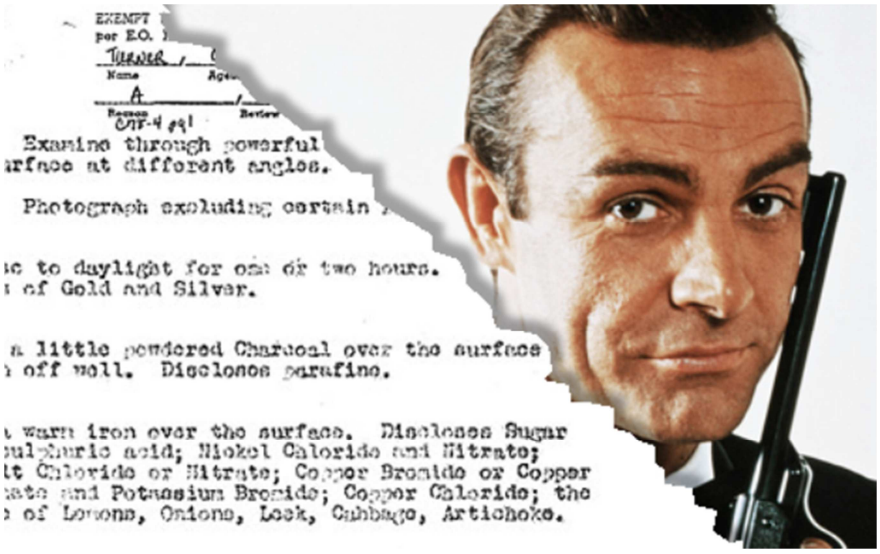
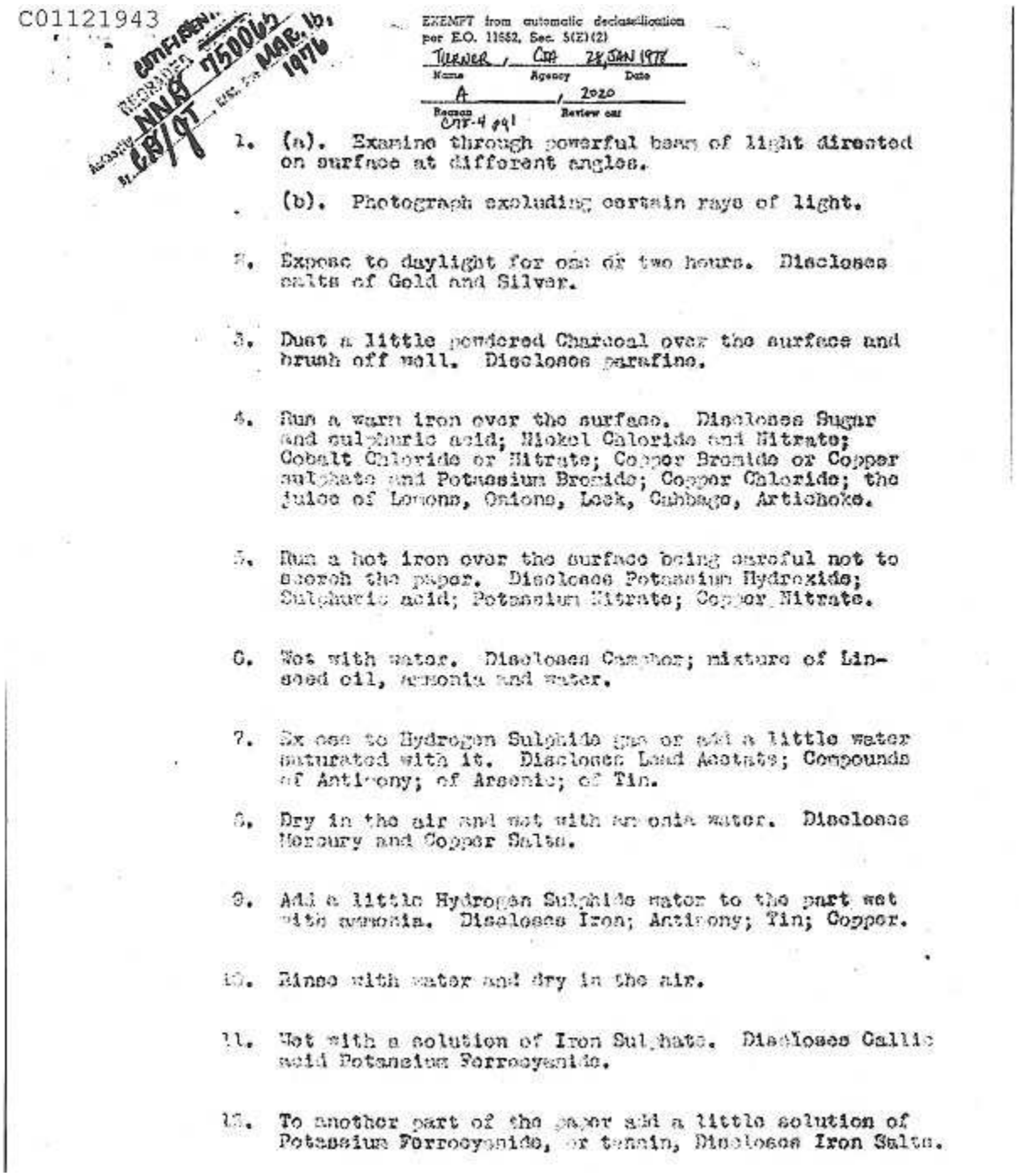
INVISIBLE INKS: HISTORY AND FORMULAE



Yesterday, the CIA posted six pages of near century-old military intelligence detailing then high-tech methods for creating invisible ink. The World War I-era papers bear handwritten footnotes, step-by-step instructions, "CONFIDENTIAL" stamps and everything. German invisible ink is more sophisticated that the lemon juice trick you can learn on YouTube. But it's still a bit bland as is the other spy secret about how open envelopes undetected. CIA Director Leon Panetta explained that technology has made the techniques obsolete, hence the public release. If you're still interested in experimenting, the Daily Mail provides shorthand instructions. Here's an excerpt form the long version:



C01121943

EXEMPT from automatic declassification per E.O. 11652, Sec. 5(E)(2)
TURNER / CIA 28 JAN 1978
Name Agency Date
A / 2020
Reason Review on
CIF-4 #91

1. (a). Examine through powerful beam of light directed on surface at different angles.

(b). Photograph excluding certain rays of light.

2. Expose to daylight for one or two hours. Discloses salts of Gold and Silver.

3. Dust a little powdered Charcoal over the surface and brush off well. Discloses parafine.

4. Run a warm iron over the surface. Discloses Sugar and sulphuric acid; Nickel Chloride and Nitrate; Cobalt Chloride or Nitrate; Copper Bromide or Copper sulphate and Potassium Bromide; Copper Chloride; the juice of Lemons, Onions, Leek, Cabbage, Artichoke.

5. Run a hot iron over the surface being careful not to scorch the paper. Discloses Potassium Hydroxide; Sulphuric acid; Potassium Nitrate; Copper Nitrate.

6. Wet with water. Discloses Camphor; mixture of Linseed oil, ammonia and water.

7. Expose to Hydrogen Sulphide gas or add a little water saturated with it. Discloses Lead Acetate; Compounds of Antimony; of Arsenic; of Tin.

8. Dry in the air and not with ammonia water. Discloses Mercury and Copper Salts.

9. Add a little Hydrogen Sulphide water to the part wet with ammonia. Discloses Iron; Antimony; Tin; Copper.

10. Rinse with water and dry in the air.

11. Wet with a solution of Iron Sulphate. Discloses Gallic acid Potassium Ferrocyanide.

12. To another part of the paper add a little solution of Potassium Ferrocyanide, or tannin, Discloses Iron Salts.

The real takeaway from the document leak is two-fold. One, the CIA website is not nearly as cool as it could be. The FOIA Electronic Reading Room feels like a trick as there's so little there, and what's there seems kind of arcane. There's also a kids' section with some rather dry games.

Two--and this is related--British spy documents are much cooler than American spy documents. While we got some instructions on how to make invisible ink, MI5 recently declassified a bundle of files detailing how Nazis planned to infiltrate and undermine American society by using a whole host of frightening, interesting assassination devices. The list includes sort of silly-

sounding items like compact mirrors loaded with bacteriological weapons and a swastika belt buckle that could be used as two-barreled pistol. Then there are the really horrifying-sounding things like headache-inducing cigarettes that invited Nazi agents to offer poison pills disguised as Bayer aspirin and small pellets that released a poisonous gas when burned that were to be hidden in ash trays.

Similarly, another set of documents released in 2009 outlined a Nazi sabotage plot that nearly changed the course of the war. The Germans evidently paid a Portuguese wireless operator for information regarding a fleet of Allied ships, including an American ship carrying General George S. Patton. With a volley of false intelligence and double agents that's fit for James Bond--from the Sean Connery era, of course--Germany was days away from intercepting the fleet when the Allies discovered the plot and arrested the Portuguese operator.

The British Security Service portal for MI-5 offers thousands more declassified documents. Highlights include sprawling narratives about people like double agent Eddie Chapman, a member of something called the "jelly gang" and a double agent during World War II, and a well-organized dossier on Klaus Fuchs, the infamous scientist who attempted to sell nuclear secrets to the Soviets during the Cold War. This tree of links to the rest of the archive should keep conspiracy theorists busy for years to come.

CIA reveals World War I recipe for invisible ink as agency declassifies secret files from 100 years ago

Most Nancy Drew fans could tell you how to make invisible ink.

But the CIA has still waited until now to lift the lid its 'secret writing' practices, revealed today in some of the oldest secret documents ever declassified in America.

The six files, which date back to World War I, painstakingly detail the recipes used by spies, generals and diplomats to make invisible ink to send secret correspondence between allies.

Despite the old-fashioned methods, the agency said it has only now been able to release the documents because the technology is at last 'obsolete'.

01121943

"Acetate of Lead "Writing 10 ~~grains~~ ms of Proto sulphate of Iron (F e S 2) in weak solution of H2 S04 in a dish. Hold papers over this and the writing becomes visible.

Hydrogen Selenate ($H_2 Se O_4$)
Hydrogen Tellurate ($H_2 Te O_4$)

Uranyl acetate ($UO_2(C_2 H_3 O_2) + H, O$ and Ammonium Phospho-Molybdate ($3(NH_4)_2 OP_3 O5 22 MoO_3$ 12 $H_2 O$)

Cobalt Nitrate
Potassium--Ferro Cyanide Dev. Ferric Chloride & Oxalic Acid.

Arsenite of Potash
Sodium Tungstate Solution Dev. Nitrate of Copper, Iron, Protosulphid and Hydrocloric Acid

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How to open sealed letters without detection.

Mix 5 ~~dragms~~ copper acetol arsenate.
3 ounces acetone
and add
1 pint amyl alcohol (fusil-oil)
Heat in water bath--Steam rising will dissolve the sealing material of its mucilage, wax or oil.
Do not inhale fumes.

Tetra chlorgunone ($C_6 Cly O_2$)
Tyrosin and Corallin in combination with ~~stannic~~ and ~~stannous~~ salts.

Selenium and Tellurium salts to generate = $H_2 Se$ and $H_2 Te$ and Uranium compounds (developer)

To be written with a pumice ink to impregnate plain typewriter ribbons which are to be used on a specially made typewriter machine with rubber composition types

NW24049

Trade secrets: Recently declassified World War I documents reveal how spies used a special chemical formula to open sealed letters

They also reveal chemical methods used by agents to open sealed envelopes without being caught, complete with a safety caveat for would-be sleuths: 'Do not inhale fumes.'

The papers, some of which are handwritten, give a tantalising glimpse into a secretive war-time world.

They were originally kept by the Office of Naval Intelligence, many decades before the CIA itself was founded.

One, dating from June 1918, is written in French, and describes the Germans' secret ink formula, showing they had cracked the enemy's code.

APPROVED FOR RELEASE DATE: 31-Mar-2011

German Secret Ink, Formulas used in preparation of. Source- N.G.

N. 433 June I4, 8

The following is a copy of the formulae used preperation of German secret ink.

I Comprime de Pyramiden	d 0,Igr
ou (or)	d 2 I/2 gr.
I Comprime ou de poudre d'aspirine	d 0 I gr.
ou (or)	d 2 I/2 gr.

Le tout doit être mélangé avec 400 cms d'eau pure.

- - - - - - - - - -

Pour faire apparaître l'encre invisible.

- - - - - - - - - - - -

Ist.

Alcool légerement camphrée	22 gr.
Eau distillee	50 gr.
Nitrate de potasse	0 gr. 50
Acide acetique	27 gr.
Tetrachlorure de carbure	20 gr.

Doit être bien mélangé et le faire appliquer dessus avec du coton mouille.

0 - - - - - - - - - - - -

2nd.

Acide acetigue	100 gr.
Alcool a 90	100 gr.
Eau distillee	50 gr.
Teinture de capsium	15 gr.
Chlorhydrade le quinine	0 gr. 50

Doit être appliqué après le premier bain, de la même maniere mais it faut attendre que la premier solution soit completèment sèche.

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EXEMPT from automatic declassification per E.O. 11652, Sec. 5(E)(2)
Name / Agency / Date: Ivanea / CER / 28 Jan 1978
Reason / Review on: A / 2020
C78-4 PAT

CONFIDENTIAL

REGRADED ~~SECRET~~
Authority NND 750065
By CR/9T, NARS, Date MARCH 15, 1976

NW 24045

Gallic ingenuity: A document written in French reveals they had cracked the Germans' secret formula for making invisible ink

Another describes how to carry invisible ink in your clothes. Spies were instructed to soak their handkerchief or starched collar in a mixture of nitrate, soda and starch before drying the fabric.

The instructions continue: 'The article thus treated is later on again put in water and a solution obtained, which can be used for invisible ink. The best means for developing are iodite of potassium.'

And spies weren't just taught to make invisible ink - they were told how to interpret it, too. Instructions include 'examine through powerful beams of light directed on surface at different angles' and 'run a warm iron over the surface'.

One of the documents is an extract from a pamphlet written by a Theodore Kytka, a San Francisco handwriting expert, which was designed to teach postal inspectors how to recognise invisible ink.

C01121943

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(b). Photograph excluding certain rays of light.

2. Expose to daylight for one or two hours. Discloses salts of Gold and Silver.

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Spy secrets: Painstakingly-detailed documents describe the different methods which could be used to read documents written in invisible ink

It lists 50 scenarios in which the ink could be used, including 'placing writings under postage stamps, wrapping messages in medicine capsules and engraving messages... on toenails.'

REVEALED: WORLD WAR I TIPS FOR WOULD-BE SPIES

How to open envelopes without being detected:

1.) Mix five of drams of copper acetol arsenate and add three ounces acetone.

2.) Add one pint of amyl alcohol (fusil-oil).

3.) Heat in water bath - steam rising will dissolve the sealing material of its mucilage, wax or oil

4.) 'Do not inhale fumes'

How to make invisible ink:

1.) 'A tumbler of water is boiled together with a tablespoon of starch, allow to cool, and add ten grams of nitrite of soda.'

2.) The mixture 'may be carried for example in handkerchiefs or starched collars'.

3.) The article thus treated is later on again put in water and a solution obtained, which can be used for invisible ink.

4.'The best means for developing are iodite of potassium.'

The pamphlet even describes how some spies may use invisible ink to carry messages on their bodies.

And a chemist who supplied some of the chemicals warns the ink may be toxic enough to corrode a steel pen, so a quill should be used instead.

Despite the seemingly old-fashioned nature of the instructions, a spokesman for the CIA said the documents have only now been released because recent advances in the chemistry of secret ink and the lighting methods used to detect it have made the secrets obsolete.

In a statement CIA Director Leon Panette said: 'These documents remained classified for nearly a century until recent advancements in technology made it possible to release them.

'When historical information is no longer sensitive, we take seriously our responsibility to share it with the American people.'

But a request to release the files, some of the oldest in the CIA's care, was rejected in 2002.

Steve Aftergood, from the Federation of American Scietists, said: 'Invisible ink was rendered obsolete by digital encryption long ago, not in the last few years.

'Director Panetta is attempting to rationalize the CIA's irrational information policies, but there is no known basis for his claim.'

All sic files are now available to view on the CIA's website, in the Freedom of Information Act Electronic Reading Room.

The History of Invisible Ink

In April of this year, the CIA released its oldest classified documents and the last from the World War I era. Dating from 1917 and 1918, the papers mainly contain recipes for "secret writing"–instructions for agents of the Office of Naval Intelligence (the CIA did not yet exist) on how make invisible ink. Such a low-tech espionage method may seem quaint today, but invisible ink was once a very serious business and an important tool in a spy's bag of tricks. So much so that the CIA bizarrely waited almost a century before revealing its most basic recipes to the public (information which was available on the web and to every Boy Scout), claiming even in the 90s that the material constituted a foundation upon which more modern tactics had been built and that invisible ink remained a viable tool for its agents.

While the use of invisible ink has now been almost entirely eclipsed by modern technology, its history is incredibly fascinating, and today as part of our Man Knowledge series we'll explore its use through time.

The Basics of Invisible Ink

There are two categories into which invisible inks fall: organic fluids and sympathetic inks. The former consists of the "natural" methods many of us tried our hand at as kids: lemon juice, vinegar, milk, sweat, saliva, onion juice, and even urine and diluted blood, to name a few. These organic invisible inks can be developed through heat, such as with fire, irons, or light bulbs, and some can be seen when placed under ultraviolet light. The organic fluids alter the fibers of the paper so that the secret writing has a lower burn temperature and turns brown faster than the surrounding paper when exposed to heat.

Sympathetic inks are more complicated chemical concoctions. Sympathetic inks contain one or more chemicals and require the application of a specific "reagent" to be developed, such as another chemical or a mixture of chemicals.

The History of Invisible Ink

The history of invisible ink is mainly the history of war, for it is during such times that intrigue, espionage, and spying is at its most vital and necessary.

Ancient Times and the Renaissance

The history of invisible ink goes back more than 2,000 years and was used by the ancient Greeks and Romans. The first record of it comes from Pliny the Elder in the first century AD, who mentioned using the milk of the tithymalus plant as an invisible ink in his *Natural History*. Invisible ink continued to be used during the Renaissance; statesmen used it in their letters, and Ovid references the practice in his *Art of Love*. Giovanni Battista della Porta, an Italian polymath, developed a formula for invisible ink that consisted of an ounce of alum and a pint of vinegar. Once painted on the shell of a hard-boiled egg, it would seep through and transfer the message onto the egg's albumen. The writing could only be seen once the egg was peeled.

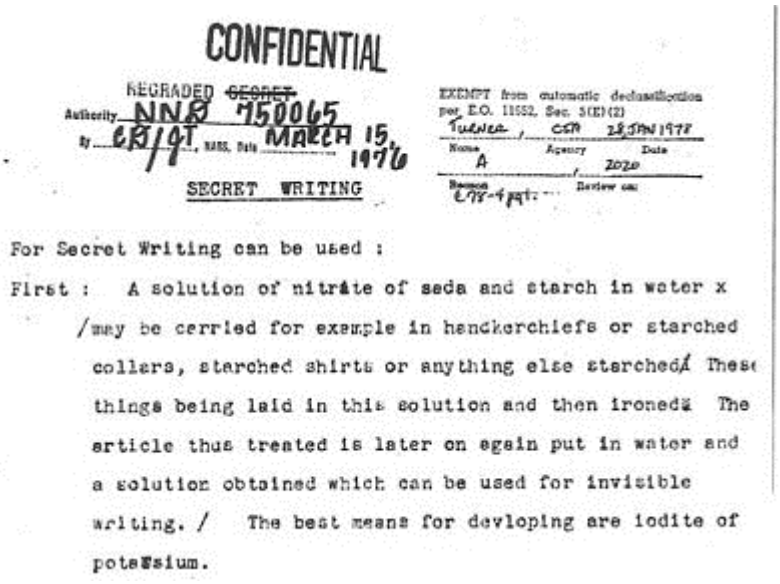
The Revolution

During the Revolutionary War, both the British and the Americans used invisible ink. The British used both organic fluids and common sympathetic inks. Major John Andre, the chief British intelligence officer, had agents put a letter in the corner of their correspondence to inform the recipient as to how the hidden secret message could be developed; for example, an "F" was placed in the corner of letters that could be revealed by fire, an "A" for those that needed the application of an acid.

But George Washington wanted something more, an ink that could only be revealed by a unique, specially formulated reagent. Sir James Jay answered the general's call. Jay, brother of American patriot John Jay and a physician that dabbled in chemistry, created a "sympathetic stain," which he supplied to Washington. Washington would then pass it on to the Continental Army's spymaster, Major Benjamin Tallmadge who in turn provided it to the members of the famous Culper Spy Ring: Abraham Woodhull and Robert Townsend. To avoid suspicion, Washington instructed his spies to write seemingly banal letters between the lines of their secret messages, or to inscribe them "on the blank leaves of a pamphlet. . . a common pocket book, or on the blank leaves at each end of registers, almanacks, or any publication or book of small value."

World War I

In contrast to the billion-dollar-budgeted intelligence agencies of today, when America entered the First World War, the CIA did not exist, and the FBI was barely 15 years old. The Office of Naval Intelligence coordinated the gathering of the country's intelligence.



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REGRADED ~~SECRET~~
Authority NND 750065
By CBJ/GT, NARS, Date MARCH 15, 1976

EXEMPT from automatic declassification per E.O. 11652, Sec. 5(E)(2)
Turner, CSA 28 JAN 1977
Name Agency Date
A 2020
Reason Review on:
C78-4 par 1

SECRET WRITING

For Secret Writing can be used :

First : A solution of nitrate of soda and starch in water x /may be carried for exemple in handkerchiefs or starched collars, starched shirts or anything else starched/ These things being laid in this solution and then ironed. The article thus treated is later on again put in water and a solution obtained which can be used for invisible writing. / The best means for devloping are iodite of potessium.

In a pamphlet included in the recently unclassified documents mentioned in the introduction, we can see that chemical inks were employed during this time, but basics like lemon juice and milk were still in use as well. While the Americans were falling back on old favorites, the Germans were at the leading edge of invisible ink development. At the beginning of the war, the Germans used inks made from headache and fever remedies and laxatives; these were handy as they could be passed off as common medicines. But when the Allies caught on, they were forced to develop inks outside those based on common household items. They utilized inks made from iron sulfate, copper sulfate, and cobalt salts, and employed reagents of sodium carbonate, ammonia fumes, and potassium ferroscyanide.

Both sides worked to find a universal reagent that could develop every invisible ink, no matter its chemical composition. The Allies struck upon a solution when they discovered that iodine vapor would turn all invisible inks brown. It worked not by chemical reaction, but by revealing where the the paper's fibers had been altered with moisture.

But the Germans then came up with a simple counter-measure; after inscribing a secret message, they would wet the entire paper by steaming it, thus altering all of the paper's fibers. After the paper was allowed to dry, it was sent on to its destination.

Both sides had to come up with sneaky ways to hide their inks as well. American agents were advised to impregnate their shirt collars and handkerchiefs with a solution of sodium nitrate; these items could later be soaked in water to create an ink. German spies employed a similar tactic by soaking their ties in chemicals that were later reconstituted. Ready-made inks were often placed inside of shaving sticks and hollowed out soap cakes and hair brushes. Agents also dipped matchsticks into the inks and let them dry; the matches could then be carried without arousing suspicion and used as writing utensils when it came time to inscribe a secret message.

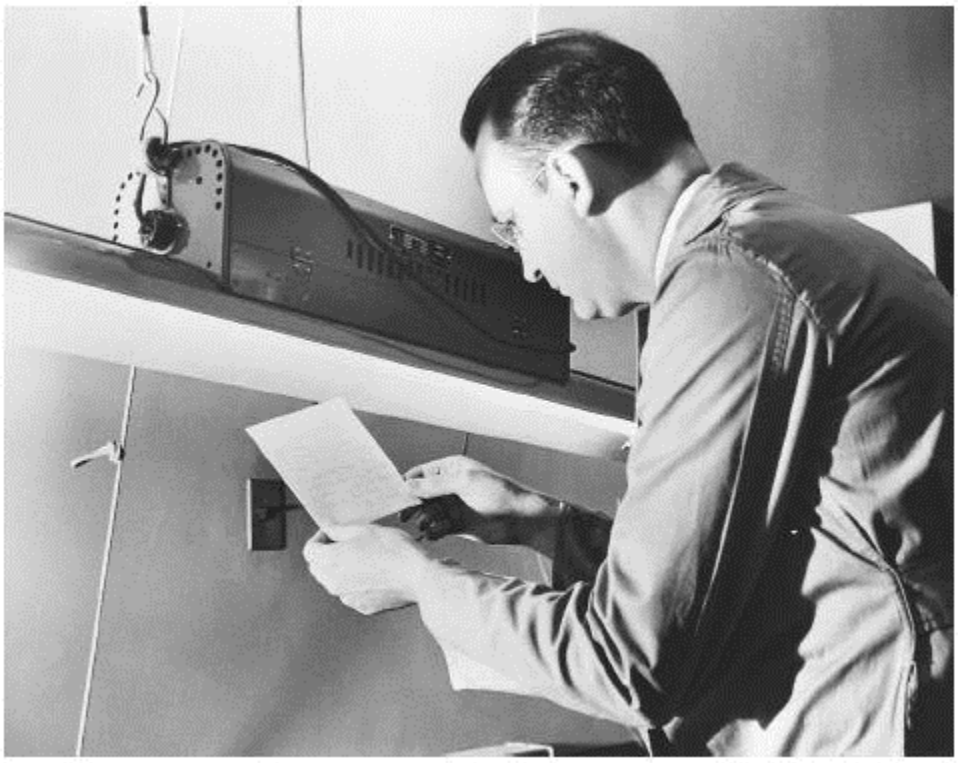
American spies also wrote secret messages on their body which could only be developed when sprayed by an atomizer. Messages were even engraved on toenails; a dusting with powdered charcoal revealed the etchings.

World War II

During WWII both the Allies and the Axis powers worked hard on developing their own invisible inks and discovering the inks used by the enemy. This battle between laboratories became a veritable arms race, with each side trying to out do the other and come up with that holy grail of invisible inks: one that was odorless, could be developed by as few reagents as possible, and could not be exposed by heat, detected with iodine, or revealed by ultraviolet light.

The Abwehr, Germany's military intelligence agency, had five levels of inks, and gave the most complicated ones to its best agents (less trusted spies could have possibly been double-agents who would have turned the secrets over to the Allies). To develop one of the inks, the recipient had to moisten the paper, sprinkle it with a red powder containing naphthalene, heat it to 140 degrees Fahrenheit, and expose it to ultraviolet light. Another crafty ink required activation by blood–the agent pricked his finger and added a drop to the mix before writing.

The Allies and Axis powers also tried to outdo each other when it came to revealing the secret inks used by the other side. As it did during WWI, the American government vigorously screened mail coming in and out of the country. 14,462 censors opened a million pieces of mail a day; correspondence that aroused the censors' suspicions was sent on to the FBI for further testing. 4,600 pieces of mail were forwarded to the government's labs, and 400 of these items turned out to contain secret writing and codes.



Censors would expose suspicious papers to heat, ultraviolet light, and iodine vapors. They would also stripe them with a tool that consisted of multiple brushes wired together. Each brush had been dipped in a different reagent, and the tool was swept across the page to check for reactions.

The Germans then counteracted this detection method by formulating an ink that required three applications of a reagent spaced three hours apart.

The Allies and Germans also tried to outwit each other in where they wrote their messages. Knowing that letters themselves were scrutinized, they wrote on the under-side of an envelope's flap, brushed certain words and phrases in a newspaper with ink, and wrote messages on handkerchiefs. When the German spy George Dasch, who landed with his co-conspirators in a submarine on Long Island, surrendered to the FBI, in his pocket was found a handkerchief on which the names and addresses of his contacts had been written in invisible ink.

The Cold War

During this Golden Age of Espionage, countries threw serious time and resources into developing spy tools and technology that would keep them steps ahead of the enemy. This included research into ever more effective and sophisticated invisible inks.

One major advancement took the form of a new method of writing. The time-honored technique had been wet-writing; the person wrote directly with the ink on the paper. But this process had significant drawbacks. The agent had to steam the paper to prepare it, let it dry, write his message, re-steam the paper to remove the indentations made with the writing utensil, let it dry again, and then write a visible message to cover up the invisible one. And even after all this, traces of the writing could still be found by trained technicians on the other side.

The Soviet KGB and East German Stasi developed an alternative during the 1950s: the dry transfer method. Instead of directly putting the ink on the paper, a chemically impregnated sheet of paper was placed between two sheets of ordinary writing paper. The secret message was written on the top sheet and transferred through the chemicals on the middle sheet to the bottom sheet. The top sheet was destroyed altogether (it was often made of a water soluble

material that could be flushed away or dissolved in a cup of water), and the bottom sheet was left with an undetectable message. The chemical sheets could be re-used many times before they had to be discarded. This dry method was even utilized by American POWs during the Vietnam War to sneak secret information into their letters home.

The development of numerous plastic products during the 60s gave agents a new way to write their messages as well. The CIA would embed chemicals in common products like credit cards, pen caps, eyeglass frames, key fobs, and even the plastic toothpick in a Swiss Army knife. The agent then simply had to rub the plastic object on paper to transfer the invisible "ink."

These and other advancements were coming from the well-staffed laboratories of the intelligence agencies of the 50s and 60s. The Stasi's Technical Operations Sector had 50 employees working on secret writing alone. The CIA had 36 secret writing specialists employed domestically and abroad.

As the Cold War drew to a close, the number of chemists and physicists devoted to working on invisible ink was reduced, and the demise of snail mail and advancements in technology slowly rendered the use of invisible ink, if not obsolete, then a much less vital tool in a spy's bag of tricks. But who knows? Perhaps when that "insurance salesman" you met at the airport offered you his handkerchief, you were really blowing your nose into the names of suspected terrorists

Favorite Invisible Ink Recipes

Invisible ink

> haw to make invisibl ink. you take a wite craon or wax and rite your meseg and give it to somewone and add a marcer. and tell that somewone "it is invisibl ink" then run of and spiy on them. and try to thiger out if they get it. (you haft to rub the marker on the page) and injoy!

MY INVISIBLE INK RECIPE

> I have a very keen interest in chemistry.I made first invisible ink when i was in class VII.At first I took an onion,and I was took the juicy extact,and write my name on a paper by the juicy extract.I got surprised when I put d paper over a hiter,my name become visible,and the colour was brown.It was my invisible ink recipe.

—supriyaghosh

invisible ink

> First you get a jar with a screw on lid then get some lemons about 1 or 2 and a knife. Then you take the knife and you cut the lemons in half as evenly as you can. Then you take the jar and you squeeze the lemons into the jar. Use the lemon juice as your ink. Hold the paper up to something warm ,then you can see what you wrote.

—Guest A Spy

My Favorite Invisible Ink

> I like to use vinegar as an invisible ink. When you paint over the message with red cabbage juice the message is revealed in a different color. It's my favorite because you don't have to heat the paper to get a result so it's great for kids to try

Invisible Inks

This smiley face was made with invisible ink. The face became visible when the paper was heated.

Sometimes people tell me they can't do any science projects because they don't have any chemicals. There are some activities that don't require any chemicals you don't already have. A great example is invisible ink.

Invisible ink is any substance that you can use to write a message that is invisible until the ink is revealed. You use the ink by writing your message with it using a cotton swab, dampened finger, fountain pen, or toothpick. Let the message dry. You may want to write a normal message on the paper so that it doesn't appear to be blank and meaningless. If you write a cover message, use a ballpoint pen, pencil, or crayon, since fountain pen ink could run into your invisible ink. Avoid using lined paper to write your invisible message, for the same reason.

How you reveal the message depends on the ink you used. Most invisible inks are made visible by heating the paper. Ironing the paper or holding it over a 100-watt bulb are easy ways to reveal these types of messages. Some messages are developed by spraying or wiping the paper with a second chemical. Other messages are revealed by shining an ultraviolet light on the paper.

Make Invisible Ink

Anyone can write an invisible message, assuming you have paper, because body fluids can be used as invisible ink. If you don't feel like collecting urine, here are some alternatives:

Heat-Activated Invisible Inks
Iron the paper, set it on a radiator, place it in an oven (set lower than 450° F), hold it up to a hot light bulb.

- any acidic fruit juice (e.g., lemon, apple, or orange juice)
- onion juice
- baking soda (sodium bicarbonate)
- vinegar
- white wine
- dilute cola
- diluted honey
- milk
- soapy water
- sucrose (table sugar) solution
- urine

Inks Developed by Chemical Reactions
These inks are sneakier, because you have to know how to reveal them. Most of them work using pH indicators, so when it doubt, paint or spray a suspected message with a base (like sodium carbonate solution) or an acid (like lemon juice). Some of these inks will reveal their message when heated (e.g., vinegar).

- phenolphthalein (pH indicator), developed by ammonia fumes or sodium carbonate (or another base)
- thymolphthalein, developed by ammonia fumes or sodium carbonate (or another base)
- vinegar or dilute acetic acid, developed by red cabbage water
- ammonia, developed by red cabbage water
- sodium bicarbonate (baking soda), developed by grape juice
- sodium chloride (table salt), developed by silver nitrate
- copper sulfate, developed by sodium iodide, sodium carbonate, potassium ferricyanide, or ammonium hydroxide
- lead(II) nitrate, developed by sodium iodide
- iron sulfate, developed by sodium carbonate, sodium sulfide, or potassium ferricyanide
- cobalt chloride, developed by potassium ferricyanide
- starch (e.g., corn starch or potato starch), developed by iodine solution
- lemon juice, developed by iodine solution

Inks Developed by Ultraviolet Light (Black Light)
Most of the inks that become visible when you shine a black light on them also would become visible if you heated the paper. Glow-in-the-dark stuff is still cool. Here are some chemicals to try:

- dilute laundry detergent (the bluing agent glows)
- body fluids
- tonic water (quinine glows)
- vitamin B-12 dissolved in vinegar

Any chemical that weakens the structure of paper can be used as an invisible ink, so you might find it fun to discover other inks around your home or lab.

Invisible Ink Using Milk

You can use milk as an invisible ink to write secret messages.

Milk is an effective and readily available form of invisible ink. Here's how to use milk as invisible ink to write and reveal secret messages. I've also included an explanation of how milk works as an invisible ink.

1. Dip a paintbrush, toothpick or stick into milk and write your message on paper. You'll be able to see the damp message, but it will disappear once the paper dries.
2. Reveal the invisible message by holding the paper over a lit light bulb or other heat source.

How It Works

The substances in milk weaken the paper and also may be more susceptible to heat than the paper, so although the message dries clear, the paper weakens and darkens where the milk was applied.

Spy agency reveals invisible ink formula

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The papers date as far back as 1917, and they were among the United States' oldest classified documents.

The pages read like a modern-day Harry Potter novel.

But the writing does not denote the characters Ron Weasley saying, "There's nothing written in this diary," and Hermione Granger responding, "It must be invisible ink!"

These are newly-declassified, nearly century-old CIA documents, typed and hand-written with titles like "Secret Writing" that, among other things, divulge formulas for making and uncovering invisible ink.

The six papers date as far back as 1917, and until their release on Tuesday were among the United States' oldest classified documents.

One of them lists ingredients used in German secret ink.

Whereas the Harry Potter character Hermione can simply command "Aparecium!" to make the words appear on the page, these documents indicate early 20th century spies had to employ much more elaborate methods.

The CIA released the documents to the public because the information contained in them is no longer considered to be sensitive. They are believed to be the only remaining classified documents from the World War I era, according to the spy agency.

"These documents remained classified for nearly a century until recent advancements in technology made it possible to release them," CIA Director Leon Panetta said in a statement. "When historical information is no longer sensitive, we take seriously our responsibility to share it with the American people."

The document listing formulas used to make German secret ink is written in French and dated June 14, 1918.

A related document in English tells spies how to expose the German correspondence, starting with the instruction, "examine through powerful beam of light directed on surface at different angles."

The instructions continue with spy novel-type techniques, including dusting a little powdered charcoal over the paper's surface.

"Run a hot iron over the surface being careful not to scorch the paper," the instructions say. "Wet with water."

The directions resemble a mix of the scientific and simple, calling for chemicals such as hydrogen sulphide and ammonia, with instructions to "rinse with water and dry in the air."

A few other steps include wetting the paper with iron sulphate and a "little solution of potassium ferrocyanide," all of which, according to the document, collectively expose a host of other substances like iron and copper used to conceal writing, thus revealing the words and making the pages readable.

The "secret writing" document instructs spies how to disguise their correspondence.

The directions call for a nitrate and starch solution, which, according to the document, "may be carried for example in handkerchiefs or starched collars."

"A tumbler of water is boiled together with a table spoon of starch, allow to cool, and add ten gramms (sic) of nitrite of soda," the instructions say.

One of the CIA documents outlines detailed instructions on how to open a sealed letter without detection, largely by using chemicals including acetone and amyl alcohol.

"Heat in water bath -- Steam rising will dissolve the sealing material of its mucilage, wax, or oil," the instructions read. "Do not inhale." Mucilage is a type of glue.

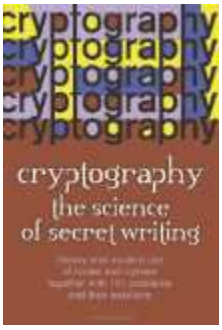
Another document is a memorandum evaluating different samples of ink. Some samples were found to be "very corrosive" on steel pens, and deemed more suitable for a quill pen.

The original papers are housed at the National Archives and copies are now available on the CIA's website and at http://www.foia.cia.gov/.

Secret Ink and Writing Techniques-1917-1918 (1 of 4)

 Several years ago, the CIA declassified six of the oldest classified documents remaining from 1917-1918, on the Germans Secret Ink formulas. One document outlines the chemicals and techniques for the development of certain types of secret ink and a method for opening sealed letters without detection.

The original document, dated July 15, 1918 is in German. A second document was translated into French. The basic formula's ingredients are a mixture of compressed Pyramiden and compressed or powered Aspirin. The formula, called for the two chemicals to be mixed with pure *(distilled)* water.



In order to make the invisible ink seen, one had to mix the following chemicals and apply them to the paper with wet cotton: Slightly camphorated alcohol, Distilled Water, Nitrate of Potash, Acetic Acid, & Chloride of cabonide.

The third document in the series explains how Secret Writing should be done.

First: A mixture of nitrite of soda and starch in water, should be carried as an example, in handkerchiefs or starched collars, starched shirts or anything else starched. These things being laid in this solution and then ironed. The article thus treated is later on again, put in water and

a solution obtained which can be used for invisible writing. The best means for developing the (secret writing), are iodite of potassium.

The fourth document explains various methods for viewing the se


SUBJECT German Secret Ink. Formulas used preparation of.

The following is a copy of the formulas used preparation of German secret ink.

Pour faire apparaître l'encre invisible.

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cret writing:

- Examine through powerful beams of light, directed at surface at different angles.
- Photograph excluding certain raysof light.
- Expose to daylight, for one or two hours. *(Discloses sources of Gold and Silver).*
- Dust a little powdered charcoal over the surface and brush off well. *(Discloses paraffin).*
- Run a warm iron, over the surface. *(Discloses sugar, sulfuric acid, and a host of other chemicals used in secret writing).*
- Run a hot iron over the surface, being careful, not to scorch the paper. *(Discloses four other chemicals).*
- Wet with water. *(Discloses camphor, mixture of linseed oil, ammonia and water).*
- Expose to hydrogen sulfide gas, or add a little water, saturated with it. *(Discloses five chemicals)*
- Dry in the air and wet with Ammonia water. *(Discloses Mercury and Copper Salts).*
- Add a little Hydrogen Sulfide water, to the part wet with ammonia. *(Discloses Iron, Antimony(?), Tin & Copper).*
- Rinse with water and dry in air.
- Wet with a solution of Iron Sulphate. *(Discloses two chemicals which I can't make out).*
- To another part of the paper add, a little solution of Potassium something or other or Tannin. *(Discloses Iron Salts).*

Revealed: skin messages, invisible ink and more WWI spycraft

How to read the Hun's letter without noticeably opening it: mix copper acetyl arsenic with three ounces acetone. Then add a pint of amyl alcohol. Heat the mixture in a hot water bath. The resulting fumes should break down the letter's adhesive. Back in World War One, this was state of the art spycraft.

Or maybe it wasn't. On a document declassified on Tuesday by the CIA listing the nearly century-old formula for surreptitiously opening mail, an anonymous agent scribbled, "Tried -- not successful."

And maybe that's why the document and five others, detailing espionage techniques used by the US Office of Naval Intelligence in 1917 and 1918, haven't seen the light of day since they were penned. Until Tuesday, they were the six oldest classified documents the US government possessed.

CIA Director Leon Panetta explained that "recent advancements in technology made it possible" to release the documents after almost a century, without elaborating. (What, PDFs?) But they could also be an early example of the government keeping some of its national security blunders out of the public view. (*Update*: CIA spokeswoman Marie Harf adds, "In recent years, the chemistry of making secret ink and the lighting used to detect it has greatly improved.")

Either way, they're a rare glimpse at the US intelligence community in the days before it ballooned to a global entity costing $80 billion every year. In a letter dated 30 October, 1917, an "assistant chemist" at the Department of Commerce named A.M. Heinzelmann provides formulas for what appears to be invisible ink, warning that some of them "doubtless exert a very corrosive action on steel pens." (Namely, 100 ml of water when added to three grams of potassium bromide and the same amount of copper sulfate.)

Back in the first World War, even the human body came under suspicion for being a medium for secret messages. A pamphlet printed for Post Office inspectors advised counterintelligence agents to "develop a suitable reagent sprayed with an atomiser" to reveal the secret tattoos. To get rid of your own hidden tattoos, scrub down with citrus.

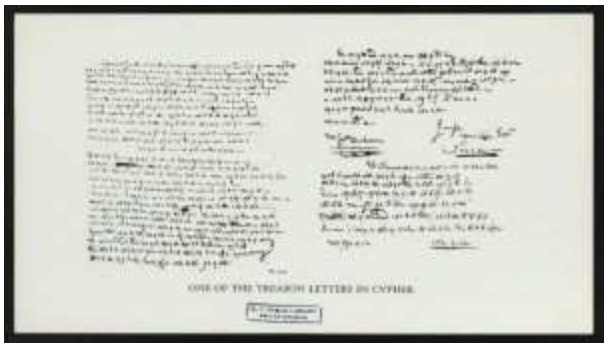
Two different documents from 1918, written in French, detail the Germans' favourite methods for concocting invisible ink. Spoiler alert: compressed or powdered aspirin mixed with "pure water."

Suffice it to say that spycraft in the first World War *really* relied on invisible ink. A different method to concoct it used five grams of "Iodite of Potassium," mixed with 100 ml of water, two grams of tartaric acid, "Sulpharated soda", "Ferro cyanite of potassium" and diluted ink.

Others are more traditional, like lemon juice mixed with potassium, a favourite of the Revolutionary War. Carefully put your parchment up to a heat source to read the hidden message.

All the more amazingly, intelligence bureaucrats believed for decades that these long outmoded tools of the spy trade needed to be kept out of the public purview. One of them carries a stamp from 1978 marking it "EXEMPT from automatic declassification." The one with the invisible tattoos has a different non-disclose stamp from 1989. So figure we'll be living in Martian colonies by the time we learn what the "secret weapon" used by special operations forces in Iraq during the surge really was. Especially if it didn't exactly work as well as the hype suggested.

Try This at Home: Invisible Ink



A letter from the Revolutionary War with lines written in invisible ink. Credit: Wikimedia Commons

Last year, the US Central Intelligence Agency released documents detailing recipes for invisible ink from 1917 and 1918. Among the recipes was a favorite ink recipe of German soliders during World War I — crushed aspirin mixed with water. Though the ink is easily available, uncovering it required a complicated chemical developer.

Other recipes in the CIA documents used solutions of iron, silver or copper salts as ink and developed the writing by heating the paper. This bit of history inspired my inner scientist and spy. Without access to chemicals in a lab, I experimented with invisible ink recipes using things I found around my house.

1. Lemon juice and heat
Dip a cotton swab or thin paintbrush in lemon juice. Write your message on white paper and let it dry. Hold the paper over a lamp, radiator or candle (but don't let it catch fire!). The heat breaks down the acid into light-brown compounds, revealing your message forever.

This is how my experiment turned out. The top part of the picture is the paper before I held it over a candle.

Using lemon juice as invisible ink, before and after developing with heat. Credit: Melissae Fellet

2. Laundry detergent and black light
White shirts glow under black lights at a haunted house because the whitening agent in laundry detergent glows under ultraviolet light. Try writing your message using liquid laundry detergent. Holding the paper to a black light reveals a glowing message without damaging the paper.

But if spies intercept a message written with one of these inks, it's likely they could decode it. We all can find something to heat paper. And black lights, though less common than candles, are still widely available.

To solve this problem, I borrowed a trick from George Washington: using two different chemicals to write and decode the message. Washington wrote with an watery ink containing iron salts. The receiver decoded the message by painting the paper with sodium carbonate, a chemical cousin of baking soda.

Maintaining ink supplies was crucial during Washington's day. Now a trip to the grocery store will keep you well supplied.

3. Baking soda and grape juice
Make a paste of baking soda in water. Write your message with this paste on a piece of paper and let it dry. To decode the message, paint the paper with thawed grape juice concentrate. The acidic juice reacts with the basic baking soda and the purple grape juice turns gray. This worked best when I used plenty of baking soda paste and undiluted grape juice concentrate:

Writing in baking soda and developing with grape juice. Credit: Melissae Fellet

In the pictures above, you can tell that the paper has been altered because the paper buckles as the watery lemon juice or baking soda paste dries. Traditionally, writers would re-steam the paper to remove the bumps after scribbling a message with wet ink.

During the Cold War, invisible ink technology improved enough to remove the time-consuming steaming step. Soviet and East German spy agencies developed chemical-coated paper similar to carbon paper we use today. Agents sandwiched this coated paper between two blank pieces of paper. Writing on the top sheet transferred the chemicals from the middle sheet to the bottom paper.

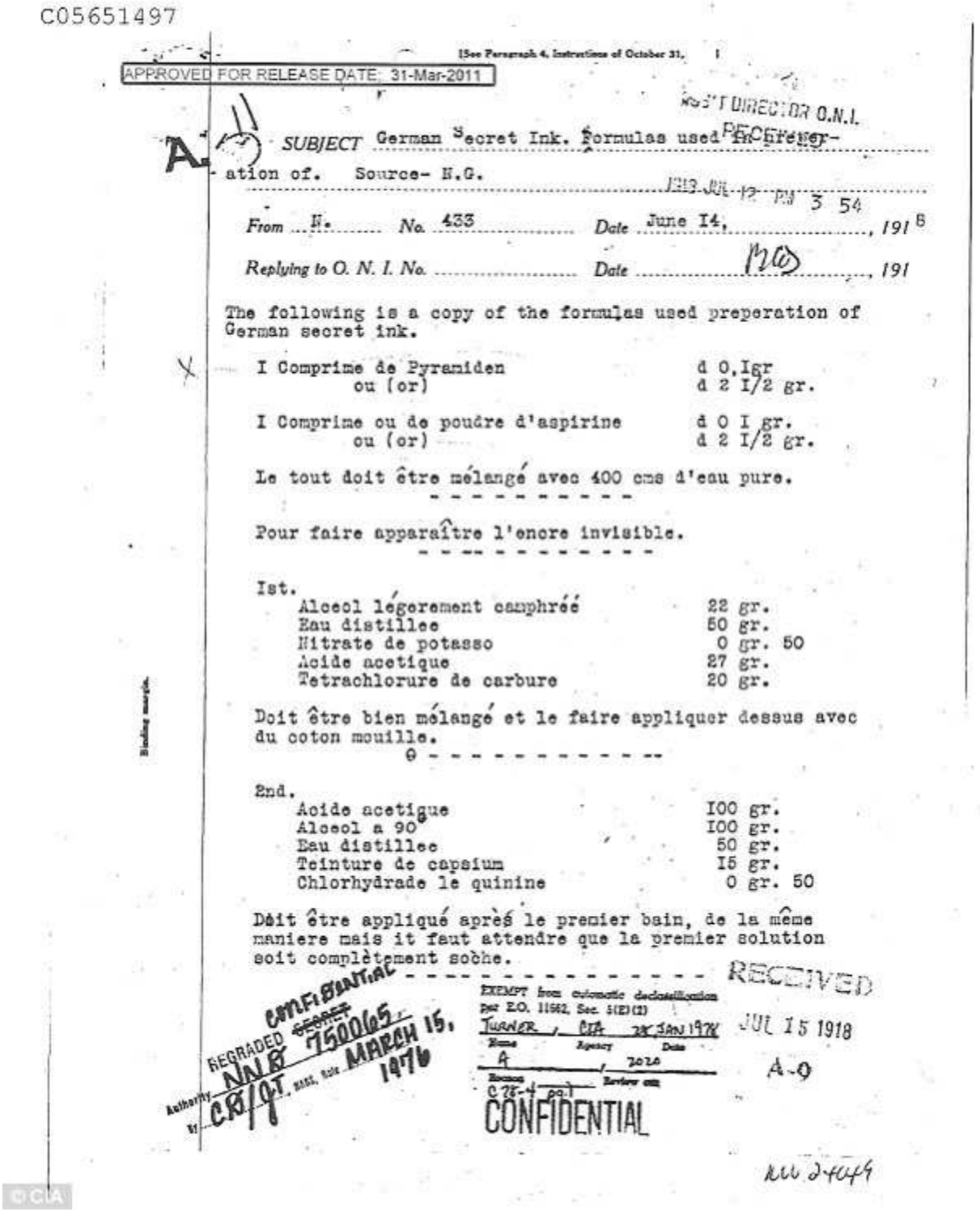
Perhaps hacking an ink-jet printer to print lemon juice invisible ink would transfer your message without damaging the paper as well. I'd love to hear from someone who has tried this.

'L'Aspirine et l'eau': Declassified documents from 1918 show how French cracked German World War One invisible ink formula

This fascinating document containing a Harry Potter-style secret formula for invisible ink was one of the oldest still classified by the U.S.

Now newly-declassified material, including the details on German secret ink formulas dating back to World War One, has been put on show to the public in Washington D.C.

The National Archives is showcasing the series after a 95-year period of secrecy and a 1918 document shows the ink was made by mixing compressed or powdered aspirin with pure water.



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[See Paragraph 4, Instructions of October 31,

APPROVED FOR RELEASE DATE: 31-Mar-2011

DIRECTOR O.N.I.
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1919 JUL 12 PM 3 54

SUBJECT German Secret Ink. Formulas used in Preparation of. Source- H.G.

From H. No. 433 Date June 14, 191 8

Replying to O. N. I. No. ..... Date 191

The following is a copy of the formulas used preperation of German secret ink.

I Comprime de Pyramiden	d 0,1gr
ou (or)	d 2 1/2 gr.
I Comprime ou de poudre d'aspirine	d 0 1 gr.
ou (or)	d 2 1/2 gr.

Le tout doit être mélangé avec 400 cms d'eau pure.

- - - - - - - - - - -

Pour faire apparaître l'encre invisible.

- - - - - - - - - - - -

Ist.

Alcool légerement camphréé	22 gr.
Eau distillee	50 gr.
Nitrate de potasso	0 gr. 50
Acide acetique	27 gr.
Tetrachlorure de carbure	20 gr.

Doit être bien mélangé et le faire appliquer dessus avec du coton mouille.

- - - - - - - - - - - -

2nd.

Acide acetique	100 gr.
Alcool a 90°	100 gr.
Eau distillee	50 gr.
Teinture de capsium	15 gr.
Chlorhydrade le quinine	0 gr. 50

Doit être appliqué après le premier bain, de la même maniere mais it faut attendre que la premier solution soit complètement soche.

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DECLASSIFIED
Authority NND 7500065
By CR/QT, NARS, Date MARCH 15, 1976

EXEMPT from automatic declassification per E.O. 11652, Sec. 5(E)(2)
TURNER, CIA 28 JAN 1976
Name Agency Date
A / 2020
Exempt Review cat.
C 78-4 pg.1

NND 24044

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Fascinating release: The German invisible ink formula, written in French and translated, is described in an Office of Naval Intelligence document dated June 1918

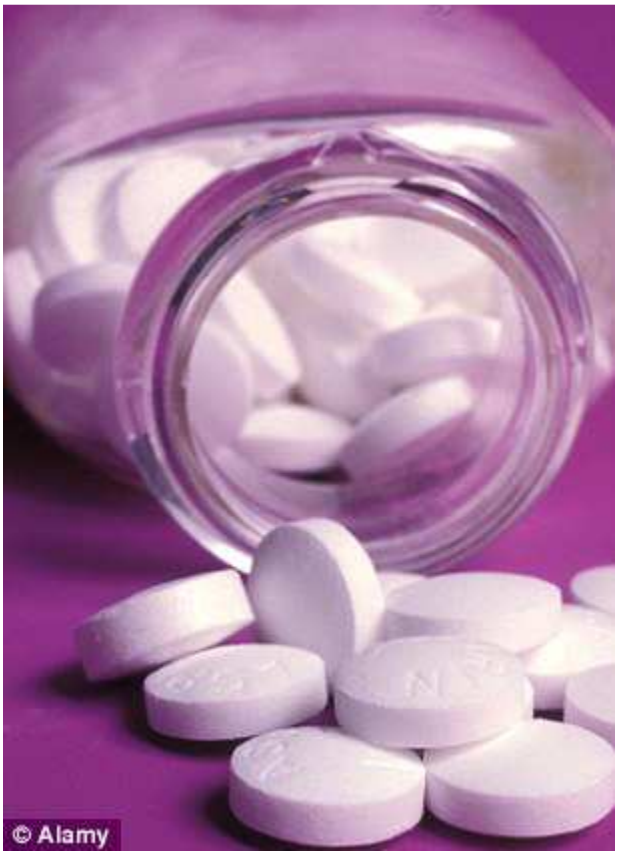
The invisible ink formula, written in French and translated, is described in an Office of Naval Intelligence document.

This shows that the French managed to crack the German's formula, reported CBS News.

Invisible ink was used by allies and spies during World War One to communicate safely by sending secret messages.

The 1918 documents, which went on display this week and will remain on view through the end of July, were released by the archives as part of an open government initiative.

They were made public by the National Archives National Declassification Center along with the Central Intelligence Agency.



Formula: The German invisible ink was made by mixing compressed or powdered aspirin with pure water

The documents were thought to be the oldest still classified by the U.S. before they were released.

The National Declassification Center in Maryland launched in December 2009 to review more than 400 million pages of classified records by the end of December 2013.

The CIA explained in April why the documents were not released to the public for such a long time.

'These documents remained classified for nearly a century until recent advancements in technology made it possible to release them,' CIA Director Leon E. Panetta said at the time.

Invisible ink

Invisible ink, also known as security ink, is a substance used for writing, which is invisible either on application or soon thereafter, and which later on can be made visible by some means. Invisible ink is one form of steganography, and it has been used in espionage. Other uses include anti-counterfeiting, property marking, hand stamping for readmission, fun children's games, and marking for the purpose of identification in manufacturing.

Invisible ink is applied to a writing surface with a specialty purpose stylus, stamp, fountain pen, toothpick, or even a finger dipped in the liquid. Once dry, the written surface should appear blank, with a similar texture and reflectivity as the surrounding surface. With letters, a cover message should be written over the invisible message, as a blank sheet of paper might arouse suspicion that an invisible message is present. This is best done with a ballpoint pen, since fountain pen ink may "run" when it crosses a line of invisible ink, thus betraying the presence of invisible ink. Invisible ink should not be used on ruled paper as it may similarly alter or streak the colour of the lines.

The ink is later made visible by different methods according to the type of invisible ink used. The ink may be developed by heat or by application of an appropriate chemical, or it may be made visible by viewing under ultraviolet light. Inks which are developed by a chemical reaction may depend on an acid-base reaction (like litmus paper), reactions similar to the blueprint process, or any of hundreds of others. Developer fluids may be applied using a spray bottle, but some developers are in the form of vapours, e.g. ammonia fumes used to develop phenolphthalein ink.

One can obtain toy invisible ink pens which have two tips—one tip for invisible ink writing, and another tip for developing the ink. Also, invisible ink is sometimes used to print parts of pictures or text in books for children to play with, particularly while they are travelling. A "decoder pen" is included with these books and children may rub this pen over invisible parts of texts or pictures, thus revealing answers to questions printed in regular ink or completing missing parts of pictures.

Security marker pens or UV Markers with fluorescent ink that glows when illuminated with a UV light may be used to invisibly mark valuable household items in case of burglary. They may be especially formulated for writing on non-porous surfaces such as glass, plastics, etc. The inks are applied and then identified using a black light or other UV light source. The owner of a recovered, stolen item which has been marked in this way can be traced simply by using an ultraviolet lamp. Security marker pens can be obtained commercially and are widely used as a crime countermeasure.

Some commercially available invisible inks glow very brightly, in a variety of colours, under UV light. This makes them suitable for use in readmissions such as hand stamping.

There is a commercially available red invisible ink which is only invisible when applied to certain types of surfaces, but visible on others.

Some vendors now offer invisible ink for use in computer inkjet printers. Such inks are usually visible under ultraviolet light. Typical uses include printing information on business forms for use by the form processor, without cluttering up the visible contents of the form. For example, some United States Postal Service mail sorting stations use UV-visible ink to print bar codes on mailed envelopes giving routing information for use by mail handling equipment further down the line before delivery.

Very rarely, invisible ink has been used in art. It is usually developed, though not always. There are artists who use the effect in conjunction with invisible and other reactive inks and paints to create a variety of effects when used in conjunction with UV lights.

An E2E voting system called Scantegrity II uses invisible ink to enable the voter to obtain a confirmation code only for the voted selection.[1]

Properties of an "ideal" invisible ink

What an "ideal" invisible ink is depends on its intended use. For example, property marking should ideally be done with ink easily read under ultraviolet light, whereas in espionage such an ink would be considered too easily detectable since a large number of letters may be screened relatively quickly using UV light.

Invisible inks are inherently "insecure" against a determined and well-equipped inspector, which must be balanced against the logistical difficulty in carrying out mass-screening of posted mail. It is easier to perform large-scale undetected screening of millions of electronic communications, than to mass-screen even a small fraction of conventional mail. Apart from in dictatorships where large numbers of personnel are employed to spy on fellow nationals, screening of posted mail is only feasible in particular situations, such as letters to and from a particular suspect or facility.

The World War II SOE training manual identified the following properties of an "ideal" invisible ink:

1. mixes with water.
2. Non-volatile, i.e. no pronounced smell.
3. Not depositing crystals on paper, i.e. not easily seen in glancing light.
4. Invisible under ultraviolet light.
5. Does not decompose or discolour the paper e.g. not silver nitrate.
6. Unreactive with iodine, or with any of the other usual developers.
7. Potential developers for the ink should be as few as possible.
8. Should not develop under heat.
9. Easily obtainable and has at least one plausible innocent use by the holder.
10. Not a compound of several chemicals, as this would violate #7.

From practical experience "6" and "9" were usually incompatible. SOE agents were trained not to risk their lives through reliance on insecure inks, most of which were of World War I vintage. In general, SOE used invisible inks as a back-up method of communication, for when more secure communication techniques were unavailable. The agency was known to supply special inks to its field agents, rather than have them depend upon improvisation from obtainable everyday chemicals. When agents were forced to improvise, they were to dilute their invisible ink as much as possible to reduce chances of detection.[2]

[edit] Screening letters for secret messages

Any invisible ink can be made visible by someone who is sufficiently determined, but the limitation is generally time available and the fact that one cannot apply hours of effort to every single piece of paper. Thus successful use of invisible ink depends on not arousing suspicion that invisible ink may be present.

Telltale signs of invisible ink, such as pen scratches from a sharp pen, roughness, or changed reflectivity of the paper (either more dull or more shiny, usually from using undiluted ink), can be obvious to a careful observer who simply makes use of strong light, a magnifying glass and his or her nose. Also, key words in the visible letter, such as "red cabbage" or "heat", in an odd context may alert a censor to the presence of invisible ink. Invisible ink should not be used with glossy or very smooth paper types, since the sizing of these papers prevents ink from being

absorbed deep into the paper and it is easily visible, especially if the paper is examined under glancing light. There are, however, commercially available inks for non-porous surfaces that are only visible under ultraviolet light and are otherwise virtually invisible on such surfaces.

Using either ultraviolet light or an iodine fume cupboard, messages can be quickly screened for invisible ink and also read without first permanently developing the invisible ink. Thus, if a censor uses this method to intercept messages, he or she may then let the letter be sent to the intended recipient who will be unaware that the secret message has already been intercepted by a third party.

A "screening station" could theoretically involve visual and olfactory inspection, an examination under ultraviolet light and then the heating of all objects in an oven before finally trying exposure to iodine fumes. In theory, some invisible inks may even show up using a camera sensitive to the infrared light spectrum.

Invisible ink types

For practical reasons, the inks are listed here according to their method of development. It must be understood however that some inks - particularly those of organic origin or those consisting of a mixture of several chemicals - may be made visible by several methods. For example, invisible writing with soap water may be made visible either by heat, reaction with phenolphthalein, viewing under ultraviolet light, or by placing the page inside an iodine fume cupboard.

Inks developed by heat

Some of these are organic substances that oxidize when heated, which usually turns them brown. For this type of "heat fixed" ink, any acidic fluid will work. The most secure way to use any of the following substances for invisible ink is by dilution, usually with water, close to the point when they become difficult to develop.

- Cola drink
- Honey solution (sugar turns into caramel by dehydration)
- Lemon, apple, orange or onion juice (organic acids and the paper forms ester under heat)
- Milk (lactose dehydrates)
- Bodily fluids such as urine, semen, saliva or blood serum.
- Soap water (carboxylate partially oxidises)
- Sugar solution (sugar turns into caramel by dehydration)
- Wine, or vinegar
- Cobalt chloride, which turns blue when heated and becomes invisible again after a while (if not overly heated)

The writing is rendered visible by heating the paper, either on a radiator, by ironing it, or by placing it in an oven. A 100-watt light bulb is less likely to damage the paper.

Detail of a software user manual security feature made with invisible ink.

Inks developed by chemical reaction

In most cases, the substance changes color when mixed with an acid or base.

- Phenolphthalein, commonly used as a pH indicator, turns pink in the presence of a base such as ammonia fumes or sodium carbonate.
- Vinegar, is revealed by red cabbage water. Vinegar contains acetic acid that affects the pH indicator in red cabbage water. Vinegar may also be developed by heat, as above.
- Ammonia, developed by red cabbage water.
- Copper sulfate, developed by sodium iodide, sodium carbonate ammonium hydroxide or potassium ferricyanide.
- Lead(II) nitrate, developed by sodium iodide.
- Iron sulfate, developed by sodium carbonate or potassium ferricyanate.
- Cobalt chloride, developed by potassium ferricyanide.
- Iron sulfate, developed by sodium sulfide.
- Starch, developed by iodine solution which turns starch dark blue and the paper light blue.
- Lemon juice, developed by iodine solution (ink turns white, paper turns light blue).
- Sodium chloride (common table salt), developed by silver nitrate.
- Cerium oxalate developed by manganese sulfate and hydrogen peroxide[3]

[edit] Inks visible under ultraviolet light

Some inks glow faintly (fluoresce) when under an ultraviolet lamp. This is a property of many substances, particularly organic substances and body fluids.

Other inks work in a near opposite way by *absorbing* ultraviolet light but without fluoresceing. When these are used on fluorescent paper, the inked areas fluoresce less than the surrounding paper area when under an ultraviolet lamp. This is especially a property of inks with a yellow tint.

Some UV-visible inks may be detected on a photocopy, due to the relatively strong ultraviolet component in light from the photocopier scanning head.

Examples of inks revealed by ultraviolet light are:

- Laundry detergents containing optical brighteners
- Soap
- Body fluids, such as semen, serum, saliva, milk
- Sunscreen
- Lemon juice

[edit] Inks which disturb the surface of paper

This includes virtually all invisible inks, but pure distilled water can also be used in this way. Application of any fluid will disturb the paper surface fibers or sizing.

Fumes created from heating iodine crystals will develop the writing, which will appear brown because the iodine sticks preferentially to the disturbed areas of the paper. Exposing the paper to strong sunlight will return the writing to its invisible state, as will using a bleach solution.

Slightly dampening paper with a sponge or by steam and then drying it before writing a message will prevent writing from being developed by this method, but overdoing dampening will result in telltale paper cockling.

Disappearing inks

Inks that are visible for a period of time without the intention of being made visible again are called disappearing inks. Disappearing inks typically rely on the chemical reaction between thymolphthalein and a basic substance such as sodium hydroxide. Thymolphthalein, which is normally colorless, turns blue in solution with the base. As the base reacts with carbon dioxide (always present in the air), the pH drops below 10.5 and the color disappears.[4] Pens are now also available that can be erased simply by swiping a special pen over the original text. Disappearing inks have been used in gag squirtguns, for limited-time secret messages, for security reasons on non-reusable passes, and for fraudulent purposes.[5][6]

Modern relevance of invisible ink messages

As an indication of security, most inks mentioned above were already known by the end of World War I. However, in 1999, the U.S. Central Intelligence Agency successfully requested that a 1940s technical report on invisible ink remained exempt from mandatory declassification, based on the claim that invisible ink was still relevant to national security.[7] The report thus remained classified until 2011.[8][9]

Former MI-6 agent Richard Tomlinson alleges that *Pentel Rolling Writer* rollerball pens were extensively used by MI-6 agents to produce secret writing (invisible messages) while on missions.[10]

In 2002, a gang was indicted for spreading a riot between federal penitentaries using coded telephone messages, and messages in invisible ink.[11]

In 2008, a British Muslim, Rangzieb Ahmed, was alleged to have a contact book with Al-Qaeda telephone numbers, written in invisible ink.[12]

Digital invisible ink

Invisible ink is not only a product of conventional writing and analogue information storage. The term invisible ink could also be applied to texts and pamphlets, which have been deleted or censored on the internet due to moral and socio-political reasons. The “Digital Invisible Ink Toolkit” is also a Java steganography tool that can hide any sort of file inside a digital image.[13]

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Invisible Photography and Writing

A small four page booklet, entitled Invisible Photography and Writing, Sympathetic Ink, appears to be the result of testing, by the chemist at the U.S. Bureau of Standards. The information, was produced by a hand writing expert, out of San Francisco, CA, by the name of Theodore Kytea(?). The booklet states it's *"Confidential and Not for Publication"*.There is some interesting information in the tiny booklet, some of which follows:

*Invisible Photographs of writings and printing-Make a silver print, fixed and bleached in mercury chloride. To make visible, dip in hypo. *(It goes on to list a number of other chemicals, which will make do under certain circumstances such as heat or light).*

Item 18: Starch writing on Linen, after it becomes dry, is made visible by fumes of iodine or by solution of potassium iodide. The writing becomes blue and disappears again by washing paper with a very weak solution of hypo sulphate of soda.

Item 19: Letters written with a weak solution of the soluble chloride of platinum or iridium, develop black when fumed with mercurial vapor. This ink is used for marking linen and is called indelible. This ink is sold in large bottles to laundries, etc. It is often used for smuggling information across the frontier, when the writing is put on handkerchiefs, shirts, underwear or on paper surfaces.

Item 20: Sulphate of copper, much diluted, used in writing with a soft tooth pick between printed lines. This is developed by fumes of strong ammonia, which makes the invisible writing appear bluish.

Item 24: Write characters on steel late, wood or any polished surface or on a smooth papered wall, with a thin solution of paraffine dissolved in benzol. Use fine stiff brush or coarsely pointed goose-quill or fountain pen. Upon evaporation, writing becomes invisible, paraffine being transparent.

To develop it, use finely powdered graphite on light background and finely powdered dragons-blood or aluminum dust, such as used by fingerprint experts, or dark background, such as on steel safes, carving knives, or covers of tin bread boxes, etc.

In every instance, use two fine camels hair brushes-One should be round, about 1/4 inch thick, with long hairs, for powdering, and the other brush, should be about an inch broad-a regular photographic camels hair brush, for cleaning up surplus powder.

Item 25: Dip a toothpick in common milk and write between lines on ordinary letter. The writing will appear by being ironed out with a hot flatiron.

Item 27: *(This next formula is especially intriguing, because the chemist states, that it was used by a forger, whom he names).* Writing on white paper with a common ordinary writing ink, containing tanno(?) garlic ferric base, using a quill, toothpick, match or rounded fountain pen, can be made to disappear, with the common ink erasers now in the market, such as *Standfords, Carters, etc.*

Such discolorized writings can again be made readable, by the application of hydro sulphurelt (sulphur?) of ammonium. Mr. Kitka, has restored erased figures after a lapse of twenty years.

This method is used by forgers, such as Karl Becker, and to alter names and dates in passports. *(Google Books: In Bankers Magazine of 1905, it's stated; Karl Becker-"the forger most feared by the bankers of America").*

Item 30: Suspect printed black ruled lines, such as sometimes border a page or divide columns. These lines are used by writing messages on them in Morse code (dots and dashes), with a transparent solution of gum, or the white of an egg, beaten up with six ounces of water. For developing, heat paper slightly and powder with finely powdered dragons-blood. The code will appear in red dots and dashes on the black lines.

How To Make Invisible Ink - Corn Starch

The writing for this invisible ink technique is done using corn starch. An iodine solution is used to reveal the writing.

Difficulty: Average

Time Required: 15-30 minutes

Here's How:

1. Essentially you want to make a thin corn starch gravy. You will write using the gravy, allow the writing to dry, then reveal the message using an iodine solution.

2. If you don't have a pre-made iodine solution, you can make some by adding a teaspoon of iodine to about 10 teaspoons of water. Set the iodine aside for later.

3. Mix about 2 T cornstarch with 4 tsp water in a pan. Heat, while stirring, until smooth. You can boil the mixture to make a gravy - just be careful not to burn it!

4. Remove the cornstarch gravy from the heat. Dip a toothpick, small paintbrush, or cotton swab into it and use it to write your message on paper.

5. Let the paper air-dry.

6. Brush a small sponge, swab, or paintbrush dipped in the iodine solution over the paper to reveal the hidden message. The message should appear purple.

Tips:

1. You can use simple corn starch in water to write the message, but the writing won't be as invisible as it is using corn starch gravy.

2. If the heat source is a problem, try using very hot tap water to hydrate the corn starch rather than using a stove or hot plate.

3. Iodine binds to the starch molecules to reveal the message.

4. Try using other starches instead of corn starch, such as diluted mashed potatoes or mashed cooked rice with water.

What You Need

- Corn Starch
- Iodine
- Water
- Toothpick or Cotton Swab
- Hot Plate or Stove
- Paper

Invisible Or Sympathetic Ink

The terms " invisible " and "sympathetic" are applied to any writing fluid which leaves no visible trace of the writing on the paper, until developed by the application of heat or chemical reagents. They have been suggested (somewhat impractically it must be owned) for use on post-cards. They are principally as follows: - (a) Solution of sugar of lead in pure water leaves no trace of writing when dry; the written characters held over a jet of sulphuretted hydrogen are developed of an intense black colour. (6) Nitrate of the deutoxide of copper in weak solution gives an invisible writing, which becomes red by heating, (c) Chloride of copper in very dilute solution is invisible till heated. To make it, dissolve equal parts of blue vitriol and sal-ammoniac in water, (d) Nitrate of nickel and chloride of nickel in weak solution form an invisible ink, which becomes green by heating, when the salt contains traces of cobalt, which usually is the case; when pure, it be-comes yellow, (e) Chloride of cobalt in properly-diluted solution (25 gr. to the oz.) will produce a pink writing, which will disappear when thoroughly. dry, become green when heated, disappear when cold, and pink again when damp.

When often or strongly heated, it will at last become brown-red. (/) When the solution of acetate of protoxide of cobalt contains nickel or iron, the writing made by it will become green when heated; when it is pure and free from these metals, it becomes blue, (g) Bromide of copper gives a perfectly invisible writing, which appears very promptly by a slight heating, and disappears perfectly by cooling. To prepare it, take 1 part bromide of potassium, 1 part blue vitriol, 8 parts water. It is better also to discolour the blue vitriol with 1 part alcohol. (A) Write with a solution

of paraffin in benzol. When the solvent has evaporated, the paraffin is invisible, but becomes visible on being dusted with lampblack or powdered graphite, or smoking over a candle-flame, (i) Writing with iodide of potash and starch becomes blue by the least trace of acid vapours in the atmosphere^ or by the presence of ozone. To make it, boil starch, and add a small quantity of iodide of potassium in solution, (j) Sulphate of copper in very dilute solution will produce an invisible writing, which will turn light-blue by vapours of ammonia, (k) Soluble compounds of antimony will become red by sulphide of hydrogen vapour. (l) Soluble compounds of arsenic and of peroxide of tin will become yellow by the same vapour, (m) An acid solution of chloride of iron is diluted till the writing is invisible when dry.

This writing has the remarkable property of becoming red by sulpho-cyanide vapours (arising from the action of sulphuric acid on sulpho-cyanide of potassium in a long-necked flask), and it disappears by ammonia, and may alternately be made to appear and disappear by these two vapours, (n) Writing executed with rice-water is invisible when dry, but tha characters become blue by the application of iodine. This ink was much employed during the Indian Mutiny, (o) Characters written with an aqueous solution of iodide of starch disappear in about 4 weeks. (p) Dissolve 1 fl. oz. common oil of vitriol (sulphuric acid) in 1 pint soft water; stir well, and allow to cool. Write with a clean steel pen; when dry, the writing is invisible; held to the tire, it becomes indelibly black. (q).. Writing executed with a clean quill peri dipped in onion or turnip juice is invisible when dry; when the paper is heated, the characters assume a brown colour, (r) Milk makes a good invisible ink, and butter-milk answers the purpose better. It will not show if written with a clean new pen, and ironing with a hot flat-iron is the best way of showing it up.

All invisible inks will show on glazed paper; therefore unglazed paper should be used. (s) Boil nutgalls in aquavitse; put some Roman vitriol and sal-ammoniac to it, and when cold dissolve a little gum-arabic, and it will, when written with, vanish in 24 hours, (t) Burn flax so that it may be rather mouldered than burned to ashes, then grind it with a muller on a stone, putting a little aquavitse to it, then mix it with a little weak gum-water, and what you write, though it seem fair, may be rubbed or washed out. (u) Widemann communicates a new method of making an invisible ink to Die Natwr. To make the writing or drawing which has been made upon paper with the ink appear, it is sufficient to dip it into water. On drying, the traces disappear again, and reappear by each succeeding immersion. The ink is made by intimately mixing linseed-oil, 1 part; water of ammonia, 20; water, 100. The mixture must be agitated each time before the pen is dipped into it, as a little of the oil may separate and float on top, which would, of course, leave an oily stain upon the paper.

How To Make Invisible Ink - Lemon Juice

Most invisible ink messages can be revealed by applying heat to the paper.

Lemon juice is acidic and weakens paper. When paper is heated, the remaining acid turns the writing brown before discoloring the paper.

Difficulty: Easy

Time Required: A Few Minutes

Here's How:

1. Squeeze lemons to obtain their juice or obtain bottled lemon juice.
2. Use the juice as 'ink' by applying it to a stick or paintbrush and writing on paper.
3. Allow the paper to dry.
4. When you are ready to read your invisible message, hold the paper up to sunlight, a lightbulb (recommended), or other heat source.
5. The heat will cause the writing to darken to a pale brown, so your message can now be read.
6. Another way to read the message is to put salt on the drying 'ink'. After a minute, wipe the salt off and color over the paper with a wax crayon to reveal the message.

Tips:

1. Experiment with other juices. White wine, orange juice, vinegar, and apple juice all work well, too.
2. A cotton swab makes an excellent disposable 'paintbrush'.
3. The writing turns brown because the weakened paper burns before the rest of the paper. Be careful not to overdo your heating and ignite the paper!

What You Need

- Lemon or Lemon Juice
- Sunlight or Heat Source

- Paper
- Paintbrush or Stick

How To Make Invisible Ink - Baking Soda

This smiley face was made with invisible ink. The face became visible when the paper was heated.

Anne Helmenstine

These are instructions for making non-toxic invisible ink using baking soda (sodium bicarbonate).
Difficulty: Easy

Time Required: A Few Minutes

Here's How:

1. There are at least two methods to use baking soda as an invisible ink. Mix equal parts water and baking soda.
2. Use a cotton swab, toothpick, or paintbrush to write a message onto white paper, using the baking soda solution as 'ink'.
3. Allow the ink to dry.
4. One way to read the message is to hold the paper up to a heat source, such as a light bulb. The baking soda will cause the writing in the paper to turn brown.
5. A second method to read the message is to paint over the paper with purple grape juice. The message will appear in a different color.

Tips:

1. If you are using the heating method, avoid igniting the paper - don't use a halogen bulb.

2. Baking soda and grape juice react with each other in an acid-base reaction, producing a color change in the paper.

3. The baking soda mixture can also be used more diluted, with one part baking soda to two parts water.

4. Grape juice concentrate results in a more visible color change than regular grape juice.

What You Need

- Baking Soda
- Paper
- Water
- Light Bulb (heat source)
- Paintbrush or Swab
- Measuring Cup
- Purple Grape Juice (opt.)