a round piece of wood held in the bench vice. Clean inside both edges, and then rivet the throatplate into one end of it using a few 1/16" or 3/32" copper rivets just sufficient to hold the parts together whilst braxing is being carried out. Note. the throatplate should project 5/32" beyond the edge of the wrapper so as to show the curve, same as the outside cleading on the full sized Jennies; see longitudinal section of boiler. Cut a strip of 16swg copper about 5/16" wide and bend it into a ring $2\frac{7}{8}$" diameter; fit this tightly into the hole in the throatplate. The edges must not overlap, but just butt together.

Boiler barrel

For this you need a piece of 3" OD x 16swg copper tube (seamless) approximately 8" long. Square off one end in the lathe; if an old wheel, disc, plug of wood or anything else suitable is driven into one end, and that end gripped in the 3-jaw, the outer end can be carefully trued up without further support, and no steady-block will be neccessary. The other end is then filed to fit closely to the flanged face of the throatplate, being filed away at top and bottom to butt closely against the flat portion, whilst the sides are left longer to meet the edge of the wrapper. I have included a sketch of this, in the drawing showing the underside of the firebox. Have the joint as close as you can all around. When a neat fit has been obtained, clean the inside and outside of the filed end for about $\frac{3}{8}$" or so, and fit the barrel over the ring of metal in the hole in the throatplate. This will retain it in position when brazing, and afford considerable extra strength to the finished joint, also prevent leakage through 'pinholes' in the brazing. Tip: be very careful to see that the barrel of the boiler, when fitted, is exactly square with the throatplate, and parallel to both sides and top of the wrapper sheet.

How to braze up the Shell Assembly.

For new readers' benefit I might repeat that a suitable brazing pan for Jenny's boiler can be made from a discarded tray, such as an iron tea-tray, with a piece of sheet iron about 9" wide bent to a half circle and stood up in it. A few pounds of small coke or breeze, a blowlamp of not less than 4 pint capacity, or a gas blowpipe of equivalent power, a pair of blacksmith's tongs, and a smaller pair of tongs, some silver solder and flux complete the equipment. The modus operandi is as follows, and "first timers" will see that there is nothing really difficult in brazing up a small locomotive boiler.

Mix up some of the flux to a creamy past with water, and paint it all around the joints between barrel, throatplate and wrapper. Stand the shell up on some coke or breeze in the pan with the barrel pointing skywards, and pile up the coke to within $\frac{1}{4}$" of the throatplate, inside and outside the firebox wrapper. Get your blowlamp going good and strong, and carefully heat up the whole doings until the copper begins to glow red. The bottom of the firebox wrapper should be towards you so that the flame can be directed partly inside and partly out. Now concentrate the flame on theleft bottom corner, and when this glows a bright red, apply a stick of solder (brazing strip). The end of this will immediately melt off and flow into the joint like soft solder, if the heat is right. If it is first dipped into some powder flux before using, it will flow all the easier. Now move the flame along a bit, and repeat the operation. When you reach the barrel, which only takes a minute or two, go right along the joint between barrel and throatplate, letting enough of the brazing strip to melt on to the job to form a fillet. On reaching the opposite side, stop and restart at the other bottom corner of the wrapper, working up as before. This time, when you reach the barrel, turn the whole issue around with the blacksmith's tongs, so that the top of the boiler is towards you. Direct the flame at the point where you left off, then gradually cary on right around the upper half of the joint between barrel and throatplate, and also running some of the brazing strip in the "crack" between throatplate flange and wrapper sheet. Keep on dippin the end of the brazing rod in the flux before every application. Don't hurry the job on any account; make quite sure the melted brazing material has become thoroughly liquid and has penetrated well into the joint at the point where the flame is playing, before you move along to the next stage. As a final touch, lay the shell on its side, and give an extra small dose to the sides of the barrel where they join the wrapper.

Novices may at first experience some little difficulty in getting the spelter, as coppersmiths call the brazing material, to flow smoothly, and the result is a rough-looking joint, the material looking like the results of a volcanic eruption after the lava has settled down to "almond rock"; ; but don't let that worry you any. So long as the joint is sound, which is what matters, all superfluous knobs and excrescences can easily be smoothed away with a file.

When the joints are finished, let the shell cool slowly to black and then carefully pickel it is a solution of one part commercial sulphuric acid to twenty parts of water. (Important - add the acid to the water, not the other way round). Don't let any splashes get on your clothes or overall. I usually hold a discarded rubber bath mat between myself and the pickle bath when dipping a boiler. A lead-lined wood box makes a good bath, or a big earthenwar jar. Leave the job in the pickle for 20minutes or so, then wash in running water and clean up. A handful of steel wool is about the best thing I know for cleaning; alternatively it can be rubbed with domestic scouring powder. Anyway clean it up, because a nice, clean job is nicer to handle for subseqeunt operations, and is also a "safety first" measure, as dirty copper has a bad effect on the cuts and scratches we usually manage to accumulate unknowingly on our hands when using tools and machinery.

If the job has been done properly, you will find that on looking inside the boiler shell, that the spelter has penetrated right through the joints, and is showing at the edge of the throatplate flange and all around the ring joining barrel and throat-plate.

If any reader owns, or can get the use of an oxy-acetylene blowpipe, the job is rendered ever so much simpler. No coke packing is neccessary, and the job can be done with the boiler resting on a firebrick, or tile. Simply start at the bottom corner using a 225 litre blowpipe tip, and Sifbronze welding rod, plus the requisite flux. When the copper reaches the melting point of the rod, drop a spot off the end of the rod into the joint, melt it in with the blowpie, then drip another spot on, just overlapping the first, melt that one in, and "ditto repeato" until you have been right around the whole works. The result is a rippled joint which is far stronger than the original copper. I do all boilers that way now. Pickle and clean off as above.

Firebox and tubes

The firebox is made up exactly the same way as the wrapper. Make or obtain the flane plate as before, and drill out the top central hole 47/64" and ream ¾", drilling the remaining ones 23/64" and reaming ⅜" diameter, countersinking lightly on the convex side of the plate.

To make the firehole ring, obtain a piece of thickwall copper tube - a piece suitable is provided with the boiler kit - 1½" diameter and ⅛" thick and ½" long. Chuck in the 3-jaw and turn a step in the end 1/16" deep and ⅛" long. Reverse in the chuck and turn a similar step 3/16" long, leaving 3/16" full diameter in the middle. Squeeze it oval in the vice, annealing first if the tube is hard; then cut a hole in the backplate of the firebox, known as the doorplate, just large enough to poke the shorter end of the now oval ring through. Note: the top of this hole should be exactly ⅝" from the top of the doorplate. Well clean the ring, push it through the hole from the side opposite flange, and carefully beat the edge of the lip back and outwards (see long-itudinal section of boiler) until the plate is gripped between it and the shoulder.

Get the length of the strip of copper forming sides and crown of the firebox by running a wire around the tubeplate as before. The width is 2⅝". Anneal it, bend to arch shape, clean edges and rivet to both flanges of tube and doorplates, with just enough1/16" rivets to keep closely together; ;note both end plates are sunk for full depth into the arched sheet, NOT left projecting like those on the outer shell.

Crown stays

The crown stays are of the simple girder type which I have found so easy to make and fit, and which ensure the crown of the firebox being firm and rigid.. They are made from 1.6mm copper, 2⅝" long at bottom, 1¾" at top, the flanges being 5/16" side and bent to suit the curvature of crown and wrapper, see cross-sectional drawing). the height is 1.3/16". They are riveted to the crown of the firebox as shown, by four or five only 3/32" rivets of copper spaced 1" apart. See that the flanges are bedded well down on the crown of the box, and extend to the full width over the flanges at each end. The firebox assembly can then be brazed up, following same procedure as given for the barrel and wrapper. Warning - don't let the full force of your blowlamp play on the tubeplate, or instead of a series of tube holes, you will suddenly find you have just one big ragged one. It is very easy to melt out metal between the per-forations. Do the doorplate first, and run a fillet of spelter around the firehole ring; then do the tubeplate, with the precaution just mentioned; finally stand the firebox the right way up, and run in some spelter all along the sides of both crown-stay flanges. It is imperative to the strength of the firebox, that the crownstay flanges are "solid" with the roof of the firebox.

Tubes

The barrel contains 13 tubes, $\frac{3}{8}$" diameter of 22swg and one superheater flue of $\frac{3}{4}$" diameter by 20swg, all 7.11/16" long. After cutting to length, and squaring off the ends, clean both ends of each tube with emry cloth, and insert them in the holes in the firebox tubeplate. The tubes should project into the firebox a bare 1/16".

To prevent them falling down while being silversoldered, make the smokebox tubeplate next and use it as a temporary support. Make or obtain as before, then chuck it in the 3-jaw, flange outward and trim off the ragged edges. Reverse and hold on the inside of the rim - gently - and turn down the outside to a push fit in the boiler barrel. Scribe a line right across the exact centre, on the side opposite to the flange. On this line at 9/32" from the edge make a centredot, and from this the tube layout can be marked out and drilled. A marked plate obtained from the suppliers can be simply drilled as required, holes reamed as for the firebox tubeplate and the holes lightly countersunk on both sides. The smokebox tubeplate may now be put temporarily on the the free ends of the tubes in the firebox tubeplate. This is a provoking job, something like assembling a clock; when you get one in, another comes out, but patience andperseverance conquers in the end. Some folk perfer to put the tubes in, one at a time, right through the smokebox tubeplate into the firebox plate. Anyhow, when they are all in, see that the whole nest is square with the firebox tubeplate, and parallel with the top and sides of the firebox. We are then ready for silversoldering them in.

How to fix the tubes.

Stand the firebox in the brazing pan with the tubes pointing upwards. Brush some liquid fluc among the tubes so that every one has a good dose all around it. This is most important. Now cut up some pieces of silversolder wire into rings - wind it around a 5/16" rod and cut along the "spring" so formed - Easyflo grade no 2 is best, and slip one over each tube right down into the flux and next to the tubeplate. Get a piece of iron wire about $\frac{1}{8}$" diameter and a foot or more long and file a point at one end. Heat the firebox carefully, keeping the flame off the tubes until the box is redhot, then heat the tubes as well, playing the flame partly inside and partly outside the box. Suddenly you will see the solder start to flow, and if the heat is right it will "flash" around every tube. If the flame is then played inside the firebox so as to keep the tubeplate and the ends of the tubes at a fairly bright red, the silver solder will "sweat" right through, and the joints willbe perfect. Should there appear to be any bubbling in the silversolder, scratch the place with the pointed wire, which will break up any bubbles. When the metal has well and truly run, let cool to black, pickle and wash off. Remove the smokebox tubeplate, heat the free ends of the tubes to redness, quench in the pickle and wash those off too.

First stage of assembly.

Cut a piece of 3/16" square copper rod approximately $2\frac{7}{8}$" long and round off one side at each end so that it is a tight "jam" fit between the flanges at the bottom of the throatplate;see drawing of underside of firebox. Clean this well, also the metal at bottom of throatplate, and press it into place. If it won't "stay put", put a couple of 1/16" rivets near the ends to hold it. Note this piece of rod forms the front section of the foundation ring and should be let in slightly, so as to facilitate the flow of the molten spelter into the joint when brazing later ; see sectional drawings.

Clean the inside of the front end of the boiler barrel, also the inside of the top of the wrapper, and the crownstay flanges. Insert the firebox and tube assembly into the shell, slide it forward until the front plate of the firebox comes tight up against the piece of copper rod just put in, and hold it there with a toolmaker's cramp, adjusting the firebox so that it is the same distance each side from the wrapper sheet, see view of underside of firebox. The crown stay flanges should be in contact with the wrapper for the full length; put a clamp over one of them and the wrapper, to hold them in position. Drill three or four no. 41 holes through wrapper and flanges and secure by putting 3/32" copper rivets; the holes outside wrapper should be lightly countersunk, and the rivets hammered flush. If a piece of bar, say about $\frac{3}{4}$" x 1" is held in the vice with a few inches projecting to one side, the boiler can be slipped over it and the rivets pokes through the holes from inside the wrapper, by cutting a V-notch like the end of a distant signal, in a piece of copper strip about $\frac{1}{4}$" long, and jamming the rivet in the notch, which will hold it quite tightly enough for inserting it in the hole. Drill 4 x no. 41 holes through the throatplate, piece of rod and firebox front plate, and put in four $\frac{1}{2}$" x 3/32" round head copper rivets, heads inside the firebox.

Countersink these holes also outside the throatplate, and hammer the rivets flush, but in every case take great care not to damage the copper. Next insert the smoke box tubeplate, and carefully drive it down untilit almost touches the tubes; line them up with their respective holes with a pencil. Being soft, they will move easily to the required position, but don't distort the ends. If care it taken to put the tubeplate in vertically, they won't need much coaxing. Finally drive down the smokebox tubeplate a little further, until all the tubes come through the holes and stand out not less than 1/32".

Expand all the tubes into the tube ends by driving a taper drift into them. Anything with a good smooth surface and a gradual taper will do for a drift; the taper shank of a drill, for example. Otherwise, you can turn a slight taper on the end of a piece of steel rod of requizite size, and polish it. Grease the drift before inserting the drift, tap the end with a hammer, and the taper will expand the tube and force it into tight contact with the hole in the tubeplate. A slight sideways tap will assist in getting it out.

How to braze the smokebox tubeplate.

Stand the boiler, barrel upwards, in the brazing pan, and put a brick at each side of it. Get an old tin lid about 8" diameter, and cut a 3" hole in the middle of it. Put this over the barrel and let it rest on the bricks, then pile coke or breeze in it, all around the barrel up to the level of the tubeplate., Plug the ends of all the tubes with little wads of asbestos string or flock, so that the flame cannot get inside and burn them. Put some of the liquid flux around the ends of the tubes and inside of the barrel/tubeplate joint. Cut some more rings of silversolder and place around the tube ends and carefully heat up the whoe as before until the work glows a dull red and until the solder starts to flow. Use the scratch rod as before if there are any "bubbles". Next direct the flame to a point on the outside edge of the barrel, blowing partly outside and partly on the inside. When this gets to bright red apply your brazing strip, and as soon as it melts and flows in, move the flame along a shade and repeat operation, same as when brazing the outer shell, until you have been right around the circle and there is a fillet of spelter lying between the barrel and tubeplate. The coke in the tin lid will conserve the heat around the outside of the barrel, just where you want it, and is a usefultip.

Remove the lid and bricks; then with the tongs, lay the boiler on its back with the firebox overhanging the edge of the brazing pan. You will probably have to put one of the bricks on the barrel, to prevent the whole bag of tricks from tipping up. Brush a little flux along each side of the crownstay flanges, and lay a strip of silver solder by the side of each, on the side away from the flange. Now play the blowlamp flame upwards, on the outside of the wrapper, until the metal glows red and the flux fuses; then direct the flame partly inside and partly out, so as to heat the flanges and maintain the wrapper at proper heat. As soon as the silver solder melts, direct the flame underneath again, and you will see the silver solder actually "sweat" right through the joints between flanges and wrapper. Apply a little more solder if there does not seem to be enough to make a little fillet. Let cool to black, then carefully dump the lot in the pickle bath. You will now find it is getting quite weightly to handle. Let soak for about 20 minutes, then wash off and clean as before.

Backhead and bushes

If the backhead is now drilled and the bushes turned and fitted, one "major operation" of brazing and silversoldering combined, will finish off general assembly. A drawing of the backhead is appended, giving the location of all the bush holes. Drill the hole for the regulator bush ½", and all the others 5/16". Thus bushes should be turned from phosphor bronze. To make the ¼" bushes (six needed) chuck a piece of ⅜" rod, face, centre, and drill down about 1" with a 7/32" drill. Turn down ⅛" of the outside to a tight fit in the holes in backhead; part off ¼" from the end. Reverse in chuck, grip by the step, slightly countersink the hole with ¼" clearing drill (size F or 6.5mm) and tap with a taper tap held in the tailstock chuck, but do not go deeper than sufficient to start the thread. Finish tapping after final brazing. This will avoid the threads being burned away during the assembly operations. All bushes are made in the same way, varying drill and tap sizes to suit. Squeeze a bush into each hole in backhead as shown.

Measure the distance from the top of the wrapper, and from each side, to the flange or lip of the firehole ring. Transfer the measurement to the backhead and cut the piece out; but cut it a little undersize. Then, if you try the backhead in place, you can file the hole so that when the backhead is erected "for keeps", the lip of the firehole ring comes through the hole. Before finally fitting the backhead, clean the flange and the edge of the wrapper. Then put it in place, and rest the inside of the firehole ring on a steel bar held horizontally in the vice jaws. Beat the projecting lip of the ring outwards and down, until the backhead is firmly clamped against the shoulder of the ring, which now forms a substantial stay between the inner and the outer plates. Hammer the edge of the wrapper all around the backhead, into close contact with the backhead flange; if it won't lie down closely, put 3 or 4 screws in. The must be copper or bronze, not brass which will melt and disappear under the brazine heat. 3/32" round head copper rivets make fine screws. Thread them with a die using plenty of cutting oil, saw a slot in the head with a fine-toothed saw.

The tapped bush for the safety valve on top of the wrapper, and the big one on the barrel for the dome, can next be fitted in a similar way to the backhead bushes, so no special instructions are needed for those.

Foundation Ring

The spaces between the firebox and sides of wrapper, and between door-plate and backhead, are now filled up with pieces of 3/16"square copper rod. Fit the one at the back first, as this is exactly similar to the one fitted to the throatplate; then file little steps at the ends of the two side pieces so that they fill up the spaces perfectly, see drawing of underside of firebox. It is hardley neccessary to add that they should be well cleaned before fitting. About 3 rivets right through shell, firebox and foundation ring sections, at each side and the end, will hold the lot securely in place during the final brazing operation.

How to finish the brazing

Cover all joints with the brazing flux paste; see that the foundation ring is completely covered, and that there are no bare places left around the backhead joint with wrapper. Put a fillet around every bush and around the beatendown flange of the firehole ring. Lay the boiler on its back in the brazing pan. Fill the firebox with asbestos cubes, or broken asbestos (I keep broken gas-fire elements for jobs like these)up to the level of the foundation ring; this will protect the tubes. Pile the coke or breeze all around the firebox also up to the level of the ring. Before starting operations, see that you have all your impedimenta handy, also that there is sufficient paraffin in the blowlamp, or plenty of gas according to what you are using for the job, as it is fatal to stop in the middle of the operation.

Direct your flame first, so that the whole issue is gradually heated up, then concentrate on one corner of the firebox where the sections of the foundtion ring meet, and blow on this until it becomes bright red. First apply a weeny bit of silversolder as a starter, then dip the end of the brazing strip into some dry flux, and apply it to the hot metal in the flame of the blowlamp. In a few seconds it will melt and flow in.

Now repeat operation a shade farther on along, and go right around the four sides of the firebox by similar stages, exactly as described for brazing the wrapper and barrel. When you arrive back at the starting point, take the boiler out of the brazing pan, then quickly stand the two bricks in it, with the tin lid used for the smokebox on top of them. Pop the boiler barrel through the hole and quickly put some coke around the firebox almost to the level of the backhead, then start with the blowlamp flame on one of the bottom corners, and work your way around the whole seam as described.

Next play the flame on each of the bushes, and when a red patch shows all around, touch the side of the bush with silversolder, which will "flash" round in a neat fillet exactly as it did around the tubes; the firehole flange is similarly treated. Lastly take the boiler out of the hole in the lid, remove same with bricks, stand the boiler right way up in the pan, and play the flame direct on the safety valve and dome bushes in turn, applying silversolder to each. Let the whole job cool to black, and very carefully indeed, put it in the pickle. Mind the splashes, as there is usually a bubble-and-squeak effect as the acid goes inside the boiler through the bush holes. Leave the boiler in the pickle for about half an hour, then wash thoroughly inside and out in running water, and clean it up.

Smokebox.

For the purpose of making the drawing more comprehensive, I have shown the boiler with smokebox attached; and although we usually finish off the boiler altogether before tackling the smokebox, the latter might be made now for the sake of convenience in describing. The barrel of the smokebox is a piece of 1.6mm brass tube, $3\frac{1}{8}$" outside diameter, and 1.11/16" long, one end being turned off square-edged in the lathe ,and the other rounded off as shown in the section. Over this is fixed an outer wrapper made from a piece of 1.6mm sheet brass bent to the shape in the front view, and attached to the shell by 3 or 4 small countersunk screws near the bottom. This wrapper is 1.11/16" wide, and the distance between the bottom edges when assembled is $2\frac{7}{8}$" so that it fits between the inside frames and takes the place of a saddle. The wrapper overlaps the front of the barrel by 1/16".

The smokebox front is a piece of similar metal cut to fit exactly inside the edge of the wrapper. Cut a hole in the centre $2\frac{3}{8}$" diameter. Bend a piece of 3/16" square brass rod into a ring a full 3" diameter (OD), butt the ends together and silver-solder the joint. A casting is available as an alternative which requires simple machining all over. It should be a fairly tight push fit inside the smokebox shell. Put the ring in the front of the smokebox shell, then put the front in place and secure the front to the ring with a dozen or so 8BA screws. When the front is pulled out, the ring comes with it, and it can be removed and replaced at any time as may be neccessary.

The smokebox door is supplied as a casting,with a turning spigot on the convex side. Hold by the spigot and face across the back flange and carefully skim down the outside to 2.9/16" diameter which is just enough to hold in the 3-jaw, spigot outwards. Do this holding on the extreme edge, centre the spigot and drill and ream through $\frac{1}{8}$" diameter. Hold a tailstock centre carefully up against the hole as a support and very carefully skim machine, or file the convex (outside) side of the door front as close to the periphery as you can. If you use a file, take two important precautions. Have a handle on the file and take care not to run the file into the chuck jaws. If the latter happened and you did not have a handle on the file, you would next have a quick trip to the local hospital for emergency treatment on a damaged hand and wrist. The spigot could just be trued up and reversed once more in the 3-jaw and the remainder of the rim blended in to desired shape. Reverse in the chuck for the last time, being very careful not to mark the rim, saw off the bulk of the spigot, and very gently face off and again blend in with a smooth file to the door shape.

Most of these old engines had a simple hinge on which the door was hung, and the drawing shows just such a one. It is made from 0.9mm metal, the larger part having a notch filed in the centre; and the strips of metal above and below the notch bent into loops witha pair of small roundnose pliers. The other part is merely a short bit of similar metal just fitting in the notch,and the end of it is bent to the same radius as the upper and lower loops, a pin through all three loops forming the pivot. The larger part of the hinge is screwed or riveted to the door and the smaller to the front plate.

The fastening is very simple. Apiece of $\frac{1}{8}$" x $\frac{3}{8}$" BMS approximately 3" long is supported across the centre of the door opening by two little brackets bent up from 1/16" x $\frac{1}{4}$" BMS strip, and riveted or screwed to the inside of the front sheet as shown in the section. The screw is turned from 3/16" round rod, $\frac{1}{2}$" long under the head, and threaded 5BA, a hole being drilled and tapped in the cross-bar to suit. A piece of 3/32" wire, rounded at the end is screwed into the head to form a handle.

How to stay the boiler

The arrangement of the staying of Jenny's boiler is pretty much the same as I usually specify for the boiler of a modern $2\frac{1}{2}$" gauge engine, two longitudinal stays giving adequate end support, whilst the flat sides of the firebox and wrapper are looked after by a good supply of copper staybolts. Although the firebox shell, like that of the Belpaire type, is bigger than the boiler barrel and has a separate throatplate, no cross-stays will be needed, as the round back of the casing is self-supporting by reason of its shape.

One long stay is solid, and the other hollow. To make the first, cut a piece of 5/32" drawn phos.bronze rod to a length of10.5/16" and screw each end 5/32" x 40, holding in the 3-jaw and using the tailstock dieholder, as the threads must be true. There should be no internal stresses in the stay rod. Use plenty of cutting oil when threading bronze to avoid torn threads, another vital point in stay-rods and bolts. The stay is secured by a blind nipple at each end. To make these chuck a piece of 5/16" hexagon bronze in the 3-jaw, face, centre and drill down 5/16" deep no.30 and tap 5/32" x 40. Turn down $\frac{1}{4}$" of the outside to $\frac{1}{4}$" diameter, thread $\frac{1}{4}$" x 40 and part off at $\frac{3}{8}$" from the end, reverse in chuck and chamfer the hexagon. Screw one of the nipples on to the stay rod about 3 threads and poke the rod through the left hand hole in the backhead, marked "for stay nipple" on the drawing of the backhead. Screw home the nipple, guiding the stay rod through the corresponding hole in the smokebox tubeplate, by means of a bit of thin tube placed over the end. When the nipple is right home the stay will project a couple of threads beyond the hole in the smokebox tubeplate, which is drilled and tapped same as the one in the backhead; screw on the other nipple, the outer threads of which will engage in the threads in the tapped hole, and when the nipple is screwed right home, the whole lot will be locked solid.

The hollow stay carries steam from the blower valve on the backhead to the jet in the smokebox. Cut a piece of 3/16" x 16wg copper tube to a length of 10⅝" and screw one end only 3/16" x 40. Note: it is essential that this tube is thick enough to take a thread without apperciably weakening it; it won't be much use for staying purposes if the thread cuts it deep enough to cause breakage!

To make the "thoroughfare" nipple which forms the connection between the hollow stay and the swan necked jet pipe in the smokebox, chuck a piece of 3/8" hexagon bronze, turning down ¼" to ¼" diameter and threading ¼" 40. Face, countersink deeply with a centredrill; part off at 11/16"from the end. Reverse in the chuck and grip by the hexagon with a full ¼" projecting. Face, centre and drill right through with no 40 drill, open out the end no. 13. Turn down ¼" to 5/16" diameter and thread 40 tpi. Drive this on the plain end of the hollow stay and silversolder the joint.

Drill a 9/32" hole in the smokebox tubeplate, corresponding to the 3/16" tapped hole on the backhead and tap 5/16" x 40. Insert the hollow stay through this, guiding the screwed end of it to the 3/16" tapped hole in the backhead by means of a long piece of stiff wire pushed into the bore and screw the lot home. As the threads on the outside of the thoroughfare nipple engage those in the tubeplate, the threads on the other end of the stay tube will engage with those in the tapped hole in the backhead; and when in due course the blower valve is screwed on to the projecting threads, the whole lot is made perfectly secure.

Firebox stays.

The staybolts in the firebox should be made from good quality copper or phosbronze rod. Do not use brass as electrolytic action will take place and after a time damage the threads within the waterspace and neccessitate considerable repair, or even a new boiler. (note. Monel metal is a very acceptable alternative). The stays are 1/8" diameter, 32 are required, the threaded part of each being ½" long,so first cut off four pieces each about 4" long. Chuck with about ⅝" projecting from the 3-jaw and using plenty of cutting oil, thread 5BA, again with the tailstock holder. Reverse in chuck and repeat operation on the other end, and ensure that the threads are perfect.

Mark off the position for the holes on the outside of the firebox wrapper as shown in the longitudinal section of the boiler. Drill clean through both plates with no.40 drill, again using a little cutting oil to prevent drill flutes clogging. Each pair of holes inner and outer now has to be tapped 5BA with a stay tap which has a pilot on it ensuring that the threads are truly cut, but try not to cut into the inner plate farther than the lead of the tap, thus ensuring that the thread is "tight" in the inner wrapper plate. Tight threads in the inner wrapper are a good insurance against leaky stays, should the water in the boiler be allowed to get too low at any time.

Clamp a tapwrench in the centre of one of the pieces of screwed rod, and pass into the threaded hole until the end of the thread butts up against the wrapper sheet. Cut off the rod leaving about ⅛" sticking out from the wrapper. Put a commercial 5BA brass nut (half nuts for this purpose are available) on the projecting part of the stay inside the firebox and tighten carefully. Don't strip the thread on the soft copper, nor distort the plate. A simple box spanner for tightening the nuts can be made from ¾" of 5/16" copper tube. Put a nut in one end and hammer down the tube on to it so that the tube end is hexagon shaped. Drill a 3/16" cross-hole in the other end and insert a bit of rod. If the nuts are tightened up with this contrivance, you won't stand much risk of damaged threads or distorted plates, because the soft copper of the box spanner will "give" and allow it to slip round the nut at the point when the nut is sufficiently tight.

When the eight screwed ends are all inserted and snipped off, chuck the "beheaded" pieces of rod again, thread them afresh and repeat operations till all 32 stays are inserted. Then put a piece of steel bar in the vice with a few inches projecting from the side of the jaws. Slip the firebox over this so that the stay ends inside the firebox rest on it; then very carefully hammer over each snipped-off stay head on the outside of the wrapper to a neat rounded cup-head, which can be finished off with a rivet snap if neccessary. This operation will also burr over the portion of stay projecting through the nuts inside the firebox, and will form an effective lock. The nuts should then be given a final test to see if the riveting over process has loosened any of them, and the process of staying is complete.

How to sweat up the stays.

If the stay threads are perfect, the holes tapped correctly and the nuts locked up properly against the firebox plates, they should be steam-and-water-tight without any further treatment, but for safety sake, to eliminate any likelehood of leakage due to a torn thread, or poor fit, soft copper being tricky stuff to work on, it is advisable to sweat over all the heads and nuts with soft solder, but not the ordinary solder but a high melt temperature grade, such as "Comsol". For this job you need a small soldering bit, preferably hatchet shape; some liquid flux of the correct type for the "Comsol". Make a little wire brush from a bundle of thin iron wires put in the end of a piece of tube and its end flatted to grip them. Have a stick of solder handy and you are all set.

First brush over the stayheads and nuts with the flux, then lay the boiler in the brazing pan and heat up with the blowlamp or blowpipe, to the melting point of the solder, so that if the stick of solder is applied, a little blob of it will melt off. You can either do this to all the heads of the nuts, or apply blobs of solder with the bit. Keep up the heat with the blowlamp and brush on some more flux; then if the solder does not run around the heads and nuts of its own free will and accord, as the flux is applied, help it to do so with the heated bit, directing the flame of the lamp on the job meanwhile. By this means you can ensure that every head and nut is truly sweated and the melted solder sealing every nook and cranny. The blind and thoroughfare stays should be given a dose of the same medecine and when all are done let the boiler cool until the solder sets, which will be indicated by its going dull, then well wash it inside and out with running water. Scrub well with an old nailbrush or similar to remove all traces of the flux, and clean up the copper with steel wool.

How to test the boiler.

The boiler should now be given an hydraulic test for pressure, and for this purpose you will need a small pump -- an ordinary tender hand pump will do -- and a pressure gauge, of which commercial ones reading up to 300 psi are readily available. Do not be tempted to use one of the small model pressure gauges for this job as you will damage it beyond repair. Plug up all except one of the holes in the backhead. Close the dome hole by putting a piece of rubber over it, cutting a disc from an old inner tyre; or a disc of any good jointing material will do in lieu. On top of this put a piece of wood, and clamp it down by a wooden bar across it, attached to a smilar bar under neath the boiler barrel, the ends secured with long bolts, or lengths of screwed rod with nuts at the ends. Connect your pump to the unplugged bush hole by a suitable adaptor and a bit of pipe; fill the boiler with water through the safety valve hole, then connect the pressure gauge to that with another suitable adaptor. Pump water in until the gauge registers 60 lb/squ.in and then examine the boiler for leaks and bulges.

If all is O K. the pressure can be gradually raised to 160 lb. the boiler being examined at, say, every 20 lb. increase to see if anything develops. There should be no bulging between the stay nuts in the firebox, nor on the outside wrapper; but if the crown of the firebox moves slightly, this is all in order; it will only be the soft copper settling itself between the girders to the position in which it can best withstand pressure. After say, 1/32" of movement, it will stay put. Leave the full pressure on for about 10 minutes, and then if all is still tight and square, you can pass the boiler O. and let the water out. To reassure novices who may be scared their first attempt may "go off with a bang", there is not the slightest danger in testing a boiler with water pressure. If the boiler gives out, which it certainly won't, if the instructions have been faithfully followed, even though the work has been done by the rawest recruits -- the worst that could happen would be an escape of water at the defective part without any explosion, or indeed any sound whatever. There is no need to test the boiler beyond 160 lb., which is double the working pressure of 80 lb., and gives a perfectly safe margin.

Boiler fittings - Regulator

The regulator is a simplified version of the old slide pattern, at one time practically universal on all domed engines and still favoured in modernised form on many locomotives of the present day, when the dome is big enough to accomodate it. A casting is not neccessary though one is provided. File it square over three sides, the one with the recess being machined square. Chuck in the 4-jaw lengthwise and face, centre, and drill a 5/32" hole 2" deep. Tap the end 3/16" x 40 for a plug. On what will be the working face - with the recess, at ¼" from the bottom and dead in the middle of the ½" raised portion, drill a blind hole no 30 x ⅛" deep. If you are unlucky and break through into the central hole, don't worry; pen out the hole to 7/32" tap it ¼" x 40, screw in a plug made from bras rod, file off flush and drill a fresh blind hole in the plug.

At ¼" from the top on the centreline of the ¾" face, drill another no. 30 hole, and this time go into the centre one. This is the "entrance to the way out" for the steam leaving the boiler. Then mark off, drill and tap the four hoes for the pins which guide the valve. The upper pair are located 3/16" from the top of the column, and 5/16" full apart; the lower pair are exactly underneath them at a distance of 5/16". Be careful toput the drill square with the face. Drill no. 54 and tap 10BA.

At ¼" from the bottom on the other side of the stand, drill a 7/32" hole into the central passage, and tap ¼" x 40 for the steam pipe. Then round off the corners of the stand on this side, as shown in the sketch, to make room for the inner dome to pass between the stand and the dome bush. Face off the working side of the block, exactly as you faced the stand for the mechanical lubricator, by rubbing it on a piece of fine emerycloth on a flat surface. Make four little studs each 7/16" long from 1/16" stainless steel;screw them into the stud holes. Finally make a 3/16" x 40 plug with a hexagon head, and screw it into the tapped hole in the top of the stand.

Valve, link and crank

The valve consists merely of a 1" length of ⅛" x ¼" brass rod. Drill and tap a hole 7BA at a distance of ⅛" from the bottom; and ½" above this drill a no. 30 hole. Round off the bottom as shown in the drawing, and face one side truly as given above. The link is a piece of 3/32" x 3/16" flat brass with a no. 41 hole in each end. It is set over as illustrated, to clear the regulator rod when the valve is in its lowest position, and the distance between centres of the holes, viz., 1.5/32" is measured after the link is bent to shape. Round off the ends with a file. The crank is made from ⅛" x ¼" brass rod, filed to shape shown½ It has a ⅛" square hole, to fit the squared portion of the regulator rod; this can either be drilled no 32 or ⅛" and filed out square with a needle file, or punched with a piece of ⅛" square silver steel which has been hardened and ground off truly. Drill a no. 48 hole and tap it 7BA at a distance of 3/16" from the middle, or square, one.

Assembly and erection.

To assemble the regulator, put the valve between the pins in the position shown in the drawing; then make tow little bridge pieces from hard, springy brass or bronze. I find the hard bronze spring from dynamo and motor commutators just right for this sort of job. It can be cut with small snips and easily drilled. These flat springs are placed across the valve as shown in the end and plan views, and secured with brass nuts.

Turn up two screws from rustless steel to a diameter of 3/32" and a full ¼" under the head. Put ⅛" of thread only 7BA to suit the tapped holes in crank and valve. Part off to leave about ⅛" of head which can be slotted with a saw. Attach the crank to the curved end of the link, and the straight end to the tail of the valve. Note: the screws should go in tightly up to the end of the thread, so that the crank and the link work on the plain part and are perfectly free, yet the screws cannot come out and drop into the boiler when the engine is at work.

The regulator is held in place in the dome by two brackets. These are made from ⅜" x 1/16" brass strip, and are about 1⅝" long. Bend to obtuse angle and about ⅞" from one end; and right at the end of each solder a thickening piece about ¼" square. About 3/32" ahead of the centreline of the dome bush, and about 5/16" from where it enters the boiler barrel, drill a no 41 hole each side into the boiler, and countersink it. Hold each bracket in place with your fingers and mark off with a scriber through the drilled hole, the position of the tapped hole in the thicknd part of the bracket, to take the screw.

Remove bracket, drill and tap 7BA, and also drill 2 x no. 41 holes in the vertical part of each bracket, filing off any burrs. Replace brackets down the dome hole, and secure by countersunk brass screws through the holes in the barrel, as shown in the back view of the whole assembly.

Next put the regulator stand between the brackets; adjust until the stand is locatedso that the rounded edges are a full 1/16" from the inner edgeof the dome bush and the nuts on the guide studs are clear of thehbush. The top of the stand should be 1.9/16" above the boiler barrel. Put a toolmakers cramp across the lot, to hold the stand in place, and then poke the no 41 drill through the holes in the brackets making countersinks on the sides of the stand. Remove stand, and drill the marked spots no. 48 and tap 7BA. The stop pin must be fitted before putting the stand back "for keeps". Push up the valve until the steam port in it, lines up with the other port in the stand, which is of course "full open" position. Now make a mark on the side of the valve right up close to one of the top pins; either side will do. Remove valve, drill a no.55 hole, tap it 10BA, and screw in a stub of 1/16" rustless wire. Give the valve another rub on abrasive cloth to make certain the face is still true and replace the valve. When the regulator is open, the pin in the valve catches the upper guide pin; and to shut off, the handle on the footplate is moved until the stop pin catches the lower guide pin, when the blank part of the valve is well over the port in the stand. This arrangement entirely does away with the need for ugly great stops on the backhead, which I detest, as neat footplate fittings are one of my fads! The complete assembly can now be placed between the brackets, and secured with four brass screws; the crank will, of course, be hanging loose from the link as we have no rod as yet.

Rod, gland and handle

The regulator rod is a piece of 5/3" rustless steel, 7.11/16" in length, with ⅛" of one end turned down to ⅛" diameter. Directly behind this file a ⅛" square of the same length. As novices and tyros seem to get in a fearful tangle when filing squares on rods, here is a simple way to do it. Chuck in the 3-jaw with as much projecting as you need for the squared portion. Place no. 1 jaw vertically, and file a flat on the bit of exposed ord. Turn the chuck a quarter turn, so that the jaw points to three o'clock and file another flat; repeat at 6 and 9 o'clock positions, and there is your square, all nice and even. Use a fine file with a plain or "safe" edge (term in general usage is a "hand" file) which should be kept pressed against the jaws whilst filing.

Reverse the rod and turn down the other end to .087" diameter and thread it 8BA, then file another square as above. Chuck a bit of 5/16" brass rod, face, centre, drill no. 23 for about 3/16" down and part off a slice 5/32" wide to form a check collar. This should be a tight sliding fit on the regulator rod.

To make the stuffing box, chuck a bit of ⅝" round brass, face, centre, drill down about ½" with no. 21 drill. Turn down 5/16" to ⅜" diameter, and thread ⅜" x 32 to suit the boiler bush. Part off at 7/16" from the end and re-chuck the other end in a tapped bush held in the chuck. Open out the hole to 5/16" depth with a 7/32" pin drill to ensure concentricity with the pilot hole and tap ¼" x 40. Face end to remove burr. Turn up a ¼" x 40 gland from hexagon ⅜" brass; chuck in 3-jaw, face, centre drill down about 7/16" depth with no. 21 drill, turn ¼" to ¼" diameter and thread accordingly and part off ⅜" from end. Reverse in chuck (tapped bush) and face off any burr.

Put the collar on the regulator rod about ¾" from the end which is screwed 8BA, then insert the other end through the regulator bush on the backhead. It requires a little judicious wangling to get the squared end through the hole in the crank and the turned end into the blind hole in the regulator stand, but it is much easier than one would imagine, as you can see what you are doing through the dome bush. When they are in place, put the stuffing box over the end of the rod and screw it home, which will force the collar along the rod to the position shown in the drawing of the whole assembly. Take the rod out again, push the collar 1/32" further along the rod so as to allow that much movement for expansion and freedom of working, drill a no. 53 drill through collar and rod and force in a 1/16" rustless steel pin. The whole lot can now be replaced, and the stuffing box screwed home with a thick oiled-paper washer, or a ring of 1/64" jointing between flange and bush. Pack the gland with a few turns of graphited yarn.

The handle can be made from a bit of ½" x ¼" BMS. I usually solder the rod on a brass disc, chuck in the 3-jaw, and turn away the metal to form the thin part of the handle, leaving a boss at the middle full thickness. This is square-holed in a similar manner to the crank. The grip is turned from 3/16" rod, leaving a pip on the shank end, drill a hole in the flat part of the handle to suit the pip, push the latterthrough and rivet over. The complete handle fits over the squared end of the regulator rod and is secured with an 8BA nut. Moving the handle anti-clockwise lifts the link, which in turn slides the valve over the portface and brings the hole in the valve into line with the hole in the portface, thus letting steam pass to the (cylinders

Steam pipe and flange

The steam pipe, or dry pipe as they call in in the U.S.A., is a piece of ¼" copper tube 3.5/16" long screwed ¼" x 40 at each end for ¼" and 3/16" lengths respectively. Smear a little plumber's jointing on the threads and insert the shorter end through the hole in the smokebox tubeplate entering it into the tapped hole athe bottom of the regulator column and screwing it home. This is easily done by inserting the end of a round file in the bore. To make the flange, chuck a piece of ¾" brass rod, face, centre, drill down ½" with 7/32" drill and tap ¼" x 40. Turn down 3/16" to ⅜" diameter and thread ⅜" x 40. Turn down another 1/16" to ½" diameter, then part off ⅜" from the end. Reverse in chuck, and skim off any burring, then put a little plumber's jointing on the external threads and screw the fitting on to the end of the steam pipe. When the external thread meets the hole in the tubeplate it will engage as the threads are the same pitch and when the ½" part is screwed right home against the tubeplate, whole lot is locked solid, same as a "thoroughfare" nipple.

Dome cap

The barrel part of the inside dome is made froma 2" length of 1" x 16swg copper seamless tube. Square off both ends in the lathe, then turn up a disc of ⅛" brass a drive fit in one end. Turn up a ring of brass or bronze 1⅜" diameter (the dome bush casting had an extra thickness of metal on it to allow for this ring) and put it on 3/16" fromthe open end. Silversolder the two joints at one heatng. Pickel, wash and clean up, then drill 8 holes no. 41 equi-distant around the flange. Drill a 5/3" hole in the top ⅛" off-centre and tap it 3/16" x 40. Make a plug from ¼" hexagon brass to suit similar to the one in the top of the stand. Put the dome cap in position over the regulator, noting that the oil hole is immediately over the valve; fun the no.41 drill through the holes in the flange again making countersinks on the flange of the dome bush, drill these no 48, and tap 7BA. The dome cap can then be replaced with a 1/64" jointing ring between it and the flange, and the whole issue secured with 7BA screws, or studs and nuts.

Superheater.

This component, the benefit of which the big Jennies never had a chance to enjoy, is one of my usual spearhead type. Two pieces of ¼" seamless copper tube are required, one 8" long and the other 11". Bend one end of each to an angle as shown in the illustration, filing the bent-over part parallel with the straight part, so that when the two sections are placed with the open ends together, they form a spearhead as shown. Tie in position with a bit of thin iron wire, put a touch of flux (Sif-flux) on the joint, and braze with brass wire and if the heat is right (bright red) it will seal perfectly, practically as strong as the tube itself. Put enough brass on to make the joint sound, but don't overdo it and block up the bore of the tube. At the same time heat both tubes to full length for softening them for bending the ends. Quench out in acid pickle, wash in water and clean up. Make sure that water will run through freely before passing the job as O.K. A blockage in the tube will seriously affect the working of the locomotive. Bend up the shorter tube into a fairly short radius bend, and form the longer end into a swan neck.

To make the header, or "Wet" flange, chuck a piece of rod similar to that from which you turned the steam pipe flange, face, centre, and drill down about ¼" with 7/32" drill and part off a bare ⅜" from the end. Drill a 5/32" hole in the thickness of this flange, right into the blind hole in the middle, and enlarge it to about ⅛" depth to take the short end of the superheater element. Also drill 3 no. 40 holes for screws, about ⅛" from the edge, equidistant as shown in the smokebox view. Make a ⅜" x 32 union nut from ½" hexagon brass rod, and put it over the swan neck, then turn a copper or bronze coned nipple to fit inside the nut and fit it to the end of the pipe. Put the flange on the short end, with the hole in it towards the back of the superheater, and silversolder both flange and union cone at one heating. Insert the spearhead into the ¾" flue in the boiler barrel and secure the header to the steampipe flange with 3 x 7BA cheesehead screws as show, putting a 1/64" jointing washer in between -- and DON'T forget to punch a hole in the middle!!

Pipework in the smokebox.

Whilst on this end of the job, we might as well make the rest of the smokebox pipes, so that all will be ready to hand when the boiler is erected on the frames. The blower pipe is merely an inverted swan neck of ⅛" tube, with a ¼" x 40 union nut and cone at one end, and a weeny nozzle on the other, this being made just like a union nut with a deep chamfer at one end and drilled no. 70. It screws on the end of the pipe, see illustration. The union is screwed to the thoroughfare nipple on the end of the hollow stay, and the little jet nozzle is set alongside the blast nozzle so that the steam is blown up the chimney.

The blast pipe is a $2\frac{3}{4}$" length of 5/16" x 22swg copper tube, screwed 5/16" x 40 at both ends. It is screwed into the exhaust hole in the cylinder block, passes through the bottom of the smokebox, and has a cap on it made like a union nut. As no two engines are exactly alike, and the best size of nozzle to suit any particular engine can best be found by test on the road, drill the nozzle $\frac{1}{8}$" for a kick off. How to adjust will be described later, all being well. The pipe should be softened, so that it can easily be bent to line up with the chimney.

The connection between superheater and cylinders is a piece of $\frac{1}{4}$" copper tube of 22g., and approximately $1\frac{3}{4}$" long, with one end screwed 40 pitch to match the steam inlet in the cylinder block. The upper end carries the female part of the superheater union, which is silversoldered to it. To make this, chuck a piece of 7/16" hexagon rod, face, centre deeply, drill down 5/32" for a depth of $\frac{5}{8}$". Turn down 5/16" length to $\frac{3}{8}$" diameter and thread 32 pitch. Part off at $\frac{1}{2}$" from the end, reverse in chuck and open out the hole with a $\frac{1}{4}$" drill for $\frac{1}{4}$" depth to fit on the pipe. The silversoldering operation will soften the pipe so allowing the union nut to fit between the smokebox front and the blastpipe.

Safety valve.

Jenny's big sisters had spring balance safety valves in a very ornate column over the firebox. We retain the column but inside it put a modern direct acting valve:To make it, chuck a piece of $\frac{1}{2}$" hexagon bronze leaving about $1\frac{1}{2}$" projecting. Face, centre and drill down $1\frac{1}{2}$" depth no.14 drill; open out with a 11/32" drill and bottom with a "D" bit for $\frac{7}{8}$" depth. Tap $\frac{3}{8}$" x 32 for about $\frac{1}{2}$" depth. Turn $\frac{3}{4}$" of the outside to $\frac{1}{2}$" diameter, and part off 1.5/16" from the end. Reverse in chuck, turn down 5/16" length to 5/16" diameter, and thread 26 picth to suit the bush in the boiler. Poke a 3/16" reamer through the remnant of the no. 14 hole.

Seat a rustless steel ball on the hole inside the casing by the usual "biff"; chuck a bit of $\frac{1}{4}$" brass rod, turn down $\frac{7}{8}$" of it to 3/32" diameter and part off 1" from the end. Reverse in chuck and countersink the blob on the end of the thin spindle with a centre drill to form a socket for the ball. Skim down the outside to a shade over 7/32" to give the steam plenty of room to pass by.

Chuck a bit of $\frac{3}{8}$" brass rod, screw about $\frac{3}{8}$" length with 32 pitch, face, centre and drill down $\frac{3}{8}$" depth no. 40 drill, and part off $\frac{1}{4}$" from the end. File two nicks at opposite sides of the diameter as shown, to let the steam escape freely from the column. Alternatively you could drill four holes in the column itself, just below the nipple, instead of slotting it, as the outside casing completely covers the valve and the effect of the steam escaping from the top would be just the same as with big Jenny's balances, noise and all complete. (Note: more recent thoughts on boiler safety introduced long after LBSC penned these notes, indicate that it would be as well to drill the four holes as well as the 'nicks', to allow sufficient escape of steam in emergency situation, ie. with blower full on and loco unattended for any reason). The spring is made from 22swg stainless wire wound around a 3/32" former rod, or alternatively a commercial spring $\frac{1}{8}$" bore could be used. The spring should be of such a length that it just starts to compress as the nipple threads engage with those of the column. The valve can be set later on, when the boiler is in steam, by adjusting the nipple so that steam pressure lifts the ball when the needle of the steam gauge reaches 80 lb. mark.

Backhead fittings

I have a deep-rooted antipathy to the word "model" and one of the reasons can be found in so-called"model-makers" catalogues which were issued up to the date of the latest paper restrictions (c.1942)! The "Scale Model Boiler Fittings" portrayed therein might well have been the type Noah would have used if he had installed a boiler in the Ark! Water gauges with huge, ugly mountings, tiny waterways through same, and plug cocks which either leaked badly or stuck fast: also huge square bodies check valves or clacks, with a tiny ball which invariably leaked and a plug cock between it and the boiler spigot, the whole presenting the fine example of the old saying that "Two wrongs do not make a right", as water invariably got past both cock and ball. Angle valves with ungainly square bodies, unions, elbows, and tees similar to those used on domestic gas fittings, and various other specimens of "ancient history", com pleted the range offered. (Note; Fittings offered in 1982 are very much more acceptable, and most commercial ones are now based very closely on LBSC's ideas.)

It might be supposed that as our Jenny is a more or less ancient sort of locomotive this brand of fittings would be suitable for her, but I very sincerely hope that nobody runs away with THAT idea! Jenny might be ancient to look at but you can compare her to a modern film star dressed up in a crinoline, inasmuch as she is quite up-to-date under her old-time exterior (witness the mechanical lubricator and superheater) and it would be useless to mis-adorn her boiler with any of the above mentioned monstrosities. We therefore depart from "period" as far as the backhead is concerned, and provide her with a set of fittings of the type I always specify for a modern locomotive, in the interests of efficiency.

Water gauge

To enable a small water gauge to give correct indication of the level in the boiler, the pasaageways must be as large as the mounting will allow, and this condition is fulfilled in this sketch. It may be made from castings, or built up from bronze bar. For the bottom fitting, a piece of $\frac{3}{8}$" rod, $1\frac{1}{4}$" long is needed, chuck, face, centre drill, drill about $\frac{5}{8}$" deep x no. 48, open out no. 30 and bottom with a $\frac{1}{8}$" "D" bit to $\frac{3}{8}$" depth, and then tap 5/32" x 40 taking care not to damage the seating formed by the "D" bit. Face off any burrleft by the tap, and slightly chamfer the edge. Reverse in chuck, face, centre, drill down $\frac{3}{4}$" depth with no. 30 drill. This hole will break into the first one. Turn down $\frac{1}{4}$" of the end to $\frac{1}{4}$" and thread 40 pitch.

At $\frac{3}{8}$" from the shoulder, drill a 3/16" hole from the side of the piece, into the central passageway; and at 5/16" further along, and diametrically opposite, drill another, 5/32" diameter into the tapped portion. Hold a piece of 5/16" rod and put a few 5/16" x 32 threads on it. Face, centre, drill down about $\frac{3}{8}$" with no. 30, open out to $\frac{1}{8}$" depth with no. 11 drill, and part off $\frac{1}{4}$" from the end. Reverse in chuck gripping tightly enough to prevent the piece slipping, but not tight enough to damage the threads. Turn down 3/32" of the end to a tight squeeze fit in the 3/16" hole in the body part, and squeeze it in. Do similarly with a piece of 3/16" rod, face centre and drill no 40 for $\frac{3}{8}$" (centre deeply) and part off $\frac{1}{4}$" long. Reverse in chuck, and turn down 3/32" length to a similar fit in the smaller body hole, and squeeze in too. Silver solder both nipples at the one heating, pickle and clean up.

Chuck a bit of 5/32" rustless steel leaving about $\frac{3}{4}$" projecting. Turndown $\frac{1}{8}$" of the end to $\frac{1}{8}$" diameter and make a cone point on the end. I never bother about setting my top slide over for these jobs as I use a facing tool with the tip ground off at one corner for chamfering purposes.If this tool is applied to the end of the pin, it forms a rough cone point which can be smoothed to a proper finish with a smooth file while revolving at high speed. The whole process takes less time than it took me to write about how to do it. Put about 5/16" of thread on the pin to match the tapped hole in the fitting; part off full $\frac{5}{8}$" from the end, drill a no. 53 cross hole and squeeze in a $\frac{1}{2}$" length of 1/16" stainless wire to form a handle, after rounding the ends smooth We had similar cross handles on the old Brighton engines and found them very handy.

From a piece of 5/16" rod in the 3-jaw, turn a few threads of 32 pitch on it, face, centre, drill 3/16" clearance to $\frac{3}{4}$" depth and part off at $\frac{5}{8}$" from the end. Reverse in the chuck and tap the other end 7/32" x 40 for about 3/16" depth and skim off any burr. Drill a 3/16" halfway along the side. Chuck the $\frac{3}{8}$" rod again, centre and drill no. 30 about $\frac{5}{8}$" deep., turn down $\frac{1}{4}$" length and thread $\frac{1}{4}$" x 40, parting off at 9/16" from the end. Rechuck the other way round in a tapped bush held in the 3-jaw and reduce the end to about $\frac{1}{4}$" diameter with a ronndnosed tool for 3/16" length, then turn the extreme tip for a 1/16" length to a tight fit in the hole in the side of the piece previously made. Squeeze it in, silversolder in, and after cleaning up poke the drill through again to clean out any burr otherwise the glass won't go through. (Note. Check sise of glass you are using as some types are made to wider tolerances of manufacture. Hole should be clearance 'just' on glass).

The nuts are purposely made shallow, to expose as much of the glass as possible. Chuck a piece of $\frac{3}{8}$" hexagon bronze in the 3-jaw, face, centre and drill to $\frac{3}{4}$" depth with a 3/16" clearance drill (note as above for glass size). Open out to 3/16" depth with 9/32" drill, tap 5/16" x 32 and part off $\frac{1}{4}$" long. Rechuck and chamfer the ends for neatness sake, also fub the facets on a bit of emry cloth. The plug for the top is made from 5/16" hexagon rod, from which hold as before, turn down a 3/16" length to 7/32" diameter and thread 40 pitch; reverse carefully and chamfer corners.

To assemble and erect the gauge, screw the top and bottom fittings into their respective bushes,(see drawing of backhead) and they should run up tight just before they reach correct position. If they tighten up about half a turn out, don't attempt to force them, but take a skim off the contact face of the bush in the boiler with a pin drill. It CAN be filed, but not one amateur in a hundred could take off the requisite skim and leave a correct contact face; I speak from experience, having seen so many examples. Alternatively a washer made from very thin copper, and annealed, may be slipped over the spigot. Anyway, when you get them almost home and reasonably tight, take them out, put a smear of plumber's jointing (Boss-white or Koprkote) on the threads, then replace and twist them home tightly to that when a 3/16" clearance drill (again see not re- glass size) is poked through from the top fitting, it will drop of its own accord into the recess of the lower one. This is absolutely essential, otherwise there will be a succession of broken and burst gauge glasses. If they don't 'go' when putting them in, they will fracture as soon as hot, if the fittings are out of line and the nuts bind on the glass tube.

The glass is packed with rubber rings. Put an inch of 5/16" rubber tube on a piece of 3/16" rod held in the chuck. Run the lathe pretty fast and touch the rubber with a wet safety razor blade at 3/32" intervals. One use for old blades! When you push the tube off the rod, it will fall into lovely little packing rings. Cut a piece of 3/16" glass tube to a length of 1½" by nicking it with a fine file, and it will snap eaisly between your fingers. Wet the glass, put it through the top fitting, put on a wet rubber washer, then the two nuts, back to back, then another washer. Let the glass drop into the bottom recess and then screw the nuts right home over the two packing rings. Finger tightness should be quite sufficient to prevent leakage; in any case tighten up the nuts just sufficient to prevent steam and water escaping, and no more. Then you'll never be troubled with burst glasses. Big engines have gauge-glass protectors between the fittings, but small ones do not need them. In passing, a smear of plumber's jointing on the threads of the top plug will prevent any leakage there, and a touch of graphite grease on the threads of the blowdown pin will prevent it sticking and render operation easy. The above gauge is suitable for any small locomotive up to 1" scale.

Combined turret and whistle valve

The body of this is 1" of 5/16" round bronze, held in the chuck, faced, centred and drill through 3/32" diameter. Open out to ⅜" depth with a 3/16" drill; bottom with a 3/16" "D" bit to ½" deep and tap ¼" deep with 7/32" x 40. Reverse in chuck and repeat the process except that the "D" bit is not used, the drilled hole being left ⅜" deep. Now drill the holes for the nipples. At 5/16" from the "D" bitted end there are three, two of them formed by putting a 3/16" drill right through the piece crosswise, and the other is mid-way between them. The fourth hole is 5/32" diameter and ¼" from the other end in line with one of the side holes; see plan sketch of completed fitting which shows position of nipples. The make the side nipples, thread some ¼" rod by 40 pitch, face, centre deeply, drill down no. 40 to ⅜" deep and part off 5/16" long. reverse and put a spigot on the end to a tight fit in the hole in the centre piece. The bottom fitting is made exactly the same as the horizontal portion of the upper water gauge fitting, as shown in the elevation, while the smaller nipple is made from 3/16" rod in exactly the same wås as described for the two side nipples. All four "excrescences" can be silversoldered in at the same heating, and then cleaned up.

Seat a ⅛" ball by the usual process, then make a cap from 5/16" hexagon rod exactly as described for the gauge glassplug, but in addition drill it out hollow no. 30 as shown in the drawing. Wind up a little spring brom bronze or stainless wire about 26swg,around at bit of 3/32" steel. File the ends off square and put it into the hollowplug screwing this home, so that the spring presses the ball lightly on to its seating.

Hold a piece of ⅜" hexagon rod and make a plug exactly as described for the top of the gauge glass, except that the head is larger; and before parting off, centre and drill down no. 51 to 7/16" deep. Slot the head across, either by milling or planing or cut with a hacksaw and finish with a watchmakers flat file. The head may either be left haxagonal, or filed away on each side of the slot. Turn up a little handle from stainless steel and file the shank of it flat to an easy fit in the slot, in which it is pinned as shown. The push rod is a 9/16" length of 1/16" stainless rod, with both ends square; insert in the hole of the plug, and then screw the latter home so that when the little lever is pressed it depresses the push rod and forces the ball off the seating allowing steam to escape to the small nipple. This will be connected in due course to the whistle.

Drill a 7/32" hole in the top of the wrapper sheet above the regulator handle as close to the edge as possible so that the drill goes through the backhead flange as well. Tap it ¼" x 40 and screw the turret into it with a smear of plumber's jointing on it. When right home the body of the turret should be parallel the the boiler centreline and the whisle valve handle just above the regulator handle.

Blower valve

This valve screws on the end of the hollow stay, the latter forming the seating for the pin. Chuck a piece of 5/16" rod, face, centre, and drill ¾" depth with no. 30. Turn down ¼" of the outside to ¼" diameter and thread 40 tpi. Part off at 11/16". Reverse, open out centre hole to 11/32" depth with no. 21, and tap 3/16" x 40. Tap the remnant of the no.30 hole with 5/32" by 32 or 40 pitch. Of late, I have been usning the coarserpitch for valves as it gives a quicker action, which I find is an advantage when the engine is on the orad. At 9/32" from the female end of the fitting, drill a 3/16" hole and fit a nipple in it exactly as described for the sides of the turret, silversoldering it in place. The valve pin is made just as described for the gauge blowdown, except that it is a bare 1" long overall, and is furnished with a little wheel on the end, although a cross-handel could be used if desired, same as on the old Brighton tank engines. If the wheel is used, turn it from 7/16" rod, and knurl the edge deeply to afford a grip for greasy fingers. My pet way of knurling valve wheels is to press a coarse,file hard on them as they revolve in the lathe before paring off, letting the file "run along" the edge of the wheel. Drill the wheel 3/32" and drive a bit of 3/32" square silver steel through it. If the steel is ground off squarely at the end and hardened and tempered to dark yellow, it will punch out a very clean square hole. The stem of the valve is filed to fit, and the end slightly riveted over.

The gland nut is made in the same way as the gauge gland nuts, but drilled no. 21 opened out 7/32" and tapped ¼" x 40, a few strands of graphited yarn being wound around the valve pin before assembly. The complete valve is then wound on to the end of the hollow stay with a little jointing on the threads; when right home the union nippple should point skywards. In case any "raw recruit" should be hazy about the "thoroughfare" nipple at the other end of the stay, I have included a sectional illustration of it along with the blower valve, which is self explanatory, the way in which it is fitted being the same as the main steam flange already described. The swan-neck in the smokebox which carries the blower jet, is screwed to the free end of the nipple.

Check valves or clack boxes.

Two are needed. Chuck a piece of ⅜" round bronze and turn down ¼" length and thread ¼" x 40, centre, part off at ¾" from the end. Reverse, centre and drill right through no. 32. Open out 7/32" and bottom with a 7/32" "D" bit to ⅜" deep, tap ¼" x 40 and not letting the tap cut deep enough to damage the seating, countersink lightly and put a ⅛" reamer through the remains of the no. 32 hole. Drill a 3/16" hole in the side and make a fitting for it exactly the same as the horizontal part of the upper water gauge fitting; squeeze it in and silversolder. Seat a 5/32" ball on the reamed hole. The cap is made exactly as for the gauge glass plug, except it is threaded ¼" x 40 and the end recessed with a centre drill to allow the ball 1/32" lift. Screw the two clacks into the holes indicated on the drawings using plumber's jointing on the threads and having the bodies exactly vertical.

Whistle

The whistle on the full sized Jennies kicked up a row like the wail of a banshee with a bad attack of 'flu. We don't want to be quite as bad as that, so will make Jenny a whistle which will reproduce her sister's cry in a little more musical tone. Square off the ends of a piece of 7/16" thin copper or brass tube to a 3" length, then at 2" from one end, file an arch-shaped slot ½" long. Turn up two tight fitting discs about ⅛" thick and drive one of these in the end farthest from the slot. File the edge of the other for about 1/3 of its circumference as shown in the cross-section then drive it in so that the filed portion is exactly below the slot.

Chuck a piece of 7/16" brass rod and turn down ⅛" of it to a tight fit in the tube. Part off ½" long. Reverse in chuck, turn down ¼" of the end to ¼" x 40 and drill through 3/32". Press the fitting into the end of the tube as shown in the sectional illustration and solder the lot with ordinary soft solder. Use only a weeny taste and be careful not to stop up the steam slot. The only reason for soldering is that a slight air-leak will have the whistle soudning husky instead of giving a clear note. This whistle can be hear ¼ mile away with 80 lb. steam if properly made. It should give no sound at all when blown by "breath. You can test it by coupling to a motor tyre pump, bending the hose connection so no air can pass, pressing on the handle till 80 lb shows on the gauge, and then letting go of the hose. A loud and shrill but perfectly clear "pip" should be the result. When the engine is completed the whistle is mounted under the trailing end, and connected by the small union on the turret by a ⅛" pipe with union nut and cone at each end.

Firehole door

I have yet to find a type of door which will beat the good old-fashioned swing type for a little engine, and Jenny's is that pattern. It is made from a piece of 1/16" steel sheet, cut to the shape shown and with two little tags on the end about 7/16" long. Bend these into loops with round nose pliers to form the ends of the hing (see plan). Rivet an inch or so of 1/16" x $\frac{1}{8}$" BMS to the opposite end and bend it to the shape shown for form the handle. Drill one no .40 hole in the middle of the door and three more aorund it for air holes. Turn a 3/32" pip on each end of a $\frac{3}{8}$" length of $\frac{3}{8}$" BMS, poke one through the hole in the middle of the door and rivet over. On the other one fit an oval baffle plate about $\frac{1}{2}$" x 1" and again rivet over. Cut a bit of steel about $\frac{5}{8}$" square for the stationary part of the hing, file a rebate $\frac{1}{8}$" top and bottom, and bend it aorund a piece of 1/16" wire. File the ends so that the bent position will fit between the loops on the door and put a 1/16"pin through the lot. The hinge is attached to the backhead by 3 8BA bronze screws.

I used to fit latches at one time, but after my continuous track was opened for traffic and we began to run a couple of miles or so without a stop, I found that the latch was more of a nuisance than it was worth, so adopted spring catches as shown in the plan sketch, which explains itself. A small bit of flat spring steel is bent to a shape that will just catch the elbow on the door handle and screwed to the backhead by a single bronze screw. Instead of having to fiddle with a sticking latch, a flick of the shovel will open the spring-catch door, and another will close it after "popping" a bit on. If the engine persistenly blows off, the handle can rest against the end of the spring instead of being pushed right home and the spring will then prevent the blast suction from entirley closing the door and making her blow off more than ever.

Chimney.

This is like a factory chimney when compared to a modern stumpy stack, but graceful withal, with its curves, beadings and polished top. It is made from a casting which has a minimum machining allowance so that it could really be surface cleaned up with a file. A chucking piece is provided on the top end, so hold this in the chuck, and fit a wood plug at the bottom end, and clean up an area near theflange to fit your 3-point steady, and the bore may now be machined in with a long boring bar as large as possible in diameter. The base can be finished off by filing, or if the centre barrelis set up carefully in the vertical slide vice with a $\frac{3}{4}$" rod passed through to reduce distortion of the clamped part, the base may be flycut to radius of the smoke-box wrapper,to which it is attached by countersink or round head screws running through clearance holes in the base into tapped holes in the wrapper. No liner or petticoat is needed.

Dome

This is also considerably outsize as compared with modern counterparts, but looks very well. The casting can be driven on to a piec of wood which is held in the 4-jaw and the top supported by the tailstock centre. If fluted castings are required, some form of indexing will be required to fit the vertical slide so that the casting may be revolved and the cross-slide passed across a ball nose slot drill held in the 3-jaw. All the sizes of both chimney and dome are given on the sectional drawings, and these should be followed, otherwise the appearance of a locomotive, especially one with a small boiler and big fittings, is bad "saddling" of same to barrel and smokebox. In the case of cast fittings as mentioned here, the radius is cast in the bottom, and is fairly correct; a half round file will usually do all that is neccess-ary. In my early days, a favourite wheeze was to lay a piece of emerycloth over the barrel, or a piece of tube of same diameter, or even a botttle, and the chimney or other base rubbed back and forth until it was properly bedded in. They can also be flycut in the lathe, as described above. When the dome base is finished, wrap a turn or two of asbestos sheet around the inner dome, and push the casing on to it, no other fixing being required, and it is easily removed for oiling the regulator.

Safety valve casing.

This is provided as a solid casting with a chucking spigot on the upper end which can be held in the 3-jaw while the body can be turned to the dimensions given. It it advisable to centre the end and give support while turning the outsides, and then drilled 1$\frac{1}{4}$" up with $\frac{1}{2}$" drill and finished at the top with a $\frac{1}{4}$" drill, and parted off at the chucking piece. The base square may be filed. A polished safety valve casing looks well, or the bell top only may be left bright, the remainder being painted. There were two spring-balance safety valves on the columns of the full sized Jennies and if anyone wants to add dummy balance levers and spring casings to represent them refer back to the general arrangement drawing where they are shown. The levers can be made from $\frac{1}{8}$" steel strip 1/16" thick, and stand out $1\frac{5}{8}$" from the column and at $\frac{3}{8}$" above the top of the firebox wrapper. The dummy spring cases are turned to shape as shown, the parallel part being $\frac{3}{4}$" long, and the lower ends are attached to the backhead by small fittings just like a handrail pillar, turned from 3/16" rod with a shank screwed 8BA which enters a tapped hole in the backhead. The dummy whistle is also turned from rod 3/16" diameter and is $\frac{3}{4}$" high. It is screwed into the top of the firebox wrapper sheet between the balance levers These by the way are not parallel; they enter the column close together and splay out toward the back.

The left hand union on the whistle valve turret in connected to the union on the blower valve by a $\frac{1}{8}$" pipe with the usual coned nippled on the ends, and union nuts tosuit the screwed fittings, is bent 'U' shape directly after leaving the nut and passes across the backhead before turning downward to meet the blower valve union. a $\frac{3}{4}$" steam gauge reading up to 120 lb. is connected to the right hand union by a $\frac{1}{8}$" pipe also bent to a 'U' shape under the gauge to form a syphon, the free end being taken up past the back of the gauge and bent around to meet the turret union, wo which it is attached again by the usual nut andnipple; Before attempting to bend a bit of copper pipe, always make it red-hot and quench in clean, cold water, thus annealing it. It will then bend easily to shape with the fingers, and will look the "berries". I there is one thing more than another that I hate to see on a little engine, it is slipshod and dirty plumbing.

Grate.

A plan of the grate was shown on the boiler drawing. It is composed of 10 bars of $\frac{1}{8}$" x 5/16" BMS (or stainless if you can get it this size). Eight of them are 2.5/16" long and the other two are 2.1/16" only, as they have to clear the corners flanges of the firebox. Each bar is jig-drilled with 2 x no. 30 holes at $1\frac{1}{2}$" centres. To make the spacers, chuck a length of $\frac{1}{4}$" steel, drill down about 1" deep with no. 30, and part off $\frac{1}{8}$" slices until you reach the end of the hole, then"ditto repeato" until you have all 18 of them. If you grind a lip in the end of the parting tool, and use plenty of cutting oil, they will come off very easily. The bearers are $\frac{1}{8}$" steel rod and screwed 5BA at each end. Cut them plenty long at first, say 3", and trim to length after fitting the ashpan. To assemble the grate, put a nut on a bearer, then a short bar, then a spacer, then a long bar and so on, not forgetting to have the two short bars on the outside. Well tighten the nuts.

Ashpan.

This is made from a piece of 18 swg steel $4\frac{3}{8}$" long by 3" wide. Bend up $\frac{3}{4}$" of each short side in the vice as shown in the illustration and cut each side on the slant at one end to that the upper edge is reduced to $2\frac{3}{4}$". Cut a strip of steel about $3\frac{3}{8}$ long, and bend $\frac{1}{4}$" each end at right angles, to fit in the square end of the ashpan, riveting it in place with 3 x 1/16" iron rivets each side.

At $\frac{5}{8}$" from the closed end, file a slot in each side to clear the grate bearers, and another $1\frac{1}{2}$" farther on, see sketch. Then at $1\frac{3}{8}$" from the front and $\frac{1}{2}$" from the top drill a no. 30 hole each side for the dumping pin.

Cut two small brackets as shown, from 1/16" copper or brass and rivet them to the projecting edges of the inside firebox side sheets. Don't drill the pinholes before rivetin, or they will probably be anywhere but in the right place. Turn the boiler upside down on the bench, and put the grate and ashpan in place; then you can run the drill through the holes in the ashpan and carry on through the brackets and know they must surely be in line. The dumping pin is made from a piece of $\frac{1}{8}$" silver steel about $3\frac{1}{4}$" long, with one end turned to a blunt point, and the other screwed to take a little knob which can be turned from $\frac{1}{2}$" BMS and tapped to suit.

How to mount the boiler

The boiler is supported in the frames by the smokebox side sheets at the leading end, and by two expansion brackets resting on blocks screwed to the frames at the firebox end. A cross section of the latter arrangement is shown in the detail. Two blocks of $\frac{1}{2}$" square brass, each $\frac{3}{4}$" long are screwed to the inside of the outside frames, just ahead of the trailing wheels, and clear of both the wheels, and the pump brackets. The exact position does not matter, but the blocks should be squared off in the four jaw chuck, and set level with the bottom edges of the frames. The boiler can then be placed in position and levelled up. The bottom of the boiler barrel is $\frac{1}{8}$" below the top line of the frames, so that there will be approximately 5/16" of the sides of the smokebox wrapper sheet below frame level; and three 7BA screw each side through both frame plate and smokebox will hold all secure at the front end. As it would be rather awkward to get nuts under the smokebox and on the screws, drill the holes no. 48, tap 7BA and screw them straight in.

At the trailing end, two pieces of angle, say $\frac{3}{8}$" x 1/16" and $\frac{1}{2}$" long are screwed to the sides of the firebox wrapper so that the horizontal part of the angles rest on the blocks. Screws and angles should be soldered over to prevent any leakage. To prevent the boiler lifting, as there is no cab to hold it down, drill a no. 30 hole in each angle and slot it lengthwise a little with a needle file. Then in the block and right in the middle of the slot, drill a no. 40 hole and tap 5BA and screw in a steel pinwith a hexagon or round head about $\frac{1}{4}$" AF, and just sufficient "plain" under the head to allow the angle to slide but not lift when the screw is right home. These two special screws are easily made in the usual way.

Pipe connections.

These are very simple. At the smokebox end there is only the superheater union to couple up and this was shown in the section of the boiler along with regulator and superheater. A short piece of pipe is screwed into the steam inlet hole in the cylinder block, and the female part of the union is silversoldered to it. A cap will be required for the blastpip, and is made from $\frac{3}{8}$" hexagon brass, exactly the same as a union nut, except that the end with the hole in it is chamfered off much more than is usual with a nut. The hole can be drilled 7/64" as a kick-off. Every engine needs individual testing for the most efficient size of blast nozzle; one size does not suit all, as workmanship varies, and with it the amount of steam used (or wasted) by the locomotive. If she persists in blowing off all the time, the orifice is too small and needs enlarging, which is best done a few thou' at a time, by the simple expedient of putting a taper broach down the chimney. If she does not make enough steam -- which is VERY unlikely -- the nozzle should be replaced by one a shade smaller to induce more draught. Beginners and novices should always remember that the larger the nozzle, the less back pressure on the cylinders and the greater the efficiency of the locomotive. All my engines are arranged for the minimum of back pressure; consequently they develop far more power than others of similar size, and with a lower boiler pressure, as the pistons have no trapped steam to impede their return strokes when the valves open the opposite end ports to admission.

The delivery pipes from the two pumps should be connected to a cross-piece, the pipes being either soldered into the opposite arms of the cross, or attached by unions. The third arm of the cross is connected by a 3/16" pipe and union to the right hand clackbox on the backhead, whilst a pipe from the fourth is led to the rear beam and terminates in a cock or screwdown valve with a short extension pipe onthe farther side of it, to take the "feed bag" or hose connection from the tender. The handle of the cock or valve is extended, and passes up through the footplate. The suction pipes are connected by a tee or "Y" piece, the steam of which is furnished with a 3/16" pipe which also goes to the rear beam and may be supported by the same bracket or clip which carries the bypass connection mentioned above.

The hand pump

For the handpump connection, chuck a piece of $\frac{3}{8}$" hexagon brass and turn down 5/16" of it to 5/16" diameter and thread 26 pitch. Centre deeply with a centre drill, and part off about 13/16" long. Reverse and turn down $\frac{1}{4}$" of the other end and thread $\frac{1}{4}$" x 40. Centre, drill through no. 40, and open out to 5/32" for about $\frac{1}{8}$" depth; silversolder a piece of 5/32" copper pipe $3\frac{1}{2}$" long into it, and put a $\frac{1}{4}$" union nut and cone on the other end. Attach the screwed fitting to the rear beam by a bracket or clip as sketched, and take the pipe through a suitable hole drilled in the footplate to the clack on the left hand side. If a suitable tender is available, or if a temporary tank is rigged up on a passenger carrying flat car, the engine can now be given a trial on the road and any neccessary adjustments made before the rest of the "top works" are put on. Tip; before trying to light the fire, make sure that all interstices at the smokebox end are plugged up, for about 90% of the cases of bad steaming which I have investigated were due to air leaking in at the smokebox end and destroying the vacuum, consequently the fire either burned dully, or went out altogether. A few scraps of asbestos kneaded into a kind of putty with a drop of water makes and excellent "asbestos cement" for permanently stopping smokebox leaks. Build up a little fillet around each pipe, which will set quite hard, and will not be affected either by heat or oil.

Running boards and splashers.

No separate running boards drawing should be needed as they are merely strips of 18g metal, brass or steel will be suitable, $16\frac{1}{8}$" long and 1.3/16" wide. A piece $4\frac{3}{4}$" long and $\frac{5}{8}$" wide is cut out of each to clear the driving wheels and the exact position of this is best measured from the actual job. Lay the strip on top of the frame, so that it overhangs the buffer beams by 1/16" each end, and you can see at a glance where the piece has to come out. The easiest way to get it out is to saw down the two $\frac{5}{8}$" lines, then clamp the strip in the vice to that the $4\frac{3}{4}$" line is level with the top of the vice jaws. Apply a small chisel with its corner at the saw cut, hold it obliquely, and hit with a hammer and the chisel will shear off the metal against the vice top in a way which will probably astonish a raw novice. After the piece has been cut out, trim the edges with a file. The running boards can then be attached by small pieces of $\frac{1}{4}$" x 1/16" angle screwed to the insides of the outside frames. Use small screws through clearance holes in the frame into tapped holes in the angles, and if round head screws are used, these, when painted, will represent some of the rivet heads which some of the big Jennies were plentifully adorned.

Make up pieces of similar metal can be fitted between the frames at the rear end to form the footplate; and at the front to fill up the space between frames in front of the smokebox, which plate the enginemen call the cylinder flap, as is is usually hinged to get access to the cylinder covers. This section, however, can be left off if desired for some of the full size Jennies had the spaceleft open.

If you refer back to the general arrangement drawing, you will notice a "T" headed sheet metal bracket connecting the smokebox with the running-board. This can be cut out of similar metal and attached to the smokebox with 10BA screws. The lower end is bent to lie flat on the running board and can be attached by a couple of 7BA screws through clearing holes in both bracket and board, and nutted underneath.

The ornamental splashers could be made from steel sheet (or brass) carefully drilled out and file to shape. However castings are available which need only careful cleaning up with files and emery cloth, and will present a much quicker solution to manufacture. The bottom face will need a lick with a file to bed it flat down, after which it can be soldered in place, or riveted direct to the running board. There is no need to fill in behind the driving wheel, though this may well have been done on the big Jenny.

Fenders and tie rods

Although the full sized engines had no cabs, they were provided with side sheets known as fenders. These can be made from the running board material and cut to size and shape as illustrated. The leading ends are bent at right angles, the corners being rounded instead of square, and the edge of the bent-over section is filed to fit closely against the boiler. They are edged with 3/32" half round beading, soldered on and attached to the running boards by pieces of angle at the bottom, riveted to the fenders and screwed to the running board. Some of the engines had long handrail pillars in addition. I showed these on the general arrangement drawing in case anyone likes to put them on, but they are really unneccessary.

Referring back again to the G/A, a short tie rod will be seen running from the dropped front end of the outside frame, to the leading hornblock; and a longer one connects the leading and trailing horns, with a "Y" piece in the middle, opposite the driving wheel. These tie rods can be made from 1/16" x $\frac{1}{8}$" BMS stirp riveted on with 3/64" rivets. They are rather frail and care should be taken when running, or they will be damaged. Of course they CAN be made from stouter metal if desired, but the trouble is that if made oversize they spoil Jenny's pristine beauty. Still, that is up to the builder! The guard irons are also on the small side, and can be made from 3/32" x 3/16" strip, bent to shape and filed to finish. They are stayed with small struts as shown, made from the same section metal as the tie rods.

"Trimmings"

The first lot of 'Jennies' had "Dumb" buffers, made of leather stuffed with horsehair, and those shown on the loco g/a simulate these. They can be turned from hardwood, the dimensions being as follows - length $\frac{7}{8}$", diameter $\frac{3}{4}$", 3 ribs 1/16" thick equally spaced. Drill a no. 40 hole in the buffer beam at 2" each side of the drawbar hole, and tap 5BA. The wooden buffers can be drilled right through no. 30, the fronts countersunk slightly and long 5BA screws used for attachment to the buffer beam. If the engine happens to hit anything hard, the screws will take the "biff" and prevent the buffers being split. The later Jennies had the usual type of spring buffer, and stocks and heads will be available as malleable iron castings, and I will illustrate these later.

The drawhooks are 7/16" diameter and can be filed from $\frac{1}{8}$" steel; they have square shanks fitting the square hole in the beams, and are secured by the usual spring and nut behind the beam. An oridnary three link coupling may be fitted, or a "period" coupling consisting of two links and a small hook as shown in the g/a.

The Handrail is continuous, that is it goes all round the boiler and smokebox in one piece on the big engine; but if you make it like that on the little one, the front handrail knob will have to be nutted inside the smokebox as it will have to be put on the handrail before bending, and so cannot be turned around to screw it in. I usually make a "continuous" handrail in two pieces, the joint being scarfed like a piston ring and located inside the front knob. It is practically invisible and saves a great deal of truuble.

The steps are rather different to those of a modern engine. They are made from $\frac{7}{8}$" lengths of $\frac{3}{8}$" x 1/16" strip and are bent up a little at each end to prevent the driver's feet from slipping sideways. Each step is supported by two hangers $\frac{1}{4}$" apart made from 3/32" square steel A piece of steel similar to the step is fixed across the upper ends of the hangers and attached to the outer frames by two screws through frame and cross-piece. The whole step assembly should be brazed together for strength. Alternatively, a plain horseshoe shaped stirrup, made from $\frac{1}{8}$" wire can be fitted. These old engines had all sorts of steps, some of them like those on the old stage coaches.

There is no need to fit lamp brackets or any other impedimenta to a locomotive intended for hard service on apassenger-carrying road, as they only get damaged, or knocked off altogether, so the next item will be the tender.

<u>Tender</u>

The tenders fitted to the Jennies, although of the same general type, varied a little in detail as the later series came out. The one shown in the g/a matches the locomotive as so far described, but I have shown it fitted with the later type of spring buffer and steps. Builders of the engine who are building same with the old kind of outside pumps, "dumb" buffers and so on, can use the same pattern of buffers on the tender, also should leave out the plate steps, and fit the same kind as on the engine. Those who wish their engine to represent the later series of Jennies should supply the engine with spring buffers as shown on the tender g/a, also plate steps instead of the "stirrup" kind. A weatherboard will also be needed, and the pumps can be replaced by an injector,

The tender is a simple job and is easilytmade. It has two outside frames only with the same type of axleboxes and springs as on the leading and trailing wheels of the engine. The body is very low-sided, typical of the period, and the tank has a "horseshoe" coal recess in it. It contains the usual emergency hand pump as specified for all my engines, and the strainer and bypass pipe for the engine pumps, or alternatively a strainer and regulating water valve for the injector. A flared coping is provided around the top, but there are no coal plates, or extra side rails.

<u>Frame assembly.</u>

Two pieces of 3/32" steel sheet 13" x $2\frac{1}{4}$" are required for the side frames. Mark one out, then temporaily rivet the two plates together and saw and file to outline. Hornblocks can be cut from the same metal, and riveted to the inside of each frame exactly as specified for the loco leading and trailing wheels. A strip of brass about 7/32" wide and 1/16" thick is bent to fit each hornslot, and soldered in position with about 1/32" projecting proud of the frame. This gives the appearance of the horns on the full-sized engine, and also provides a smoother surface for the axleboxes to bear against than if they ran direct in the steel slots. This should have been mentioned also when describing the fitting of the leading and trailing axleboxes on the engine, but due to an accidental oversight it was omitted, though the brass lining can be clearly seen in the general arrangement drawing. However it doesn't matter a great deal if the boxes have been fitted direct to the steel slots.

The leading beam of the tender is the same as the drag beam of the engine, so does not call for repetition, and the buffer beam at the back is the same as the loco front one. Both are attached to the side frames by pieces of angle riveted to the beams and screwed to the side frames.

A small piece of brass angle is reveted to the side frames over each of the middle wheels to form an extra means of attachment when fitting the soleplate to the frame assembly, the main angles being riveted to the beams.

The axleboxes and springs are exactly the same as those specified for the leading and trailing wheels of the engine, so again no repetition is called for. The springs may be cast, with little spiral springs in the hoops of the cast dummies, or real working leaf springs which I reccommend only if the builder has the time and patience to complete them. The action of these springs is fascinating in the extreme as they are in full view above the tender soleplate. A tender fitted with working springs holds the road better at speed. The tender wheels and axles are also the same as the carrying ones on the loco. The axleboxes are prevented from falling out of the horns by a strip of 1/16" x ¼ steel running the full length from leading to trailing hornblock as shown, something like the tie rod on the engine. It is attached to the horns at each side of the opening by 8BA screws.

Brass is perhaps the best material to use for the tender body, but galvanised steel could be used, or a heavy gauge steel with a brass or copper lining would be an alternative, if involving more work. The problem with a steel tender body is rust, and means to avoid this should always be taken. In the long term, and for the tyro, brass is perhaps the best, use 18 swg.

For the soleplate, a piece of 16swg - stiffer - 13¼" long and 5¾" wide is required to leave 1/16" overhang at front and back and ⅛" overhang each side. It is attached to the frame angles at sides and ends by 7BA brass screws put through clearance holes in both soleplate and angles, and nutted underneath. Tip; slightly round off the sharp corners; the later may look very nice, but they are prone to scratch your hands and clothes. Holes, will of course, be needed for the spring hangers.

The bodies of some of the Jenny tenders had square corners and others were rounded so choose for yourself. If the former, the body can be made in three pieces, two sides and one end plate; and the flared coping can be produced by gripping of round rod in the vice with the tender plate beside it and bending the latter around the rod. The back corners of the coping are filed off at an angle to the end of the sheet so that they meet and form a continuous flare when sides and end are assembled. Put a piece of ¼" x 1/16" nagle brass in each corner and rivet same to side and end plates with a few 1/16" rivets which makes a strong joint.

If rounded corners are preferred, both sides and end should be bend from a single strip 2⅜" wide and 30" long. If however a long enough strip isn't available, make it in two pieces with the joint in the middle of the back sheet. Butt the ends together, and rivet a strip about ⅜"-wide inside the body. Bend the flared coping each side as above, but for the corners either get a piece of angle say 1" x ¼" section, or bend up an agle from a bit of 3/16" bar. Ronnd off the shorp edge of the angle and smooth the rounded surface with a fine file; then place the corner of the tender in the angle with the part to be flared level with the rounded off part of the angle. Beat down the metal outwards, like flanging a boiler plate; you will have a lovely curved coping in a brace of shakes. It takes about as long to do the job as it took to write these instructions.

The tender sides do not finish square at the front end but are bent to a curve as shown in the plan sketch. These curves can easily be made by gripping the sheet metal in the vice alongside a piece of rod of the required radius, and bending the metal around the rod. The whole lot can then be stood on the tender soleplate, adjusted for position, and "tacked" with a few touches of solder, just enough to hold it temporarily, and no more. Put a piece of angle across the back, and along each side near the front end, also near the back, for screwing or riveting them to the sides of the soleplate. Finally solder the whole lot right around, being careful to cover the heads of any screws used and the brass angles.

A strip of brass is bent to the shape of an arch, and fitted in position as shown in the plan view. This forms the coal space and is soldered to the soleplate and to the curved in ends of the tender sides. The next job is torivet pieces of brass angle 1/16" x ¼" to the upper sides and end of the tank for attachment of the tank lid or cover plate. These should be level with the bottom of the coping, so that the cover plate will be 2" above the soleplate. The angles need not go right to the full length of the tender sides, but only sufficiently far enough to accomodate the removeable part of the cover, see drawng. The fixed portion of the cover plate is then cut to shape and fitted in position between the tender sides and around the "horseshoe" coal space, and may be soldered in position. This will be plenty strong enough as there is neither heat, nor pressure, to stand against. The removeable part of the cover plate is then fitted on top of the angles, to which it is attached by small round head brass screww, say 8BA. An oval slot is cut in this plate as shown and a little "wall" of brass strip about 5/16" high soldered all around it. A hinged lid is fitted to the top. Cut out the lid to the given shape, and leave two little tags at one end. These are bent into loops with round pliers. A strip of brass is cut to fit between the loops and the end of this is also bent to the same loop diameter. A piece of wire put through serves as a hinge pin, and the lower end of the central strip is cut to suitable length, bent at right angles and riveted to the cover plate so that the lid exactly covers the oval hole. Incidentally the filling holes on the old tenders were circular, but we have to make ours as shown in order to operate the emergency hand pump through it if occasion arises. It is more convenient and far neater than having an unsightly slot in the cover plate, with part of the pump handle permanenetly projecting through it, for no advantage whatsoever.

Tender pump.(these notes correspond to the supplied casting, not the drawing)

A casting is provided. File the base flat, and then mark off centres on the end and grip the body in the 3-jaw, centre, face off, and drill and ream through $\frac{1}{2}$" diameter - there should be room between two of the jaws for the base portion. If the casting has a valve box portion attached - saves two castings and corresponding patterns - saw this off first.. The faced end becomes the one adjacent to the valve box. Set up on your surface plate and mark for the top hole $1\frac{3}{4}$" up. and drill through $\frac{1}{8}$" diameter.

Grip the valve box in the 4-jaw with the larger boss outward and set this running truly. Face the end, turn down to a close fit in the reamed hole in the body, centre and drill through 5/32" diameter into the centre of the vertical part. There is again just room between the jaws of the -3-jaw to hold the vertical valve box, do this, and face off, centre, drill $\frac{1}{4}$" by 5/16" deep, follow this with a "D" bit, and then tap down 3/16" only 40 pitch. Drill right through no. 32, and ream out $\frac{1}{8}$" diamter. Reverse in the chuck and repeat procedure on the bottom. Seat a $\frac{1}{8}$" ball on one end as already described and in the other, with a small chisel, make two or three distinct grooves in the upper face so that the water will flow around the ball when the pump "sucks". Make a top union as shown in the drawing, not forgetting the cross-nicks and centre deeply on top for fitting a coned nipple and union nut to the connecting pipe. For the bottom cap, make up a plug exactly as described for the top water gauge fitting, but use $\frac{3}{8}$" hexagon brass (also for the top fitting) and ream through $\frac{1}{8}$" diameter. Seat a ball on the threaded side of the plug, and then press the valve box into the pump body, and secure with solder. Assemble the plug and top fitting with a little smear of jointing compound on each with balls inside. The ram is simply turned from a piece of $\frac{1}{2}$" stainless steel with a $\frac{1}{8}$" x $\frac{1}{8}$" groove $\frac{1}{4}$" from the inner end, which should be packed in the same was as for the engine pistons. The outer end may be slotted $\frac{1}{8}$" and accurately cross-drilled $\frac{1}{8}$" diameter for a pin which will pass through and be held a press fit in the lever, which is best made from a piece of brass $\frac{1}{8}$" x $\frac{3}{8}$" section. At $\frac{7}{8}$" from the hole, mark and drill another of the same size. Now make up a pair of links with 1.9/16" centres from 1/16" x $\frac{3}{8}$" section brass, with holes as before. Pass a stainless rivet - simply a piece of bar stock, through both holes and lightly rivet over the ends just enough to prevent the links slipping off.

Put the pump in the tender so that when the lever is vertical, the lever is exactly in the middle of the filler hole. Drill No. 30 holes through the base and the sole-plate and fix with 5BA brass screws, nuts underneath.

Fittings inside tank

If the engine is fitted with the two pumps as previously described, the fittings inside the tender will comprise a feedwater connection with a strainer on it, a similar connection with a telltale pipe for the return of water fromthe bypass, and a handpump for use in emergency. If the feedpumps are dispensed with, and replaced by the injector, the feed and bypass fittings will not be needed; and a screwdown valve, for regulating the water supply to the injector, will take their place. A section of the tender showing the former fittings is given, but please note that for sake of clarity, the feed and bypass connections are shown one behind the other. On the actual job they are side by side. If the engine has an injector, the valve for this may be placed in one of the "water legs" at the side of the coal space, where it would be handiest for a Lilliputian fireman to operate, if one could be found to ride on the footplate!

Feed connections

All the feed connections are made from 5/16" or 3/16" round brass rod. For the hand pump fitting, chuck a piece, face the end, centre deeply, drill down about $\frac{7}{8}$" deep with no. 40, turn down $\frac{3}{8}$" of the outside to $\frac{1}{4}$" and screw 40 pitch. At $\frac{1}{4}$" from the bottom fit a union nipple exactly as described for the one at upper end of the valve box and this can be silversoldered in or threaded. Drill a $\frac{1}{4}$" clearance hole anywhere in the tender soleplate near the pump, poke the fitting through from the underside, and secure with a $\frac{1}{8}$" thick locknut on top. Make the locknuts from $\frac{3}{8}$" hexagon brass, drilled and tapped $\frac{1}{4}$" x 40 and part off as desired. The nuts may be rechucked separately and chamfered slightly on both sides if a "posh" finish is required, but as no one crawls around inside tenders, it doesn't really matter. The screwed part projecting inside the tank is connected to a nipple at top of the valve box by a piece of $\frac{1}{8}$" pipe having a 7/32" cone silversoldered to each end, and a couple of union nuts over them - don't forget toput them on first, back to back, before soldering.

The feed and bypass fittings are made and fitted in similar manner with the exception being that they are shorter, only $\frac{3}{8}$" projecting beyond the soleplate. In place of the screwed union nipple, each one is furnished with a piece of 5/32" copper tube about $4\frac{1}{2}$" long silversoldered in. Two $\frac{1}{4}$" clearing holes are drilled side by side, just ahead of the handpump, and clear of the outlet for same, A plain locknut is screwed over the bypass fitting, but a gauge finger or strainer is soldered over the locknut securing the feed fitting, for the purpose of keeping any foreign matter from entering the feed pumps and putting them out of action. A tiny bit of grit under either valve will effectively stop the pump from feeding. The strainer is merely a piece of 80 mesh gauze rolled into a double thickness around a pencil, pinched at the top and soldered. Put a $\frac{1}{8}$" drill into the bypass fitting for about $\frac{1}{8}$" down; into this solder a piece of $\frac{1}{8}$" copper tube bent at right angles, and long enough to reach the end of the filling hole, as shown in the sketch. When the bypass valve is open, a stream of water should squirt violently from this when the engine is in motion. As the driver can see this by merely opening the filler lid, it is an easy matter to regulate the supply to the boiler by operating the bypass valve. The less water issuing from the telltale pipe, the more is going into the boiler, as the pump delivery is constant. After the fittings have been installed in the tank, the removeable top can be screwed down "for keeps" as it is not neccessary to take it off again except for cleaning out the tank, or examination of the hand pump in the extremely unlikely event of that failing in the hour of need. Incidentally it is always advisable after coupling up the engine and tender pipes preparatory to a run, and filling the tank, to give the hand pump a few strokes to test same, and see that the valves are not sticking on their seats.

Connection between feed and bypass pipes on engine and tender, are made by pieces of 3/16" rubber tube (or plastic) thick walled for preference, no fastenings being required as there is no pressure to withstand. The hand pump connection being under pressure, a metal pipe with screwed unions must be used; and this should be $\frac{1}{8}$" diameter, about 24 swg, and coiled a couple of turns directly ahead of the back union to allow for the neccessary flexibility between engine and tender when negotiating curves.

Tender brake gear

Brakes are of course optional, many builders leaving it out as "non-essential", but if working brakes are fitted, it kind of "finishes off the job"; here, however, a word of warning. If you fit brake gear as described here, don't use it as a service brake, but merely to prevent the engine drifting off on its own, from any cause, when left standing. The weight of the tender fully loaded is not sufficient to stop Jenny and her normal load of passengers in anything like a reasonable distance; consequently the wheels would "pick up", as the enginemen term it, and slide on the rails, wearing flat places on the treads. In full size practice, as any driver will tell you, the loco pulls the train, but the train stops the engine by virtue of the automatic continuous brakes, the whole weight of the train being used as a retarding influence. We can do the same think, so to speak, by fitting hand brakes toour passenger vehciles and not using the brakes on the locomotive at all, except as stated above.

Blocks and hangers

These are of the old fashioned type, in vogue at the date of the engine; iron brake blocks had not yet made their appearance, and the big Jennies had wooden blocks mounted on flat hangers. We copy these, except that instead of wood, red fibre should be used (tufnol is a good substitute - not readily available to LBSC!). Small wood blocks would split, work loose, or fail in other ways. The hangers are made from 3/32" x 3/16" flat BMS, the eyes at each end being formed by bending into a circle if brass, or a spearate piece of drilled rod brazed on if steel.

The blocks are sawn to shape and are attached to the hangers by 7BA screws running through clearance holes in the hangers into tapped holes in the blocks. ...

that "period" touch, either use large headed screws and file the heads square, or chuck sqaure rod and make special screws. The heads can be chamfered with the bolt held in the 3-jaw.

The studs on which the hangers are supported are turned from $\frac{1}{4}$" diameter BMS. Chuck a length in the 3-jaw; turn down a 5/16" length to $\frac{1}{8}$" dia., further reduce $\frac{1}{8}$" of the end to 7BA and part off at 15/16". Reverse and turn down $\frac{1}{4}$" of the other end to $\frac{1}{8}$" and thread 5BA. The position in the side frames for the holes for these hangers is 1.15/16" behind the vertical centreline of each axle, and $\frac{3}{8}$" below the top of the frame. Use a no. 30 drill, and put pin through from inside, nutting up on the outside the frame. The eyes in the hangers are slipped over the inner end ,the $\frac{1}{4}$" section locating the block in correct relation to the wheel treads. Secure with a 7BAnut and washer. The hanger should swing freely, and the radius of the block coincide with the wheel tread when pressed against it.

Beams and Rigging

Three pieces of flat steel $\frac{1}{4}$" x $\frac{1}{8}$" section, and 4.3/16" long are needed for the brake beams. Chuck truly in the 4-jaw and turn a spigot on each end 3/32" diameter and $\frac{3}{8}$" long. If you are using screw and nut fixing to prevent the hangers coming off the beams, turn down a further 5/32" each end to 1/16" diameter and thread 10BA. If using the washer and pin, simply drill a no. 55 hole across each spigot end. The centre part of each beam is filed "barrel shape" as shown in sketch. The eyes at the hanger bottoms fit over the ends of the beams, and are kept in place with either nuts, or pins, with a washer between them and the end of the hanger. Plain pins fitted tightly may be used; but a touch of realism can be given by using tiny split pins 1/32" diameter.

As the brakes are more for ornament than serious use, there is no need to bother with compensating the brake rigging and plain pull rods may be used. The simplest arrangement is to use a couple of short links, above and below each beam, securing with a screw or pin as detailed. Each pair of links is connected to its adjacent neighbours by a piece of $\frac{1}{4}$" x $\frac{1}{8}$" rod same as used for the beams; these rods are placed between the ends of the links on the beam, and either pinned or screwed, or riveted as shown. Another method is to use round pull rods, $\frac{1}{8}$" diameter with a small fork, or clevis, screwed on to each end, also shown in detail sektches; but please note, if this method(which makes a neat job) is adopted, the first and second brake beams would be made $\frac{3}{8}$" wide in the middle so that the holes for the pins or screws can be drilled in line without unduly weakening the beam. As the third(rear) beam carries only one fork, or a pair of half-length links, the size of this can be as shown.

Cross-shaft and pillar

The brake cross-shaft should be as short as possible, to avoid being bent when the brakes are put hard on; and naturally a good, strong bracket to carry it is desireable. In the present instance the bracket is made from a casting which needs only the bolting face carefully machined flat holding in the 4-jaw with a block of wood, or a suitable bolt and nut acting as a screw-jack, between the ends to afford a grip. At $2\frac{1}{4}$" from this face, drill $\frac{1}{4}$" diameter across for the shaft, and drill and tap four 5BA holes in the top for fixing screws. Turn the tender upside down on the bench, and locate the bracket so that the holes for the cross-shaft are $1\frac{3}{4}$" from the front beam, and one side of the bracket is 5/32" from the centreline of the tender; mark the position of the screwholes in the soleplate using the bracket as a guid, drill through no. 30.

The cross-shaft is a piece of $\frac{1}{4}$" round steel a bare 1.13/16" long. Chuck and turn down a full $\frac{1}{4}$" of one end to 3/16" dia., then reverse in chuck and turn down a full $\frac{1}{2}$" of the other end to same size. The drop arm which connects with the pull rod, is made from $\frac{1}{4}$" x $\frac{3}{8}$" BMS, a piece $\frac{7}{8}$" long being needed. Mark off on the wider side the holes for the pull rod pin and the shaft at $\frac{1}{2}$" centres as shown; drill the former no. 40 and the latter no. 14. Round off the ends and cut a $\frac{1}{8}$" slot for the end of the pullrod, by any of the methods previously described for valve gear parts etc., after which the arm can be squeezed on the shorter end of the cross-shaft using the vice as a press.

A piece of rectangual stock $\frac{1}{2}$" x $\frac{3}{8}$" and $1\frac{3}{8}$" long is required for the actuating arm which is made in the same way as the drop arm except for differences in measurements. It is 1" between shaft and pin holes, the latter being slotted, as the end of the arm moves in a curved path while the nut goes straight up and down. The jaw is also milled or filed out to 5/16" width to accomodate the nut. Put the cross-shaft, with the other arm on it, through the holes in the bracket, and press on the actuating arm at right angles to it. Setting by "eye" is quite accurate enough for this job. The bracket, complete with shaft can now be attached to the soleplate. The front section of the brake pull-rod is twisted at right angles, and put between the jaws of the drop arm; a pin made from 3/32" steel, nutted at both ends will make secure.

The pillar or spindle is a piece of 5/32" round steel apprximately 4¾" long. The lower end is threaded 5/32" x 40 pitch for about ⅝" length, and the upper end is furnished with a boss ¼" diameter, through which is pressed a cross-handle of the well known cranked type, and made from 3/32" steel wire. Drill a 5/32" hole in the soleplate ¾" from the back of the leading beam and a full 1⅜" from the centreline of the tender. Make a little bracket from ⅛" x ⅛" anlge, or a bit of sheeet brass bent at right angles, and solder it to the tank, inside the coal space, about ⅜" from the top, and drill a 5/32" hole in it so that when the brake spindle is put through the holes in bracket and soleplate, it is exactly vertical. Two collars made from ¼" rod, about 5/32" wide, are placed on the spindle,one above the soleplate and another below it.

The brake nut is a block of bronze or brass, 5/16" square, drilled no. 30 and tapped to suit the spindle. Drill a no. 48 hole in the middle of two opposite sides, as shown in the section, and tap them 7BA. Turn up two screwed 7BA pins from 3/16" hexagon steel, threading the ends just enough to let them screw in tightly without projecting into the tapped hole; the plain part of the screws should be ⅛" long. Put the nut between the jaws of the actuating arm, and screw a pin into each side through the slotted holes; enter the screw on the end of the spindle into the nut, and adjust so that when the nut is halfway along the spindle, the arm is horizontal. Pin the collars to the spindle above and below the soleplate, so that the spindle can turn freely but not move up and down. The length of the pull rod should be adjusted so that the brakes are hard on when the nut is almost at the upper end of the thread. To prevent the nut running off the spindle when the brake is released, a hole can be drilled in the end and a pin put through. Note; a final brake adjustment should be made with the tender about ¾ full of water, and a load of coal aboard, of the tender loaded to equivalent weight.

Details or "Trimmings"

The beading around the tender coping can be made from 3/32" half round beading soldered on; the front handrail column is similar to those on the engine. The couplings on both engine and tender are plain hooks filed from ⅛" x ¾" flat steel, and are furnished with 3-link chains, the links being bent up from 3/32" steel wire and the jionts brazed, or they will open out in service. Some of the Jennies had screw links fitted in later years, when they were rebuilt or modernised up to standards obtaining at the time; but screw couplings are not suitable for the rough handling they usually get while passenger hauling, and it is hardly worth while fitting them in the present instance. The coupling between engine and tender is a plain link made from ⅛" x ⅜" strip steel with a hole at each end, the pins being ordinary commercial split pins passing through holes in a channel-shaped bit of steel riveted or screwed to the beam over a slot in same.

The tender steps on the 1847 series of engines were "stirrup-irons" as shown on thh loco g/a; but later ones had plate steps as shown on the tender drawing. If you prefer this type, simply fill in the openings between the front horns and the leading tender beam, with a piece of 1/16" sheet which may be attached to the inside of the frame with 1/16" rivets or small screws. The steps can be made from pieces of angle, or sheet metal bent to an angle section, and riveted to the plates. The upper steps are ¾" long and the lower ones 1".

Spring buffers.

All the rebuilds, and the later series of new engines, were fitted with spring buffers, and a section of suitable "flush back" spring buffer is shown here. Complaints are often received from readers who build small locmotives, that there is difficulty is providing clearance for the tail plunger and nut of the usual type of spring buffer, owing to the tender frames getting inthe way. Personally, this trouble never affects me, as I simply poke endmill into the socket hole, and that soon makes the clearance, irrespective of what is in the way. The present buffer gets over all these difficulties, and all it needs is a hole in the beam itself, to recieve the screwhead when the buffer is right home; and even that may be dispensed with if a countersuk screw is used to fix the washer.

As the socket is attached in the present instance by a square flange in each corner, turn the sockets from the malleableiron castings held in the 4-jaw to the shape shown in the drawing, then centre, drill ⅜" clearance, before reversing carefully into the 3-jaw, and removing the cast spigot by sawing, and then facing right across. Counterbore $\frac{5}{8}$" deep with a $\frac{1}{2}$" drill. Drill a no. 41 hole in each corner of the flange after trimming this to size. The heads are turned again from malleable iron castings, held by the flange, face, centre and drill no 48 for about $\frac{5}{8}$" and tap 7BA being very careful not to break the tap in the blind holes. Turn $\frac{5}{8}$" of the outside to $\frac{3}{8}$" diameter using a roundnose tool and leaving a radius as shown. Reverse in the chuck and finish off the head as shown. Put the stem in the socket and turn up a washer about 3/32" thick an easy sliding fit in the counterbore; attache it bo the stem inside the counterbore by a screw as shown. Put a 20 swg steel wire spring in the socket and attach the lot to the buffer beam by 4 x 7BAhex bolts. When the buffers are compressed, there is nothing projecting through the beam, and the washer prevents the head coming right out when the buffer is fully extended. A somewhat similar arrangement is used for "self contained" buffers in full size practice.

That is about all there is to tell about the earlier Jennies. The later series had weatherboards, and if you wish your model to represent those, a suitable type of weatherboard is drawn. It is merely a piece of 1/16" brass sheet cut to shape shown and attached to the top of the firebox wrapper behind the safety valves by a couple of small pieces of angle and brass screws. The windows should be "glazed" with mica or cellophane (perspex) retained in place by rings turned from brass, riveted to the weatherboard with small rivets (1/32" or 3/64").

As to painting I have given instructions for this several times already, but to repeat briefly for new readers' benefit, give the engine a thorough wash down -- outdoors! in petrol or similar, to remove all traces of grease; then when thoroughly dry, paint the boiler and smokebox with any good heat resisting enamel. Stand in some place free from dust and put a tiny flame in the firebox. Heat to just below boiling point and keep it at that temperature for about 12 hours which will effectively "stove" the enamel, so that it will not be affected anymore by heat, dirty water, or splashes of hot oil. The rest of the engine can be dried off in air in the usual way. The usual colour of the Jennies was dark green, with black smokebox, maroon or chocolate framing, and red buffer beams.

Additional Notes

Since LBSC penned his instructions for Jenny Lind, and these were published in 1943, conditions of supply have changed since those days of wartime restrictions, thus many materials hard to get then are now readily available, and more sophisticated ones are also readily to hand. The use of adhesives of the cyanoacrylate type - "Loctite" has superceeded the old press fits in many instances and can certainly be used, (though at the builder's discretion), such as in assembly of the crankshaft. It must be used here carefully though, and must be kept away from the collar if the slip gear is used.

Construction of boilers has also "advanced" considerably, and the original notes have been amended slightly emphasising the use of bronze for fittings and bushes. Also boiler plates are no longer threded directly for fittings and a separate bush silversoldered into the plate first is now recommended. It is quite possible to silversolder throughout using one grade of solder of which "Easyflo" is perhaps the best, relying on the fact that the remelt temperature of work already done is appreciably higher than the initial melt temperature. Note that phosphorous based silver solders should not be used where components will be subjected to sulphurous atmospheres at high temperatures, ie in the firebox and smokebox, but could be used on external joints if cost considerations are important. Cadmium free solders equivalent to Easyflo are also available, but are higher priced. Do read up more modern literature concerning construction of miniature locomotives and boilers before commencing construction, as it is quite possible that preferable methods and materials can be adopted.

LBSC's original and inimitable style has been amended only slightly and where obviously superfluous writings were given and not connected with this model, or where it has been found convenient to supply a casting instead of a complex fabrication of a component. Description of the injector has been omitted as these can be commercially obtained and guaranteed to work within their stated range. An amateur requires considerable experience before he can make one, even to LBSC's instructions; they do not always work and are troublesome in the very small sizes to locate and correct the fault.

CASTINGS & ASSOCIATED MATERIALS FOR JENNY LIND.

Drawings RV51 (6 sheets)
Mainframe steel
Bufferbeam material; (loco)
Main hornblocks
Main axleboxes
Leading & trailing axleboxes
Leading & trailing springs
Leading & trailing wheels T78
Sandbox/stretchers.
Driving wheels D158
Cylinder castings set (11 items)
Piston blanks
Crossheads
Big end brasses
Eccentric straps (slip gear)
Eccentric straps (Stephenson gear)
Motion plate
Reverser stand
Smokebox door
Smokebox front ring
Dome bush & ring
Regulator block
Chimney
Outer dome body
Outer dome cap
Safety valve casting
Driving wheels splashers
Tender frame steel
Tender buffer beams
Tender axleboxes
Tender springs
Tender wheels T78
Tender brakeshaft bracket
Tender handpump & valvebox
Bufferheads & stocks
Fixing angle for loco & tender beams.

Boiler materials set including flanged plates, or
Flanged plates only (set).

Prices for all above may be found in our comprehensive catalogue and price list, or on request accomanied by 9 x 4 SAE.