Austrian precision telescope mount © (APTM) newer version 2 with friction wheel drive, invented by Rudolf Pressberger

Design idea

This does not come out of nowhere. **Rudolf Pressberger** has learned through many years of experience (during the 60s and 70s) in the construction of several large telescopes (including a 16" Newtonian with German-mount and a 24" RC telescope with old style Fork-mount) the one hand, the disadvantages of conventional constructions, on the other hand, he had the opportunity to try new design ideas. So he could find a solution that is unmatched to this day under equatorially mounted telescopes. When building his own 40" RC telescope that could be impressively demonstrated. His version 1 is one with a large worm gear wheel in right ascension equipped. Originally there were at 1m RC telescope in declination still a tangential arm, which was later converted to spur gears of the highest precision. Version 1 contains commercially available bearings, but in a special arrangement.

The new version 2 of the 1995/96 replaced the ball bearings with self-made special bearings with even better properties and has a friction wheel drive in both axes. The experience derives from the construction of Version 1. Production and adjustment be simplified. The design principles will be further optimized without taking compromises. A telescope thoroughly engineered. The essential criteria are listed under "benefits of the design."

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Benefits of the design

- Fork mounts have a bad reputation among the amateurs. But among the professionals they have prevailed. The APTM is a fork mount with open truss optical tube. A fork mount, better than most other fork mounts and better than any German mount telescope.
- All conventional astronomical equatorial mounts you used have a strong flexurally tension on the hour axis. The closer together are the bearings of the axis, the greater the tension on the bearings. That is why the hour axis is so long. Unfortunately, making the inventor of single arm fork mounts the same error in the second axis, and this axis is only quite short. With the APTM mount this troubles has been eliminated.
  Others think now, so what? I make the bearings just big enough. They are too stupid to realize the new problems with it. Mr. Pressberger, a true champion of mechanics has known that.
- The APTM is not designed for a Newton. A Newton is also no optimal Observatories instrument. No professional uses a Newton nowadays. Nevertheless, the APTM is also successfully used with conventional Newton-tube used by amateurs, see reference list
- The ratio of weight to modulus of elasticity is essential for the use of steel as the preferred material.
- Welding as a joining technique gives the stiffest compounds and this is also an argument for the use of steel and against other materials e.g. Fiberglass or carbon fiber. Thus explains the stability of the adjustment of the optics from APTM optical tube. For RC telescopes which is particularly important. At observatory telescopes carbon fiber can not exploit its weight advantage.
- Elegant design solutions make it possible, for example, make do with steel sheets of small wall thickness at the primary mirror cell and obtain the same stiffness where other designs require thick iron plates with welded stiffening ribs or a heavy crown-like structural complex construction from welded form pipes.
- Despite the use of steel optical tube along with mirror cell weighs for our 50cm RC only 100kg (without mirror set and weight rings).
- Only the Serrurier principle in unadulterated shape prevents (together with the extremely stiff spider ring) tilting the optical axis alignment in a change in position of the tube.
- At primary mirror side is a Serrurier principle equivalent design used, which allows a very small distance of the mirror to the supporting structure of the tube and thus to the declination axis.
- Our Spider ring with triangular cross-section is far superior to the usual design not only in terms of stiffness, but also by its low weight and the production technology.
- The whole secondary mirror unit is held on pull loaded Spider-sheets extremely stable from the stiff spider ring. For an RC optics, this is important.
- The parallel shift of the optical axis by change in position of the tube is structurally minimized and meets the high demands on the stability of the adjustment of the optics.
- In the primary mirror cell a 9-point Grubb mirror support is used with temperature-compensated lateral support elements. Contrary to certain assertions, this type of mirror mount is used with the correct mirror cell, even with large telescopes. Additional counterweights in the mirror cell are not required.
- The secondary mirror is micro-focused completely without tilting or shifting. The expensive linear ball bearings commonly used are unnecessary. At his place, a simple special design is used by R. Pressberger.
- The focus driving is performed with a computer-controlled motor located behind the secondary mirror cell.
- The centering of the optics can be done sensitive in all directions. We use a self-made optical centering gauge, equipped with laser or alignment telescope. The method we have learned by R. Pressberger.
- The conventional long RA axis with the usual heavy, large and expensive tapered roller bearings does not exist here. Here at all sitting no axle to the fork. The large drive gear is itself a part of the bearing. A strong tension on the hour axis bearing does not exist. The tension is put to good use.
- The axle bearing from the tube and the fork is done with special ball joints (for version 2), which are better then self-aligning roller bearings with respect to the bearing friction. They are DIY and are an invention of R. Pressberger. Some have the ATPM construction already criticized because of the small bearings, so I think they did not understand it.
- The weight distribution of mount and the tube is optimized for low vibration tendency.
- It is driven by two friction wheels made of hardened steel (in version 2). **The rule of Pressberger: drive wheel diameter = primary mirror diameter** is met.
- Friction wheel drives have previously been tried several times, but not always successful. The high and sometimes uneven bearing friction often led to uncontrollable slippage at the friction wheel. The have also noticed those who wanted to copy this design, without understanding them. Only the combination with the special bearings (mentioned above) ensures the desired success.

- The required contact pressure of the drive shaft to the friction wheel in RA is applied of the weight of the fork and of the tube. So the remaining load torque in RA is used wisely. For this purpose is not necessary a compression spring. In declination, the spring force is applied by another elegant design solution.
- Periodic errors practically no longer exist. Using an auto-guider generally not required (at least for the use of digital cameras).
- The backlash on reversal of the direction of motion is negligible in both axes.
- Numerous adjustment elements (eg in the form of pull and push screws) allow precise adjustment of polar alignment of the axes tuning with each other and the driving parts. Both cone errors of the mount are easily minimized by adjusting (unique to version 2 in construction of all astronomical mounts).
- Along with the computer-based **telescope control by Dr. Manfred Stoll**, we are positioning our telescope with an average accuracy of 25 arc seconds over the whole sky. Although the friction wheel slip is not measured and compensated electronically, it is still as accurate. And start from the state without the daily alignment. The tracking accuracy is better than **5 arc seconds**, but not in a short period of time but rather **in a whole hour** (in average). Not only close to the meridian (where it is even better) but in all places more than 30 ° above the horizon. Data without auto-guider and without modeling of mechanical transmission errors (PEC) in the controller. When others claim to tracking with sub arcsec accuracy, forget it.
- The alignment to the sky can be controlled any time with a highly precise doses vial in the powerless state.
- The maximum weight is 15kg for focal-plane instruments at the Cassegrain focus. Changing the focal instrumentation being without affecting of positioning and tracking possible (no change of the telescope model in the software). However, the focal-plane instruments is a demand for precision-crafted.
- On top of that you might as well fast tracking in both axes, for example, NEO's and with an extension of the software also fast satellites like the ISS.
- The best to the conclusion: The whole telescope can even customize the DIY enthusiasts.

15 Credentials

14 telescopes in Austria, 1 telescope in Germany, of which 12 are in operation and 3 under construction (as of 2016): The references refer to mounts of version 1 (worm gear with ball bearings in an unconventional arrangement) and version 2 (friction drive with special Teflon bearings). Often, only the mount for an existing (mostly self-constructed) optical tube was built. 7 astronomical mounts were made with a Cassegrain tube as it was developed by Pressberger. Twice the optical tube was modified: Once there is a camera at the prime focus with optical corrector. In another a Newton telescope tube can be later converted into a Cassegrain. 6 of these devices are powered by the professional GoTo telescope controller by Dr. Manfred Stoll. A reference list at the home-built telescopes is unparalleled:

- **40" RC-telescope** in the Purgathofer Observatory, Klosterneuburg near Vienna (worm gear drive with 1m diameter, Model for all other telescopes) built himself completely alone only by Rudolf Pressberger, finished as version1 in 1978
- **24" RC- telescope** of the university of Innsbruck (worm gear drive, conventional axle bearing on request of the client, built in the workshop of the university observatory in Vienna by Rudolf Pressberger and staff of the institute1996)
- **24" Deltagraph** in Davidschlag observatory (friction wheel drive, tube modified for prime focus camera, build 1998-1999)
- Mount for **60cm Cassegrain/Newton** by Dr. Josef Pratl, build 1994-1998, only equipped with 40cm Newton, Brenntenriegel observatory
- our own **20" RC-telescope** in Harpoint Zell am Moos, Upper Austria (friction wheel drive, build 1996-2000, base of version 2))
- **20" Cassegrain** telescope in Kepler observatory Linz (friction wheel drive, largely identical with our own telescope, build 1998-2000)
- Mount for **20" Newtonian**, built by Michael Mross, Lüneburg Germany (friction wheel drive)
- **20" Cassegrain** telescope by Erich Kowald, private observatory Posiberg in Styria (friction wheel drive, since 2009 in construction, largely identical with our own telescope, under construction since 2009)
- **16" Cassegrain** of Siegfried Müller, Krumbach (worm gear drive, 1987)
- **16" Cassegrain** of Gerhard Sickha (sen), Leitzersdorf (worm gear drive)
- 2 mounts for **16" Newtonians**, built by Erich Kowald, Markt Hartmannsdorf (friction wheel drive)
- Mount for 13" Newtonian by Hans Heinrich Wenk, expandable to **20" Cassegrain** (friction wheel drive, since 2009 in construction)
- **Mount for Celestron C11** tube of Thomas Langthaler (worm gear drive)
- Mount for portable **10" Cassegrain** by Wolfgang Neszmerak, Vienna (helical teeth spur gear – worm gear combination, 1992)

After the publication of this series of articles in German language (10 years ago here on the Internet) in Europe and especially in the German speaking countries friction wheel drives suddenly will appear increasingly on (both commercial as well as DIY). This is certainly not remained hidden from us. Apparently, some people have at least copied some suggestions from here. These people have not mentioned that they were inspired by the Pressberger construction. Of the other design advantages these people have nothing implemented. Partial principles have been applied, which have been rejected by Pressberger. For this reason, these mounts are also not included in our reference list.

Literature

Publications about the construction can be found in the Austrian magazine "Der Sternbote". See the following article (in german only). You'll find a collection of this magazine in the library of the Astronomical Institute of the university of vienna.

- „Mein Ritchey-Chretien-Teleskop 100/890“ (by R. Pressberger) [booklet 6/1978]
- „Selbstbau einer anspruchsvollen Montierung für mittlere und größere Amateurteleskope (30-100cm)“ (by R. Pressberger) [booklet 11/1986]
- „Erste Ausführung der österreichischen Präzisionsmontierung (by S. Müller, Deutschlandsberg ST)“ [booklet 11/1987]
- „Die Purgathofer-Sternwarte bei Klosterneuburg“ [booklet 6/1989]
- „Neues 60cm-Teleskop der Sternwarte in Davidschlag OÖ“ (in a paper by Ing. E Meyer and E. Obermair) [booklet 12/1999]
- „Neues Teleskop für die Johann Kepler Volkssternwarte Linz“ (by Dipl.Ing. Raab) [booklet 1/2001]
- M. Stoll: „Das 1m-RC-Teleskop der Purgathofer-Sternwarte: Seine Mechanik, seine Optik und seine Einsatzmöglichkeiten“, [booklet 5/2005]

Links

- Purgathofer observatory http://www.astronomisches-buero-wien.or.at/ps.htm
  https://de.wikipedia.org/wiki/Purgathofer-Sternwarte
- About Rudolf Pressberger https://de.wikipedia.org/wiki/Rudolf_Pressberger
  http://www.astronomisches-buero-wien.or.at/pressberger.htm
- Metallbau Madlmayr Gramastetten (Manufacturer of telescope in Linz and Davidschlag)
  http://www.mametall.at/html/produkte/sonderanfertigungen.htm
- Johannes Kepler observatory, Linz http://www.sternwarte.at/sternwarte.html
- http://www.langthaler.de/littlebearobservatory/equipmnt/mount_assembly/contents.htm
- Observatory of Michael Mross http://www.starmystery.de/
- Observatory Davidschlag http://www.astrometrica.at/POMOD/telescope.html
- New observatory Uni Innsbruck https://www.uibk.ac.at/astro/observatory/60cm/telescope.html.de
  Image https://www.uibk.ac.at/astro/observatory/images/60cm.jpg
- Observatory Benntenriegel http://www.alrukaba.at/cms/front_content.php?idart=993

DIY concept

The key for the DIY aspects of the design are the following:

- It is achieved optimum precision, without expensive bearings and worm gears and without special procedures, such as "Annealing" or "Milling of bearing seats in one clamping"
- It can be almost anything made basically in the proverbial "home improvement garage". The whole construction is designed for easy DIY.
- Only few parts make high demands on the manufacturing tolerances although as I said, the entire result satisfies the highest demands. These few items could be also customize.
- The plans are available (for serious interested) in the astronomical office in Vienna at cost price. As far as I know, only the plans of the version 2 (ie, the plans of our telescope) issued.
- Modifications to the design should only be made when one is quite sure to understand all the details. Only then can the amendments will also result into a meaningful development of the construction. Examples of such meaningful advancements we have cited.
- The rights to the design are among the descendants of R. Pressberger. You must not use the plans for comercial purposes.
- The construction being documented in detail on our website. Certainly, other proud owners of APTM mounts and complete APTM telescopes will be happy to provide information.
- When you drive the telescope several alternatives are possible. It is both customary for amateurs telescope control with stepper motors provided (in many telescopes from the reference list in use), than use a professional control. A later conversion to the latter is possible in the telescopic mechanism without major changes. The telescope control by M. Stoll is a professional control, which one (like we did) can even develop on its own. Unfortunately, for the computer old hardware is necessary.

A fundamental question: RC, Cassegrain or just a Newtonian?

In a Newton, the tube is just too long for an observatory. Even with an aperture ratio of less than 1:5 it is still too long (the picture quality is then useful only with an additional correction optics). Accordingly, large and expensive must be the observer dome. The focus on the front of the optical tube requires a complex observation stage for visual observations unless one loves acrobatic contortions on a large stepladder. Weighty focal-plane instruments are only balance out with even much heavier counterweights. The top-heavy arrangement is highly susceptible to vibration. Massive heavy machinery with huge diameter bearings are the answer. Which professional astronomer still works with a Newton? Nevertheless Pressberger's APTM even for a Newton is better suited as many other types of mounts. The practice shows it.

The Cassegrain has decisive advantages over the Newton. The tube is forward considerably lighter.The dimensioning of the whole mount is determined by the weight of the secondary mirror, its mirror cell and spider ring and the tube length. The smaller these values are, the thin-walled can be built the mount.

The fork can also be designed so that initially a smaller Newton and later a larger Cassegrain is used (see References).

In contrast to the Cassegrain or Newtonian delivers a coma-free imaging the RC. This allows a better aperture ratio compared to the Cassegrain. Thus, the RC has the shortest tube and requires the smallest protective building. A smaller protective building also helps in temperature compensation of the observatory. Since the optics may even be slightly more expensive. Why are probably 90% of modern large telescopes with RC mirror systems in place?

Sure, you can also a significantly worse Cassegrain design (eg Dall-Kirkham) of the coma free with a multi-lens corrector front of the focus, as well many other image defects (errors) and reflections, however, is on. A largely error-free image in the field of view with only 2 optical reflecting surfaces has been its appeal. If even a lens in the beam path, then only one for flatness of field, which compensate for the field curvature of the RC, which incidentally is only slightly larger than in other Cassegrain types.

Occasionally, it is not recommended acquiring an RC-mirror system. It is claimed he was not or only barely better than the normal Cassegrain. This is a misconception which is always confirmed when an RC installs in a tube that is inappropriate and this then perhaps hang on one side only, as it is the case with the Germans mount or similar mounts. A poorly centered or even tilted RC due to change in position of the tube is in fact optically even worse than a normal Cassegrain. We need there to be afraid when APTM construction.

Not to mention the fairy tale about the harmfulness of the obstruction in the observation of planets. I have never observed planets visual as well as by an RC (with our own telescope and even with that of R. Pressberger). Only the high demands on seeing and temperature balancing of the telescope and dome are unfortunately rarely met. But it is not to blame for the obstruction.

Convertible between Cassegrain and Newton?

Such an approach is the engineering design at the Brenntenriegel observatory (60cm-optics). The main problem encountered in multi-focus instruments, is the Necessary readjustment of the optics after retooling. Hardly such a telescope is constructed, collimation that can be waived. To realign the telescope model of a computerized Goto control and tracking, creates a additional complexity. The result: only one of the two foci is used in practice, the other turns out to be ballast. Wide are significant trade-offs to make: A fork with short fork arms for the Newton faces a fork with long fork arms for the Cassegrain. The Newton requires a low as height for an ergonomically favorable insight which Cassegrain, however a higher mounted tube. At the Brenntenriegel observatory attempts have been made to circumvent the latter problem with a tertiary mirror designed in Nasmith arrangement. Another mirror that may have to be collimated.

Conclusion: I can only advise against it.

Planned as a foreword, an afterword now

Everyone wants to build the ultimate telescope for their own observatory itself and can meet the below requirements, has himself to blame if he builds something else.

You think this is exaggerated speech? You think we are arrogant? I tell you we handicrafts maybe some more than others otherwise we are just normal amateur astronomers. That can not be said of Mr. Pressberger. He was so ingenious, you have no imagination. And not just in optic and mechanics. Unfortunately, he died too early.

10 years ago I started to write this article series and now in the year of death of the great John Dobson, I translate it into his native language. John Dobson has shown all of us that you can build yourself transportable telescopes so that he has founded ATM. Rudolf Pressberger showed me and my friends, you can build yourself stationary telescopes and he gives the ATM comunity a daunting inovation. His publications were hardly observance. I want to change with this article series, honorary. Granted this is peculiarly for our time in each is doing everything to make money. You say money makes the world go round, stupid? Good, then let it be. Others know it can be lots of pleasure to make something with their own hands. Something tangible that comes from you. Not this worthless printed paper which is called money.

Appendix: Requirements

The optics

We want to discourage anyone to grind the optics themselves, but give borne in mind that real experts only themselves should dare there. Rudolf Pressberger has honed his 40" RC-optic itself, and with incredible accuracy. 20" are also not chicken feed. With an opening ratio of 1:3 has massive ablate glass, especially at Pressberger's 1:2.5. In addition to the actual grinding process often necessary optical test at Cassegrain and even the RC is no easy task. The fact remains that (apart from Rudolf Pressberger) no amateur has really successfully honed one RC mirror system. Others have tried it though, but a real RC is not come out. You should try to purchase the mirror. Americans have RCOS but this company does not sell RC mirror systems without telescope. Looks over to russia. There are still ready to buy good mirror sets in certain sizes of LOMO. Even if you only grinds a large parabolic mirror itself is the work expended in no reasonable relation to the cost of manufactured mirror (as of 2000). It asks the following question: Will you get delivered ready ordered a RC-mirror set in half a year or maybe even grind for 3 years on a parabolic mirror around and can then only Newtonian build it? Anyway, we bought the optics simple.

Craft skills

Now comes in a sense the crux of the matter. Welding should be able (in our team, the at least one). And thin iron sheet 1.5mm thickness. The easiest way is by electric welding with a MIG machine (metal inert gas), but also better by TIG welding (tungsten inert gas). For thicker material itself provides the welding with coated electrodes. The thicker plates of the fork and pole block could be welded together by a locksmith, there really can not go wrong a lot.

Usually it can be welded horizontally. The welding overhead does not have to be able. When welding thin sheets of metal a specific procedure or sequence is required so that the work piece after cooling of the weld does not warp hopeless. In wire welding (MIG) a tedious post-processing by grinding the above welds is required in many cases. In TIG welding can usually dispense with a post-processing of the weld.

Other techniques such as electric resistance welding connection points, brazing, gluing, riveting or bolting would also be conceivable. Since we have not used this, there are no statements to us. This is here not a forum where the unsuspecting chat. We want to talk about facts and not give guesses at best. The high precision of optical centering will be permanent only possible with a rigid connection. Furthermore, it should be noted that many compounds are under considerable mechanical stresses, some of them in manufacturing.

All other technical skills of metal and sheet metal processing, the handling of the lathe is easier to learn. Thus, the thin sheets can be cut, for example, with a good DIY jigsaw. The thick-walled sheet metal parts (5mm to 1cm) is allowed to cut and deliver cost by specialized companies with cutting machines. You need to give them only the CAD plans.

Workshop requirements

You not almost everything do yourself (like we did). It is e.g. expedient to produce turned parts up to a certain size with a small lathe itself (which is available in many specialty markets). This makes so even after the completion of the telescope for accessories paid quickly. The large rotary parts such as friction wheels, flange and counterbalance rings and a few more complex machined parts can be safely customize favorable. The following list shows only those requirements are specified, we consider for a successful construction absolutely necessary.

- handheld power tools
    - Hand drills and battery operated screw driver. The latter can be used well for thread cutting in sheet metal
    - Jigsaw with metal saw blades (bimetal) or an electric nibbler for sheet metal processing

- several angle grinders in different sizes with cutting discs, grinding wheels, polishing wheels and wire brushes
- Tool grinder with angle gauge, especially for grinding twist drills
- Belt sander
- Usual hand tools in a small locksmithery such as vise, set of hand files, open-end wrenches, socket wrench set, allen key etc.
- Thread cutting set M3 to M12 and individual fine taps and thread hand file (the English technical term for the German word “Gewindefeile” I could not find). If it is more common in your country, then just UNC / UNF similar-sized.

- Cutting Machine tools

  Most of the lathe is here immediately called and we want to do with it. The peak width is not important, rather it is the peak height. But almost as important is the ability to drill and mill. We're not talking about the small holes you drilled elsewhere in the house. It's about big holes in hard steel. A to clamping four times individually adjustable lathe chuck or a plane disc provides a way to produce large non-concentric drill holes. An angle plate for the support of the lathe (it must be adjustable in height) is the cheapest method to be able to also mill with the lathe and drill. The stability of the tool management is better as with a Burr Attachment to the lathe. With both you are unfortunately limited to small workpieces. A special milling machine is recommended in any case when an entire team is building on the telescope. A second lathe of other size would be for multiple people also appropriate. Now we include it on:

  - Small lathe enables large peak height and equipped with Milling Angle or Burr Attachment (the latter with no particular requirements for accuracy)
  - Instead of the Burr Attachment may notice a small milling machine (desktop). Rudolf Pressberger had a large standing milling machine from bridgeport type.
  - Basic set of lathe tools and end mills for these machines.
  - absolutely necessary is a manual indexing head or a simple rotary table chuck as an accessory for milling machine or geared head drill press
  - geared head drill press (DIY quality) with HSS and cobalt drill bits as well as bi-metal hole saws. Of course you can also use the milling machine to it, but if you are watching a workpiece is clamped at the same time you will often want to drill something else.
  - A small electric metal saw (circular saw hacksaw or band saw)

- Measuring Tools

  - Roll tape measure, callipers 150mm and 300mm, possibly micrometer set 0 to 150mm
  - mechanical dial indicator (distance amplifying instrument) with 10mm measuring range and 1/100mm resolution. This includes a magnetic base
  - Steel squares of different sizes, hair angle
  - Scriber, steel ruler and dividers

- welding area

  Here we will also include all of the options for the home made processing of steel. This you do not have all under control.

  - MIG / MAG gas shielded welding unit (30A to 250A): build-up welding uses a continuous wire feed as an electrode and an inert or semi-inert gas mixture to protect the weld from contamination by oxygen. A gap between the parts to be welded may be present. Handling with a little practice to learn.
  - small welding inverter (5A to 160A) with TIG hose assembly: manual welding process that uses a nonconsumable tungsten electrode, an inert or semi-inert gas mixture, and a separate filler material. The parts to be welded must fit together with no gap. Especially useful for welding thin materials, this method is characterized by a stable arc and high quality welds, but it requires significant operator skill (soulful people with a steady hand).

- Both welding equipment mentioned above are also suitable for the use of coated electrodes. In contrast to simple welding transformer DC power is applied.
- An acetylene / oxygen gas welder is appropriate only in exceptional cases. However, one can hard soldering with it. Quite small appliances using other burning gases.
- Welding shield with electronic dimmer for the arc welding (very convenient)
- Massive welding iron table (as a sample homemade) or work table with a thick sheet metal support
- The room in which the welding is performed, should not contain flammable materials. By welding work already many fires have emerged. So please be careful.

- painting equipment

  Their comprehensive is determined by the desired quality of the paint job. It starts with the simple "coloring" and ends with the professional "car paint". We have there chosen a middle ground.

  - Workshop air compressor (about 120L/min). With a blow gun he is otherwise quite useful
  - High quality compressed air spray gun. With electrostatic spray guns we have not tried it.
  - A suitable area (eg garage) which can be well ventilated. In cold weather, the room must be heated.

- Transport and lifting equipment

  These tools are useful for telescopes from 16"

  - Small pulley or winch, both at the installation location (eg garage) and in the Observatories dome mountable. Looking to our DIY bridge crane on the pictures to. It can be disassembled into easily transportable components.
  - hand truck with wheels to mount the large and heavy items (also used for the mirror assembly), Buy yourself a concrete formwork panel and a couple of wheels and do it yourself.

By the way: Some special tools required for the telescope and mirror assembly are made in the course of the ATM itself. We have special wrench to fasten the main mirror cell and for the adjustment of the main mirror.

Financial requirements

You think you not be able to finance all this? Do not worry the. You do not need everything at once. You can purchase used machines. You can use replica Chinese machines. Much is discoverable with a little patience and a little money on eBay. That's just the trick of the ATPM-construction that only moderate accuracy required by the machines. Find like-minded fans of the ATM you from your local neighborhood. Help each other, each with its own differently styled workshop. The raw material for the telescope is really not expensive. 'll Double what you've saved to buy for the finished RC-mirrors, and you should get along and you have also a nice workshop set. Maybe you can even use your local astronomy club inspire a APTM-project, but you do not expect too much of them. Take it into your own hands and you'll see it goes on.

Psychological requirements

Here are mentioned primarily patience and persistence. If someone wants to have as fast of one day to times its own observatory with a large telescope, then he should beat the DIY from his head. With the purchase of the usual germans mount and the finished telescope of its choice part, it comes faster. Do not be mad make of those people. They believe that they have the best, the best ever and nothing would come close there (some of which even have a mount from Austria). But you have already realized that the commercially available products for amateurs (and no matter how expensive) do not reach the APTM-mount and the APTM-tube, the thing looks different. If you want to DIY do not dare, you still have the opportunity to contact you to those who have already made such a telescope. It may be possible there get into the business and so what can make (though not by us). Then you have to but again, at least have the patience. In the Austrian company “Metallbau Madlmayr” it could go faster. They have already built such a telescope (against the throw small coins, of course). But the management and quality control will that you have to do it yourself.

The Patient and the Tenacious be told: You have a beautiful way to go: Without pitfalls and without difficult to solve problems in manufacturing a beautiful item after another will arise. You'll maybe need a few years of time. Without the uncertainty that after the installation it really works. Just because it works, because it works very well. With this success certainty can be approached much more relaxed on the matter. We know from the very beginning: you build yourself a superior telescope.

Asking for forgiveness if the translation is down a bit bumpy, but that had to be said especially for our American friends once.
