse not to attend some of Madame’s famous social events.

General laughter

MLR:

Well, my love (in French) , you obviously do not enjoy the literary repartee. Actually, my Rumford makes me very happy if he keeps quiet (keeps his mouth shut) at these gatherings. Most of my friends, although they are interested in improving their fireplaces and kitchens, are not fascinated by the details of scientific investigations.

Rumford:

But I seem to recall, my dear, that, not so long ago, love and science coexisted nicely. Three years ago, when we traveled to the Mer de Glace above Chamonix, you did not seem to mind when I disappeared for a whole day, studying the mysterious cylindrical holes that are found on the glacier surface.

MLR:

Well, when you are in love, you become very tolerant.

Everyone seems amused

Rumford:

Turning to Davy

Davy, my boy, you have matured since I appointed you to the post of assistant lecturer at the Royal Institution about 5 years ago. I believe you were only 19 at the time. I remember being impressed by your early experiments on heat, although they were a little amateurish in your investigations. ....By the way, how is Thomas Young getting along? I appointed him just recently as the expert on light and radiation.

Davy:

He certainly is a brilliant natural scientist and mathematician. He distinguished himself with equal brilliance in the classics, in mathematics, physics, and in even in Egyptology. A little difficult to work with, - but most geniuses are.

He looks at R and smiles. Then continues...

Yes, Count. I have learned much about experimentation since you appointed me, especially from your recent splendid scientific work. Actually, M. Laplace and I have just been discussing the caloric theory of heat that was developed by Lavoisier and him some 25 years ago.

Laplace:

You are too kind, Mr. Davy. I really just tried to give the theory a mathematical framework. I am sure we will discuss this topic a little later.

Turns to the Count..

From the remark made by Madame, I assume that the shiny surface is to reflect the cold rays, what you call frigorific rays?

Rumford:

Yes. Based on some experiments I have done I am convinced that these rays exist. What I found was that polished bodies were poor radiators and rough, sooty bodies radiated well. In other words good radiators were poor reflectors and poor radiators were good reflectors.

Goes to his radiation apparatus

Let me show you .....Rumford explains how the apparatus works.

Brief discussion follows–with questions by both Laplace and Davy.

Davy:

I am still interested in showing that what you called “frigolistic” rays exist, Count Rumford.

Rumford:

No. Frigorific, my dear Davy, frigorific. Alright. I have set up a special apparatus to demonstrate that. .....If I now place a piece of ice in the focal point of this parabolic reflector....So you see, I can read the effect of the frigorific rays at the focal point of the other parabolic reflector. Thus, one can stay warm by simply reflecting these rays from white surfaces. Therefore, one should wear shiny white clothes in winter to keep warm.

MLR:

Don’t forget, my dear (in French), to mention that I made sketches and helped you write your report on radiation.

Rumford:

Yes, my love (in French). Gentlemen, I should mention the invaluable contribution to my work of my wife. She certainly gained much experience in scientific matters helping her former husband, the great chemist Lavoisier, with the publication of his chemistry experiments, and, of course, his great textbook (name of textbook in French). I know that it is considered unseemly for a woman to be engaged in scientific activity but Madame is knowledgeable in scientific matters and would be a great help to any natural scientist.

MLR:

Gentlemen, I don’t think Count Rumford is saying that a woman is not capable of being a scientist. Are you, my dear?

Rumford:

Well... I ..I am not saying that ..it is just that I know of no woman natural scientist.

MLR:

What about Caroline Herschel, the sister of the famous British astronomer William Herschel?

Rumford:

Not unlike you, my dear (in French) for assisting Lavoisier in chemical experiments, she was a great help to Sir William in astronomy, cataloguing celestial objects.

Laplace:

Allow me to interject Madame. I know of at least one woman mathematician who, if she were a man, would probably rank among the best of us. She adopted a male pseudonym and recently sent her work to the young mathematical genius Gauss in Gottingen, who commented very favourably on it.

MLR:

It is a pity that we women have to go to that extreme to have our efforts recognized in a male-dominated world.

Laplace:

I am certain their day will come.

Rumford:

But let us proceed... Since we have Laplace in our midst, as well as the young chemist Davy, I would like to discuss my experiments in heat and my efforts to show that the caloric theory is wrong. I am well aware that you, my dear Laplace were working with Lavoisier to lay the foundations for the caloric theory of heat, about 25 years ago.

Laplace:

Yes, it was my privilege to work with the great chemist. We built a calorimeter when we studied respiration. I also used my mathematical and scientific knowledge to give the theory a respectable physical and mathematical framework. Recently again I am studying the nature of heat from a purely mathematical point of view.

MLR:

Do not forget M. Laplace that Madame Lavoisier played a prominent role in this. Not only in recording the data and making tediously detailed sketches but also in conducting the experiments

Laplace:

Forgive me Madam, of course you played an important part.

A slight pause. MLR gets up.

MLR:
Excuse me gentlemen, I will go and see what is happening in the kitchen. I must confess that the stoves that my husband built are so much more efficient than the ones we replaced.

MLR leaves.

Rumford:
Well, thank you my dear for this public recognition.

To engage in experiments on heat was always one of my most agreeable employments. It is only, recently, however, that I have had the good fortune to mount several experiments that, I believe, will cast grave doubts on the caloric theory of heat.

Davy:

I am very interested in what my two eminent colleagues have to say about the state of the caloric theory, some 25 years after its formulation. Count Rumford, tell us what counts as evidence against this widely used theory.

Count Rumford:

Being engaged in 1796 in superintending the boring of cannon in Munich, I was struck with the very considerable degree of heat which a brass gun acquires. The heat achieved in separating the metallic chips was high enough to boil water, much to the astonishment of the bystanders. But I often noted to the people watching this curious phenomenon that this was not an economical way to boil water!

Now, the caloric theory says that heat could not be produced in an isolated body continuously. However, I found that no matter how long I kept the experiment going, the length of time it took the water to boil starting from room temperature was always the same. I came to the conclusion that the heat produced by the boring was inexhaustible.

Rumford goes to the large image showing the famous canon boring experiment and explains.

Davy:

As you know, I have shown that you can melt ice by rubbing two pieces together vigorously.

A little pause..but noone responds to Davy's comment...

Laplace:

Gentlemen, let me just say that these experiments, impressive and surprising as they are, by no means destroy the caloric theory of heat that chemists since 1780 have used so effectively. First of all, I remember some critics of your conclusions based on the canon boring experiment, challenged you to prove that "the heat produced by the boring was inexhaustible". As we mathematicians would say: You extrapolated experiments that lasted only a few hours to infinity.

Davy:

I suppose they meant that if the canons were bored for a very long time, they would yield a lot of heat but would ultimately be worn away?

Rumford:

The notion of infinite time has no place in physical experiments. What is significant is that the length of time it took the horses to rotate the dull drill to heat the water to boiling was always the same. If heat were a material substance it should eventually be drained out.

Laplace:

We laid the foundation of the caloric theory in 1780 and can now be seen as part of the new atomic theory of matter as Mr. Dalton has so brilliantly outlined recently. We postulated that heat was a self-repulsive, invisible fluid. So atoms can be seen to be attracted by an inverse square force and repelled by the caloric force whish followed a logarithmic law, like the density of the earth's atmosphere.

Davy:

M.. Laplace, tell us what important phenomena connected with heat can you explain using the caloric theory?

Laplace:

Based on this theory we can explain thermal expansion, the difference between, solids, liquids and gases. We could predict that denser bodies would have a higher conductivity than less dense bodies. We could even predict that the specific heat of a solid should increase with the temperature. This I think was a triumph of our theory.

Rumford:

Before carrying out my experiments on conductivity I convinced myself that conductivity increases with density. I then showed that heat could be transmitted through a vacuum. If the caloric theory were correct then there should be no conductivity of heat in the absence of a material substance. There would be no atoms to attract the *caloric*.

Davy:

I agree with the Count: He told me some time ago that he could not imagine how heat can be communicated in two entirely different ways.

Laplace:

Come, come now, my dear Davy: We know that heat is transmitted by conduction, and radiation. Not to mention a third way, that Count Rumford demonstrated in connection with his experiments on clothing for the Bavarian Army.

Rumford:

Ah! Allow me demonstrate a remarkable experiment I have devised. This experiments clearly suggests, nay shows, that there is atomic motion at all times. Any school boy can replicate this simple experiment.

He goes to his apparatus

I took two liquids, a salt solution and pure water and put them in a glass container in such a way that the salt was at the bottom and the water on the top. I put the water in first and then introduced the salt solution below the water by pouring it through a funnel to the bottom of the glass. At this point I dropped a small hollow glass sphere into the glass. The glass sphere sank in the water but floated in the salt solution and came to rest about half way down the liquid column.

The experiment was carried out in a cellar where the temperature was constant. What I found astonished me. In the course of a few days the hollow glass sphere rose slowly to the surface.
Looks at the container and points to the glass sphere.

Davy:

That is extraordinary. This seems to suggest that the internal motions of the particles continued even at temperature equilibrium. The caloric theory does not allow this, that is, there is no motion at temperature equilibrium.

Rumford:

You are right, Davy. But I have several more arguments against the theory. First, I was unable to find any weight associated with the caloric. Secondly, it is well known that ice cannot be melted with a lower degree of heat than 32° F. But, in spite of that, in the midst of winter, in cold places, and when the temperature of the air is much below 32° F, ice, exposed to the air, has been found to evaporate. How can that be?

Davy:

One is almost led to the conclusion that some of the particles of air come into contact with air are so hot that they not only melt a small amount of the ice but also change the water to steam.

Rumford:

I am pleased that I appointed you to your position at the Royal Institution, Davy.
Rumford pats him on the shoulder

Laplace:

Gentlemen, let me be the devil's advocate, just for a moment. It is also well known that when a piece of iron is made red hot by hammering, it cannot be heated a second time in that way unless it was agin first introduced into the fire. The caloric theory explains this phenomenon by saying that the caloric has been pressed out of the iron by percussion and that the caloric then was recovered by the fire.

Rumford smiles and indicates for Davy to respond

Davy:

I have discussed this phenomenon with the Count some time ago. We agreed that it was a strong support for the caloric theory. But one can also say that the pounding itself changes the internal structure of the assembly of iron atoms..........

Rumford:

with great emphasis, hitting one fist into the other hand

I believe that the heat comes from the motion of particles, as Robert Boyle and others believed over a hundred years ago. I am not pretending to understand the mechanical contrivance that underlies this excitation, continued and propagated, but we know some of the laws of its operation. A thermometer can do no more than indicate the mean of the different temperatures of all those bodies or particles of matter which happen to come into contact with it. If it be suspended in air, it will indicate the mean of the temperatures of those particles of air.

Laplace:

Very imaginatively put, my dear Count. We know these laws and we have made quantitative investigations of heat as it operates in chemistry. The calorimetry that Lavoisier, the Scottish Chemist Joseph Black, and in some small measure myself, have applied have been very successful. The conservation of mass and heat (call it caloric, or whatever) has opened up a whole new chemistry.

MLR suddenly appears and interject.

MLR

Gentlemen, as I was returning from the kitchen, I overheard part of your conversation. Such passion and conviction! I remember my former husband being very proud of the caloric theory.

MLR turns to Laplace

So, you are saying in effect that it does not matter what you call the “cause of heat”, these quantitative procedures will not change?

Laplace:

Yes, indeed, Madam Moreover, I believe that until we have a quantitative relationship between work and heat, your particle motion theory is not very helpful. The caloric theory has been a very successful theory in guiding our work, however imperfect it may be.

At any rate, I believe it will be difficult to replace a successful theory in science, even by such an able champion as you, my dear Count. Remember, the phlogiston theory that was ultimately displaced by the new chemistry is till alive today! Joseph Priestly is still arguing for it, albeit with less and less fervor.

Davy:

I would like to ask the Count what his ideas are now about the existence of an aether in explaining the phenomenon of radiation of heat. The Count and I discussed this topic at the Royal Institution some years ago.

Rumford:

Alright, I will try to answer that. Since I have shown that radiation of heat is possible in a vacuum, this radiation, analogous to sound, would require a medium to transmit that radiation. So I think there is an all pervading medium that we called “aether” that is massless and infinitely elastic. Of course, Thomas Young has shown recently that light travels by undulatory motion, and not by way of corpuscles as Newton thought. So radiant heat I suppose to be merely undulations in the Etherial fluid, or as Young said in his famous lecture “a Luminiferous Ether pervades the Universe”.

MLR:

Gentlemen, I just want to remind you that about ten years ago William Herschel, with the assistance of his daughter Caroline, that a thermometer records the presents of heat beyond the spectrum of sunlight produced by a prism.

Laplace:

Yes, indeed, Madam, this is very interesting. We seemed to have banished the idea of caloric fluid to explain heat phenomena and divined another magical fluid called the ether. My God (in French)!

Laplace is interrupted by Madame-Lavoisier

MLR:

Gentlemen, gentlemen, please permit me to have the last word before I ask you to retire to the dining room for food and drinks. It seems that I am in the unenviable position of having married Lavoisier who displaced the phlogiston theory and created the caloric theory and then married Rumford who toppled the caloric theory and invented the ether theory.

She walks slowly to the edge of the stage, looks at the audience, and emphatically asks:

I ask you: Is this how science progresses?

General laughter
The party retires noisily to the dining room

Narrator B:

Count Rumford died suddenly and unexpectedly in Paris in 1814, at the age of 61. He was buried in Paris.

Toward the end of her life, his daughter Sarah, Countess Rumford, insisted that he did not die as reported, that someone else was in the coffin. She wrote in a letter that he lived for many years in England where her friends reported seeing him on several occasions, strolling in Hyde Park in a white suit, with a large medallion hanging from his neck. She ended her letter by saying:

.. *He was a very strange man, and quite equal to a thing of this sort.*

The narrator walks away, and Rumford appears on the stage, looking at his medallion, holding it lovingly in his hand.

I think I deserved this honor. The committee really had no choice. Who else would have been worthy of this award? I can't think of anyone.

______________________________END___________________________________

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