

Failure by Design?

“ Exploding the Petromax Myth ”

By Neil Mc Rae

I have for years been telling people that pressure lamps don't explode and even gasoline burning lamps and lanterns were designed not to blow up customers. If you think about it this is reasonable as blowing up customers is probably not a good marketing policy. So I was most un-prepared when, on 21 November 2001, a question (Q 1491)* was posted to the Guild web site by a gentleman in the U.S. asking why his Petromax had exploded.

The ensuing discussion was most interesting and brought to light some facts I was not until then aware of. This question of an exploding lantern has been occupying my thoughts ever since and I now have a much better understanding of the design of a Petromax lantern and whilst I cannot be sure exactly why this lantern went bang I do know why gasoline and Petromax do not go together. What still amazes me is the fact that we do seem to have a lantern that was designed to blow up customers and it has been around for over 50 years.

The exploding lantern that sparked my interest was almost certainly a Hong Kong made lantern sold in the US as a Petromax brand lantern. I do not know which US company sold the lantern but in a reply to some of my questions the owner stated *"The lamp was brand new, purchased in the United States on 11 October 2001. The lamp was used twice, with the accident occurring on the second occasion, on 27 October 2001, after burning for about four hours. The retailer indicated any fuel was appropriate, but white gas was used on this lamp. The pressure gauge was not read immediately prior to the accident. By "exploded" I mean there was a loud "Whooomp" sound and the entire tent (a large tent) was temporarily consumed in a large ball of fire"*. If the retailer is the one I think it may be then the instructions do indeed state that the lanterns can be run with either kerosene or white gasoline.

One of the "facts" I learnt from this discussion was that in or around 1960 the German army had banned the use of gasoline in their Petromax lanterns. Rumour has it this ban was because significant numbers of these gasoline lanterns had suffered catastrophic failure in use. If true that was significant as the German army version was model number 829B and the B signifies the lantern is designed to use Benzin or Gasoline.

I was told that prior to the ban several army lanterns had failed and the army were trying to make sure the more volatile fuel was not used. Now that introduces a whole new dimension. A failure of a Chinese lantern might be possibly due to poor construction but regular catastrophic failures of German made lanterns designed to use gasoline in the late 50s when Petromax were actually being made in a German factory has to be a design problem.

Right there is where I began to look at the design of gasoline lanterns and in particular to look at Petromax design.

The first problem I had to resolve was to set about acquiring one or more gasoline burning Petromax lanterns in order to compare the design with the more normal kerosene lanterns in my collection, of which I have many, including a lot of Far Eastern made Petromax copies. I now have a Swiss army Petromax 250cp gasoline lantern which has no model number but is essentially model 821B with a larger font as fitted to 500 cp lanterns.



I also have a Bundeswehr model 829B made in the Altena Petromax factory in May 1960. After dismantling both lanterns I found that apart from a different generator and gas tip the design of these gasoline lanterns is exactly the same as the more familiar kerosene lanterns. The only difference being the substitution of a generator built to use the more volatile fuel.

The instructions for the Swiss version states the fuel to be used is benzin (gasoline) and no mention is made of the possibility of using kerosene. The German lantern came with the correct army issue steel case and the instructions. Both the instruction decals on the case and the leaflet state the preferred fuel is Benzin (gasoline) but that Petroleum (kerosene) can also be used.

In each case the reference to the use of benzin has been crossed out and there is a decal on the fount stating "*Nur Für Petroleum. Verwendung von Benzin verboten*" This roughly translates as "Only for kerosene. The use of gasoline is forbidden" So this gasoline lantern has instructions to use only kerosene and that reinforces the statement that the Bundeswehr banned the use of gasoline in these lanterns.

I should perhaps at this juncture point out that here we have a hugely successful lantern that has been copied all over the world and has been sold in vast numbers in most countries. The Petromax kerosene lantern is perhaps the most successful piece of pressure kerosene lantern design by a considerable margin. However that design seems to fail when gasoline is used so what is wrong ?

Let us then look at the design of a Petromax in some detail with particular reference to it's suitability for burning gasoline.

The founts are made of brass with a lead solder base seam and lead solder seals for the upper fittings such as the valve unit, filler cap, central fixing point, and pre heater blow torch if fitted.

A lot of Far Eastern copies have steel founts but this is not significant. The valve and blow torch units are screwed into the fount and use a lead washer to make a seal. The filler cap is normally provided with a pressure gauge and a pressure release valve and is sealed to the fount with a synthetic rubber sealing washer.



The control valve unit performs two functions.

It operates a tip cleaner rod which runs through the generator and has a needle at the top to clear any blockages in the gas tip. It also operates another rod, which passes through the fuel pick up tube, to open and close a valve mounted at the bottom of the fuel pick up pipe located near the bottom of the fount. This lower valve is a spring loaded rubber seal unit much like the check valve in a Tilley or Primus stove pump tube. The two rods are arranged on a cam so that when the tip cleaner is in the clean or raised position the valve will be closed by the action of the spring forcing the rubber seal against the orifice in the bottom of the fuel feed tube.



When the control wheel is rotated a half turn the tip cleaner is lowered and the lower rod pushes the rubber seal back from the orifice so fuel can pass. The pump provided is a simple tube angled down towards the bottom of the fount and again has a spring loaded valve in the same style as a Tilley or Primus stove valve. This valve is therefore located in the fuel when the lantern is in use.

There are other design features that make a Petromax look the way it does but they don't concern us much here, except perhaps with air flow patterns, because they are only to do with mixture and the upper parts of the lantern where the fuel is already vaporised and burning. What I am looking for is reasons for fuel burning where it should not.

Let us look at the design in detail then. First the use of lead solder and lead seals in the fount. Lead solder melts at around 550 to 800° C and as most of you will know that is a comparatively low melting temperature well below that of a candle flame never mind a pressure lantern burner flame.

Is this important?

Well maybe it is. Like a lot of lanterns the mantle in a Petromax hangs down from the burner. Petromax mantles are sewn with a gather at the bottom and it is possible for there to be a small hole at the lowest point. Therefore it is possible to get a spike of flame vertically down from the mantle. This flame can reach the top of the bolt which holds the globe cage in place. The lower end of this bolt is screwed directly into the top of the fount so it is possible to heat the top of the fount with conducted heat through the bolt, maybe to the melting point of the solder and lead seals.

Incidentally I suspect this conducted heat through the bolt, or even down through the valve casting, is the major cause of all those exploding lanterns. I said earlier that the upper parts of the globe cage and hood are of little concern here but there is one design feature of these lanterns that affects heat transfer around the top of the fount. Most pressure lamps take air for combustion from within the globe cage, or below it through holes provided in the support collar. Such an air intake at low level provides a flow of cooling air across the top of the fount.

In a Petromax design the air intake is through the lower series of holes in the hood and the products of combustion are vented through the upper vents. The two parts of the hood are separated in use so the products of combustion do not affect the fresh air intake. Therefore any heat conducted through the metal parts down towards the fount are not cooled in any way which may be a contributing factor to the possible failing of the lead or solder seals.

It is also interesting to see that most modern Petromax lanterns are now fitted with an extra heat deflector plate which protects the holding bolt from possible over heating from a damaged mantle. This very late, possibly 60s design, plate is visible evidence that the manufacturers recognised a problem and were attempting to reduce the risk.

Now a look at the control and fuel supply. Spring loaded valves will fail in time. This is not a possibility it is a fact. Rubber seals will wear out and at some point require replacing. In the Swiss army lantern I found the valve did not close off the fuel supply so the operation of the control wheel only reduced the fuel feed through the gas tip but it was not sufficient to turn off the flame at the mantle. I therefore had a lantern that would not turn off and this is not good news. If there is a problem it means the lantern cannot be turned off and the only steps you can take are big quick ones. In a kerosene lantern this is no problem as you can just dump pressure by opening the pressure release or removing the filler cap. Not a great idea with gasoline in the fount so close to a burning mantle. This is possibly not so very dangerous because the release valve vent is a small hole and a flash back into the fount is unlikely. However this is not a theory I want to test.

Staying with spring loaded valves, the same sort of problem is found in the pump tube. The seal in the valve will fail at some point. It is in the nature of the beast that now and then you will get a discharge through the pump tube. A Petromax pump check valve discharges air directly into the fuel at the bottom of the fount. It is therefore inevitable that when the valve fails raw fuel will discharge back up the pump tube. I have twice now had a kerosene lamp vent a fount full of fuel through the pump tube. With a kerosene lamp this makes a mess but with gasoline would have been a serious and exciting incident.

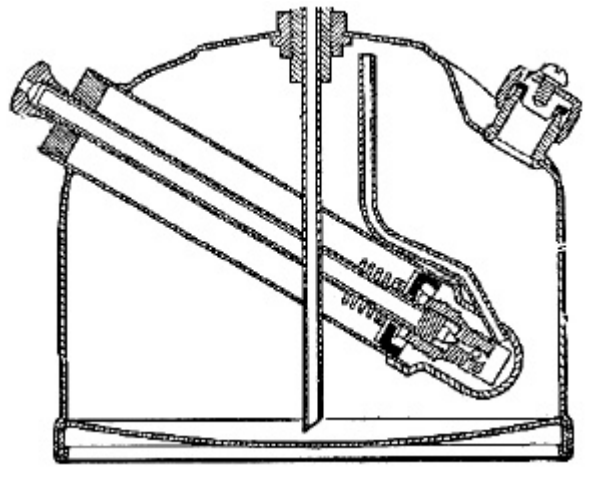
Next is the filler cap and its pressure release. The cap itself is fine but a pressure release in a gasoline lantern is a poor idea because you might be tempted to use it to turn the lantern off and I don't think it is a great idea to release gasoline vapour within six inches of a burning mantle.

Finally I would like to compare Petromax design with just about any Coleman gasoline lantern. This comparison makes the design of the Petromax when used with gasoline look very poor if not dangerous.

Coleman founts are generally not sealed with lead solder. They are copper brazed and will not fail when heated. All the fount top fittings are screwed into the fount with a tapered brass thread with only a small amount of thread sealer which will not be affected by heat. Also Coleman lanterns nearly all take air for combustion from below the base plate and through the collar which provides a gale of cooling air across the top of the fount.

Coleman and most other American gasoline lanterns have a positive needle valve fuel shut off. None of these lanterns rely on a spring loaded valve to do this job. That feature of a Petromax is strictly a European kerosene product idea.

Only a few Coleman Kerosene lanterns are fitted with a pressure release valve in the filler cap. None of their gasoline lanterns have this feature. Similarly with pumps, only a few kerosene models have a Petromax type of European pump check valve. All the gasoline products have a double check valve with a steel ball valve and then a screw down needle valve.



Coleman 247 SCOUT cutaway

Also typically from the bottom of the pump tube there is a tube leading up to the top of the fount so that even if the valves both fail there will be no fuel discharge. Such failure will only vent the fount of air and therefore a pump failure will just stop the lantern burning due to failing pressure.

My conclusion is that there is no Petromax or Petromax type of lamp or lantern that is safe to use with gasoline as fuel, even if the company designed the burner to use such fuels. They are good reasonably safe lanterns with kerosene but with gasoline or similar fuels are quite literally gas bombs just waiting to demonstrate what bombs do best. Incidentally these design features have persuaded me to the opinion that even with kerosene this type of lantern is not good engineering design.

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* Question 1491 and reactions on the bulletin board of
The International Guild of Lamp Researchers (www.lampguild.org)

1491. Petromax explosion: A CAUTION TO PETROMAX OWNERS by John Kluksdal (****@aol.com)
Posted: Nov. 21, 2001 @ 16:52.

I recently purchased a Petromax nickel plated brass lantern. The light was fantastic, but about four hours after turning it on, flames started shooting out the sides and about 12 inches above the lantern. Just before I picked it up, intending to throw it outside our cooking tent, it exploded. Has anyone had a similar problem or do you have an explanation for why this happened? Thank you for your responses.

o On Nov. 21, 2001 @ 18:28, Neil A McRae (****@nmcrae.freemove.co.uk) wrote:

John: Yours is the first exploding Petromax I have heard of. This is a serious business as these lanterns are supposed to be near fool proof and a catastrophic failure is almost unheard of. Before I comment, can you answer a few questions please. Was this a purchase of a new lamp or a second hand one? Where was it purchased? Just the country will do, not the actual supplier for now. What fuel were you using at the time and had you ever used any other fuels in it? What fuel were you recommended to use? Was the pressure gauge working and what pressure was the lantern operating at? I also need the precise model number as stamped on the lantern, in fact I would like details of all the information on the lantern. At this stage I will not give a public comment as there could be legal implications and I cannot give an opinion without some more facts. I suspect I do know why but I need more information first please. ::Neil::

+ On Nov. 23, 2001 @ 07:13, Cav (****@yahoo.fr) wrote:

RE: "I suspect I do know why but I need more information first please." --- If it may happen with other pressure lamps, could you tell us the problem, in order to avoid any other accident with our old lanterns? Thanks!

o On Nov. 23, 2001 @ 13:25, Wim van der Velden (****@wxs.nl) wrote:

Hello, Without having more "facts" I will tell my story. I assume the lantern in this case was filled with gasoline. One BIG problem can occur in the following case: A little hole in the bottom of the mantle will give a very hot (spike) flame, almost not visible. If the safety-plate [the metal plate that serves as a base plate on this design] (part number 126, on the britelyte site) isn't used, this jet of flame can de-solder the main bolt or burn a hole in the generator or tank. Loosing pressure with gasoline as fuel and an open flame can or will result in the mentioned dangerous situation.

I don't say this is what happened here, only that is IS a possibility reported before in Europe!! Only more details or pictures of the remains will tell us what happened. All the best, and take care. Wim

o On Nov. 23, 2001 @ 19:12, Neil A McRae (****@nmcrae.freemove.co.uk) wrote:

Cav: OK I guess you are entitled to my thoughts, although I still would like some answers. Until Wim contacted me off this page yesterday I was not aware that any Petromax lanterns in Germany had suffered this problem he mentions. I have been advocating for some time that Petromax type lanterns should only be run on kerosene unless they were specifically constructed for the use of gasoline. It is true that Petromax lanterns from the 30s up to at least the 60s WERE made that used gasoline but these were not the same models as the kero burners. ALL the gasoline burners had the letter B after the model number. So the 500 cp rapid lantern for gasoline was model 829B instead of the 829 model which was always for kerosene only. The B is for Benzine, German for Gasoline or Petrol. As far as I know the modern 500 cp Petromax lantern being sold in the US is model 829 and therefore to my mind a kerosene ONLY lantern. The German army for some years used model 829B lanterns and these are now coming on to the German second hand market in quantity. I suspect it is these gasoline lanterns that have failed in Germany, but Wim will know better than I the truth of that. I very much share your concern here but exploding pressure lanterns are rare. Very rare in fact. In general it is not good marketing practice to blow up your customers, so most manufacturers make sure their products are safe to use. Therefore if one brand of lantern fails it is not reasonable to assume all the others are suspect. I find it odd, and perhaps significant, that America is the only country I know of where Petromax lanterns are advertised as capable of burning fuels like gasoline, Coleman fuel, kerosene and even diesel. This type of lantern is sold all over the world and I know of nowhere else where retailers suggest anything other than kerosene as a fuel. I am most concerned to know why this one failed. I suspect the use of gasoline may be a contributing factor but I do not know that until we hear again from John Kluksdal. I have no doubt that there was a catastrophic failure of the pressurised part of the lamp somewhere at the top of the fount, at the valve unit, or in the generator tube. From the information we have, of flames to the side and above the lantern, there had to be liquid fuel burning in quantity. In a lantern that had been burning for four hours that can only be either a metal failure of the fount or the generator tubing, or a melted solder joint. If the lantern in question was bought new in the US then John was probably following the instructions if he used gasoline. The lantern would have been supplied with Petromax mantles and that is probably what was fitted. These mantles are made from a tube and are stitched at the bottom in such a way that it is possible to get a small jet of flame straight down. Coleman mantles do not have the same

construction and will not do this. In this case I don't know why the lantern failed and I very much want to. Finally, pressure lanterns are safe. They are used in huge numbers world wide and failure is extremely rare. Modern lanterns made by companies like Coleman and Vapalux are very solid and as safe as it gets. Even the cheaper Far East imports have to meet strict safety standards. Incidentally it is interesting to note that Petromax lanterns are not sold in the UK because they do not meet the British Standard specifications and the trading standards offices will not permit an import licence. All pressure lamps, lanterns, and stoves have the potential for such catastrophic failure. They are all constructed not to fail and generally it is only operator error that causes problems. With a new lantern, when the instructions are followed, there should be no problem. A failed new product, used in accordance with those instructions, that causes damage is the start of litigation. Most of us collectors and researchers are aware of this potential for disaster and are careful to test the old stuff we find before firing them up. If I have a 40 year old lantern fail then it will likely be my fault not the manufacturers. In this case at the moment I just don't know what happened and, like you, I very much want to know because I want to be able to make reasonable recommendations to people who are not as familiar as I am with these things. ::Neil::

o On Nov. 24, 2001 @ 11:28, Bart J. Meijer (****@worldonline.nl) wrote:

Hi All This is my first time posting here, i read the post at Stuga-Cabana and saw this question. There can be two things in my opinion that could have occurred: 1 The previously mentioned flames through a hole in the mantle wenn not using the protectionshield especially made for Petromaxes that use Gasoline/petrol. That could cause the Tank to overheat and start leaking fuel through soldering places or the lead gasket rings. 2 The Tank of a Petromax is pumped up with normal air, so in the case of using Petrol/gasoline, you might get and mixture of air and vaporized fuel on top of the fuel. That as you all know can explode very easily. So if there is a leak and the fuel has all come out, it starts leaking the air and fuel gasses and that mixture can explode. It has worried me before to use the BW Petromax on Gasoline/petrol just for the simple reason that if the tank gets empty just by using it normally you also can get the situation that the combustible mixture in the tank comes out at the nozzle and the whole thing might explode. So i always keep the tank full enough that this cant happen. What i also noticed is that the German army has forbidden to use Petrol/gasoline in their lanterns since 1960 and maybe this is the reason. Hope you are ok John Regards Bart J. Meijer

+ On Nov. 24, 2001 @ 17:08, Neil A McRae (****@nmcrae.freeserve.co.uk) wrote:

Bart: I am sorry but I cannot agree with some of that. Your #1 possibility is quite correct and is more or less what Wim and I have said. However the second part of #2 is not right and is just creating an unnecessary worry to people using perfectly good and safe gasoline lanterns. I agree that if there is a leak with fuel still under pressure there is a serious risk of explosion but that is the situation covered in your first suggestion. However in a sound lantern in normal use, if the fuel is gone, it is gone, and if the lantern still has pressure and the valves are open with the lantern burning normally I assure you it will just go out. There may be some of the lighter vapours in the pressurised air but it will not burn at the mantles for the good and simple reason that there is far too much air for those lighter vapours to ignite. You must remember that the vapour stream issuing from the generator is diluted with approximately 95% air. It might smell of fuel but the smell is about all there is. It will not even burn much less explode. This vapour inside the fount will explode if you put a lighted match to the open filler hole but we are not talking of anything other than normal use so that is not at issue. It is most definitely not necessary to keep the lantern full when not in use. Besides unless you expel all the air you are not achieving your objective anyway. In fact with a lot of lanterns it is actually detrimental to the metal base plate to keep it full and the fuel will also deteriorate in the fount. We would do well to remember we are discussing the failure of one lantern here. In fact the first such failure I know of for certain in over 40 years. So we are not discussing the possible decimation of the worlds campers. I have not had the opportunity to examine either the 829B lanterns as used by the German army, or the modern Petromax lanterns as sold in the US. However if they both have the same shut off valve arrangement as the 1960s and earlier kero burning 829 models, then in my opinion gasoline is most definitely not safe to use. I would still think that even in a lantern advertised by the manufacturer as suitable for gasoline. However we are talking a single Petromax here and in fact at this moment we do not know the reason for the failure. For all we know this failed lantern could have been pumped up to an excessive pressure and the cause may therefore have been a failure of the fount due to over pressure. If that was the case it is operator error not the fault of the lantern. I deplore the modern trend to install valves on these lanterns in order to use a foot pump. The pressure gauges fitted to these lanterns are not an accurate instrument and a foot pump can insert far too much pressure very quickly. I know the pump on a Petromax can be a trial but it is designed so you almost cannot over pressurise the fount. I suspect we will never know. Since his first posting of this question John has been silent. I am beginning to think his silence may be because of instruction from a lawyer. If that is the case we will never know the truth and all we are doing is frightening people without good cause. ::Neil::

On Nov. 26, 2001 @ 14:52, John Kluksdal (****@aol.com) wrote:

Neil: I do not have the lantern with me, so I cannot identify the precise model number, but can answer most of your other questions regarding the lantern. The lamp was brand new, purchased in the United States on October 11, 2001. The lamp was used twice, with the accident occurring on the second occasion, on October 27, 2001, after burning for about four hours. The retailer indicated any fuel was appropriate, but white gas was used on this lamp. The pressure gauge was not read immediately prior to the accident. By "exploded" I mean there was a loud "Whoomp" sound and the entire tent (a large tent) was temporarily consumed in a large ball of fire. We have not noted any cracks in the fount, although this is something that may have been overlooked. I appreciate everyone's feedback. Thank you, John

* On Nov. 29, 2001 @ 04:14, Anders Willman (****@surfeu.fi) wrote:

Hi John! I have to check one thing out here as BriteLyt informed me that this wasn't a Petromax but a Butterfly lantern. So was it a Petromax or a Butterfly lantern? As you know these are complete different brands from different factories, and the Butterfly is made out of steel not brass.

o On Nov. 26, 2001 @ 17:54, Neil A McRae (****@nmcrae.freemove.co.uk) wrote:

John: Thank you for the reply. Now we know it was a Petromax bought in the US new last month and therefore most likely made by Santromax in Hong Cong. As you may have gathered I do not consider Gasoline of any sort to be an appropriate fuel for a Petromax. However that may actually have little bearing on the reason for your catastrophic failure. It may have made the explosion occur earlier than if kerosene was used but the failure could have happened anyway. When kerosene gets hot enough there is little difference between the two fuels. I would dearly like to examine the remains but I guess that will be impossible. There were no cracks in the lantern before it failed as it would not have run for four hours. The loss of pressure would have made it go out long before that. There had to have been a sudden failure of the pressurised system somewhere. Without examination I can only guess at the cause. I do hope this lantern is to be examined by some responsible and independent engineer, and independent is vital here. It is important that we understand what happened as there are many lantern users who will be worried about using gasoline lanterns, and we can only learn truth from examination of failure. If the retailer gets the lantern back it will possibly end up with the manufacturer and I would not trust either a retailer or a manufacturer to publish the result of any examination. They would probably have to be ordered by a court to do so. So we are still in the speculation game here. It seems to me that you have been using this lantern quite normally and in accordance with the instructions you were given. I may deplore the use of gasoline but if the retailer told you it was OK then you were only following those instructions. If you were using the lantern correctly then there is no doubt in my mind this lantern was not fit for the purpose form which it was made and further was actually dangerous to the point where lives could have been at risk. My conclusion is that one of two things happened. 1, A metal failure occurred in the fuel supply system between the top of the fount and below the gas tip or jet, which caused a leak of liquid fuel at a point where that liquid was ignited by the heat from the mantle. This burning fuel then so heated the fount that either the seals failed and the contents of the fount were opened to atmosphere at which point the whole of the contents of the fount ignited, or the air/vapour above the fuel in the fount reached ignition temperature. 2, A faulty mantle caused a flame jet to heat the top of the fount to the point where the solder or lead seals failed and therefore also opened the fount to atmosphere. Of the two I prefer 1, as that is perhaps more likely to have resulted in quantities of liquid fuel to be discharged into the upper part of the lantern. You say the lantern was producing yellow flames both around and above it before it exploded and I suspect therefore that the fault was in the generator tube. ::Neil::

o On Nov. 29, 2001 @ 20:33, Fil Graff, Guild Secretary (****@epix.net) wrote:

CAUTIONARY NOTE TO PETROMAX USERS: THE PROBLEMS OUTLINED IN THE ABOVE QUESTION SHOULD AT LEAST PROMPT A CAUTION TO OWNERS AND USERS OF RECENT PETROMAX (AND OTHER CHINESE-MADE) PRESSURE LANTERNS. THESE LANTERNS LACK A POSITIVE FUEL SHUT OFF VALVE, AND HAVE A PRESSURE RELEASE VALVE THAT VENTS THE FOUNT; THE USE OF GASOLINE/WHITE GAS/COLEMAN FUEL/NAPHTHA IN THESE LANTERNS CAN PRESENT A MAJOR HAZARD SHOULD THE LANTERN RUN AWAY (FROM ANY NUMBER OF CAUSES RANGING FROM OPERATOR ERROR TO STRUCTURAL OR COMPONENT FAILURE OF THE LANTERN ITSELF). IT IS OUR CONSIDERED OPINION THAT GASOLINE AND SIMILAR FUELS SHOULD NOT BE USED IN THESE LANTERNS, WHICH WERE DESIGNED IN THE 1930'S FOR THE BURNING OF KEROSENE. THEY ARE FINE PRODUCTS, AND QUITE SAFE WHEN KEROSENE (A MUCH LESS VOLATILE FUEL) IS USED. THE GERMAN ARMY HAS BANNED THE USE OF GASOLINE ("BENZIN") IN THEIR ISSUE LANTERNS SINCE THE 1960'S. IF YOU WON'T BELIEVE US, THEN PLEASE LISTEN TO THEM!