INTRODUCTION TO THE REVOLUTIONARY DESIGN OF SCHEFFLER REFLECTORS

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ABSTRACT

This paper describes some ideas about the intricate design of the Scheffler reflectors and how it was developed.

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1. INTRODUCTION

Solar energy for everybody

Parabolic Scheffler Reflectors can provide [you with] high temperature heat for all types of cooking, steam generation and many other applications.
Their speciality is a flexible surface curvature and a non-moving focal area.
Their use is now becoming increasingly popular in many parts of the world, especially in India.

2. BACKGROUND

The design of solar parabolic concentrators has been going on for more than 150 years, with an almost 100 year long break due to our obsession with liquid fossil fuels.

Almost all concentrators have a rigid structure and the focus, the hot area where all light is concentrated , moves along with the direction of the sun. This makes its use a bit impractical.

So about 24 years ago I started thinking of a design to make the hot focus available at a fixed place.

This way the use of solar energy can be very convenient.

With a fixed focus, also many more applications can be thought of.

The following development of the Scheffler Reflector was done in rural mechanical workshops in Kenya and in India, to ensure the resulting technology would be within the reach of everybody who would need it in future.

Over the years, many motivated friends and wellwishers joined in this endeavour and made it what it is now.
Several small organisations worldwide took it up in their own fashion.
The way of doing things is always a bit chaotic.
It is characterized by friendly and informal cooperation between many independent individuals and groups.

3. THIS PROJECT

3.1 Stopping the sun

The sun gives us the impression of movement basically because the earth is revolving under our feet.
One way to stop moving while rotating is to locate yourself in the center or axis of the rotation.

Imagine a carousel. When you go to its center, you will still rotate, but not move sideways any longer.

The same way, the hot focus of the Scheffler Reflector is placed in the axis of rotation of the reflector.
Thus it remains in a fixed place, giving maximum convenience.

3.2 Moving with the sun

Just as the earth spins around an axis through the north pole and the south pole, the Scheffler Reflector spins around an axis parallel to that, just in the opposite direction.
(It counteracts the earth's rotation,cancel it out.)
This is called polar mounting or mounting on a polar axis.
The speed is one revolution per day, or, better, half a revolution in half a day, since we do not use at night.
This way the reflector keeps facing the sun in a constant manner.
The constant speed is controlled with a mechanical clockwork.
For practical reasons, the shape of the reflector is such, that the hot focus is outside of the reflector, either on the north side or the south side.
This way the hot focus can be even inside a building while the reflector remains outside.

3.3 Bending and flexing, the most unique feature of the Scheffler reflectors.

This is the most important point of the design of the Scheffler reflector, and is normally completely overlooked by people who see the reflector.

In winter, the sun is low above the horizon, while in summer it moves high up into the sky.
Under these changing conditions, having a different angle of the sunlight everyday, it is difficult to maintain a small and hot focus in a fixed place during all the four seasons.

The design of the Scheffler Reflectors provides the only widespread solution to this demanding situation.
First it sounds almost unbelievable, but the reflector is made to change the shape of its entire surface to adapt itself to the different angles of the sunlight.
This way, a small and hot focus is achieved during all seasons.

This sounds very complicated to make and to handle, but it turns out not to be so.

If you take a round or elliptical piece of orange peel and slightly squeeze it in your hand, you get a similar change of shape as it is required for the reflector.
When you squeeze it, in one direction it will become more curved, while in the other direction it flattens out a bit. When you pull it apart instead, it will flatten out in this direction and curve in the other one.
This gives you the basic idea on what type of shape change is required for the reflector to achieve a small focus at all seasons.

For the real reflector all these shapes are of course calculated first. A scientific pocket calculator and your school math are sufficent to do this job.
Its all based on the equations of a parabola and straight lines and calculating their intersection points.

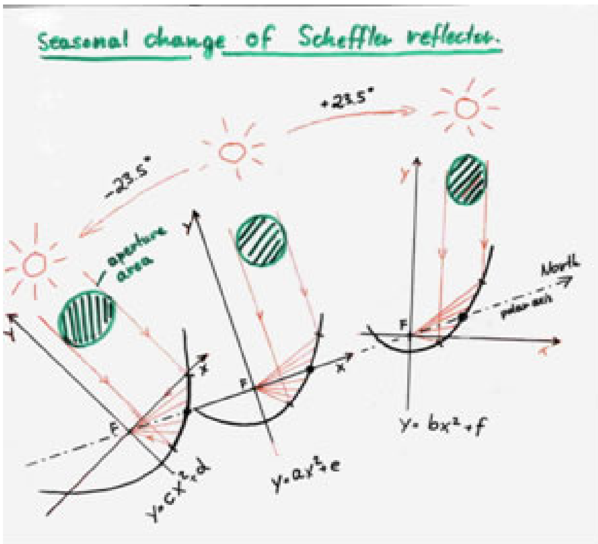

Fig.1 Different parabolas focus the sunlight at different seasons. The incident light has to be parallel to their y-axis. Note the seasonal change in the aperture area.
The focus F and the center of the Scheffler reflector (black dot) remain stationary!

It also uses the fact that whenever you cut a paraboloid with a plane, you get an ellipse in school we used to learn this only for a cone).
That is why the Scheffler reflectors have this typical elliptical shape (see Fig.3 and Fig.4).

The small straight section of the frame near the focus improves the flexing behavior in that section. This was found by trial and error.

Reflectors like the SK 14 are circular.

This is because their the plane of cutting is perpendicular to the paraboloid. In that special case the short and the long dimension of the ellipse become the same length and we see a circle

After a lot of research I found that five points were sufficient to support the reflector frame.
And, very important, only two of them needed to be adjusted in order to create all different shapes required during the whole year.

These two are adjusted manually after every few days, just pushing or pulling them until all light enters the hot focus again properly .

Fig.2 Manual change of the length of the reflector`s rear support (seasonal adjustment).

It was very important to me to keep the number of adjustments to this minimum, otherwise I felt that handling would be too cumbersome for the user.

Actually a third adjustment in the center of the dish would have been necessary, but after studying the geometry for some time, I found that I could design this adjustment as an automatic lever.

The lever pushes the center of the reflector forward or retracts it automatically when the reflector is set for the seasonally lower or higher sun.
At that time, the angle of the reflector towards its mounting along the polar axis changes, and the lever is activated.

The whole structure is well balanced and easy to turn.
It is made from light iron tubes and bars, which are softer in the places which require more bending (like near the focus) and stiffer where less bending is appropriate (the areas far from the focus).

3.4 Big and small

Scheffler Reflectors have been built in many sizes, from half a square meter of reflective surface up to 50 square meters.

For family use, the sizes of 2 m² and 2,7m² are appropriate.

Fig.3 2,7m² Scheffler Reflector used by a family at the Barefoot-College in the village Tilonia, Rajastan, India.
The circle in the center highlights the position of the lever for the seasonal shape change.

For school canteens and industrial applications the sizes of 8.0 , 9.7 , 12.6 and 16 m² are now commonly in use.

Fig.4 9.7m² Scheffler Reflector at the main kitchen of the Barefoot-College in the village Tilonia, Rajastan, India.

3.5 Powerfull and conveniant

About half of the power of the sunlight which is collected by the reflector becomes finally available in the cooking vessel.
The power output varies with the season (see Fig. 1).
A sun which shines more from the front into the reflector sees a larger reflector (large aperture), and thus more power is collected.
In the same way, a sun shining more from behind sees a smaller reflector and less power is collected.

A 2.7 m² reflector can typically bring 1.2 lts of water to boiling point within 10 minutes.

A 9.7 m² reflector can typically bring 4.5 lts of water to boiling point within 10 minutes.

The bigger reflectors (12.6 m², 16m²) are all used to produce steam, either for cooking or for industrial purposes.

3.6 Power for everybody

Scheffler Reflectors were specially developed with the aim to assist regions which have much less energy at their disposal as for instance we in Europe, but have abundant sunlight.
Everything is designed for local production in simple rural metal workshops.

Fig. 5 Women of the Solar Cooker Cooperative in Tilonia construct a 2,7m Scheffler Reflector

Fig. 6 Welding some part of the solar cooker

Recently, during the last few years, the technology also started to cater to industrial energy needs, especially for producing steam.

The total installed area worldwide is not exactly known, but around 8000 m².

4. CONCLUSION

For me, the technology as such is not important, but that we were able to build up this very nice and informal international cooperation around it.

That way, through cooperation, we can avoid problems which are created essentially through non-cooperation and misunderstanding, because we are not looking at each other as equals and friends.

Fig.7 The author uses a 2m Scheffler Reflector in front of his home in a village in southern Germany