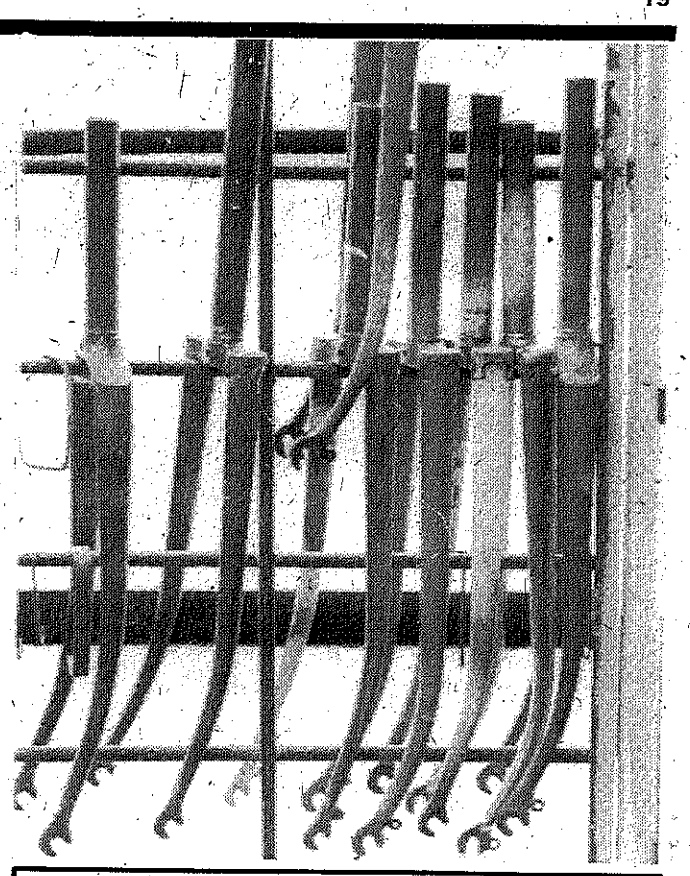
FRAMES

THERE'S nothing new under the sun in frame design. Or is there? Do six-day riders use too-steep seat angles; could kilometre riders hold a steadier line with shallower head angles, and go faster on steeper seat angles; and how many women riders have to make do with frames that look like cut-down larger versions?

Inviting discussion on these and other themes, frame-builder Dave Moulton airs his views on how frame design can be improved.

Also in this feature, news from other frame builders.



Time for a new angle

More experimenting with Dave Moulton

CYCLE racing is a unique sport which really has no parallel with any other sport. Apart from rowing I can think of no other where you have a machine propelled entirely by human power. As in all sports great strides forward have been made in training methods, but is the machine itself being exploited fully? One area which I believe could be developed further is in the design of the frame.

When engineers are designing and developing a racing car or motor cycle, the engine is developed to achieve maximum power, and the car chassis or motor cycle frame is designed to make full use of this power with good road holding, which means minimum loss of traction, and the ability to go round corners fast with maximum safety.

Exactly the same criteria should apply to the design of the racing cycle. The development of the "engine" which in this case is the rider, is the job of the coach. The frame-builders' job should be to design the frame so that all the power of the rider develops is being exploited fully.

I feel that this is not always being done. For a start seat angles could in many cases be steeper. Look through the pages of CYCLING any week and you will often see photographs of riders sitting right on the front of their saddle, sometimes with almost the whole saddle showing behind them. This is because when making maximum effort the rider slides forward to get into a natural position, which is right over the bottom bracket. The trouble is that in sitting on the front of the saddle where it is narrower, apart from being uncomfortable it has the effect of the saddle being too low.

Watching the Olympic cycling on television recently, in the kilometre event for example, some of the riders were starting off out of the saddle for the first half lap or whatever, and then sitting right on the point of the saddle for the duration of the race. The saddle was only used for sitting on while waiting for the starting pistol. Surely there is room for experiment here with steeper seat angles, to get the rider right over the pedals, sitting in the saddle so that he is at the correct height for maximum efficiency.

Sitting farther forward has other advantages in that the rider can breathe better because his legs do not come up so tight to his chest. If you sit back you are bent double more than if you sit forward. I don't mean by this that you are sitting in a more upright position, but that the upper part of the body remains horizontal or whatever position you normally sit, it is just that your whole body is moved forward in relation to the bottom bracket.

The other advantage in this position is that with the rider's weight more forward, stability of the bike is improved, providing you don't have too steep a head angle.

This brings me to another point I noticed in the Olympic kilometre. The riders who were fighting to keep control of their bikes, and one rider who crashed, all seemed to have very steep head angles. Why anyone should need a steep head angle to give sensitive steering in an event where you travel in a straight line is beyond me. When a rider is making maximum effort the bike is tending to jump and sway all over the place and a very sensitive steering means that the rider has to waste effort and concentration in controlling the bike.

During the last 20 years frame design has changed very little. In the 1950s we had the 72 degree parallel frame, which moved on to the 73 degree parallel frame of the '60s, which is still the basic road frame most riders use today, although recently some frame builders are building 75 degree parallel frames, copying Contin-

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ental frames which are now being imported.

The other big influence on frame design in recent years, which I think is wrong — although other frame builders may disagree with me — has been the six-day track bike. Six-day racing on small indoor tracks is so specialized, and so different from other forms of cycle racing, as to require a special design of frame.

For a start, due to the steep banking there are G forces pushing the rider down on to the bike, so a shallow seat angle is called for around 73 degrees, and a fairly long tube so that the rider can sit back making a long body so that his weight is spread out, minimizing these G forces. Also six-day racing requires an in-the-saddle, fast pedalling type of effort over long periods to which this type of position is best suited.

The head angle needs to be steep, around 75/76 degrees for quick sensitive steering, necessary for switching in and out between changing riders. So here is a very specialized bike for a very specialized type of racing, and of little use for any other, and yet nearly every track frame used today, and a large percentage of time trial frames, are based on this design.

Frame builders in general are not entirely to blame for this trend in frame design. They are often only catering for the

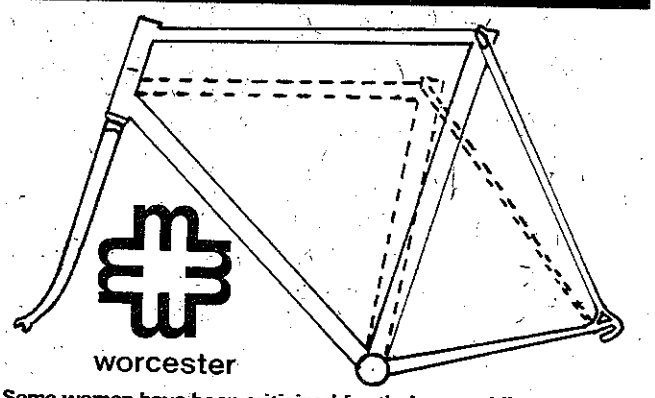
demands made on them by their customers, brought about, I can only assume, by pictures of six-day bikes and their riders shown in the cycling Press during the winter when new frames are being ordered.

A frame based on a six-day track frame may seem very attractive with its ultra-short wheelbase, and front wheel just missing the down tube (due to the steep head angle) but a frame like this will handle badly on the road, and is unnecessary in most forms of track racing where on a banked track you are in theory travelling in a straight line.

Getting back to the slow development of cycle frames. There seem to be so many traditions in frame design, often laid out in books such as the well-known cycling manual published by the Italian Cycling Federation, which makes statements but gives no reasons for doing so. For example it says that the head angle can be steeper than the seat angle but never shallower. I can see no logical reason, scientific or otherwise, for making such a statement.

This book also states that the seat angle can vary according to the size of the frame, and then goes on to say that the head tube should normally be parallel with the seat tube, but again gives no reason why.

I agree with making the seat angle steeper, for a smaller frame, and in fact build my frames this way; after all the smaller rider has shorter thighs and therefore needs a steeper seat angle. But to vary the head angle just to keep it parallel affects the steering and handling characteristics. Also, in making a frame parallel you limit the length of the top tube. If for example you have a parallel frame with a 22-inch top tube, then it becomes obvious that the measurement between the bottom bracket centre, and front wheel centre will be 22-inch plus the fork rake, say 1¼-inch which equals approximately 23¼-inch (I say approximately because the line between bracket and front spindle is not quite parallel with the top tube).



Some women have been criticized for their poor riding positions on frames that are often cut-down models of larger frames. In the photograph and diagram is Dave Moulton's answer, a 76-degree seat tube, and corresponding changes in seat stays and top tube lengths.

All this is fine for the taller rider, but what if someone wants a 19-inch frame, they must also have a 22-inch top tube, or a shorter top tube and more fork rake which again affects handling. The method I use is to start at 73 degree parallel for large road frames (23½-inch and over); then, keeping the head angle at 73 degree, fork rate at 1¼ inches I bring the seat angle up steeper as the frames get smaller, making each frame "square" with the top tube approximately the same length as the seat tube. This is shown clearly in the illustration. Of course the actual seat angle and top-tube length is dependent

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Head angle 73 degrees; fork rake 1¼ inches

Seat tube	Top tube	Seat angle
36	22½	73
35¼	22½	73
34½	22¼	73½
33¾	22	74
33	21¾	74
32¼	21½	74½
31½	21	75
30¾	20½	75½
30	20	76
29¼	19½	76½
28½	19	76½

on the rider's thigh length and other measurements, but generally speaking frame specifications work out as above.

The table is for road frames, I generally make track frames one degree steeper in the head and seat angle. I know that some people will be alarmed at the thought of 76 degree seat angles but for smaller frames this looks all right. In fact a more balanced look than a small 73 degree parallel frame with a long tip tube.

Take a look at the photograph of a top lady rider on a track frame which has a 77 degree seat angle 74 degree head, according to the Italian cycling manual this frame is wrongly built (remember it said the head angle should never be shallower than the seat. Yet how else can one build a frame with a 19¾-inch top tube necessary for a rider of such small stature? The fact that the rider has still moved slightly forward in the saddle proves that the seat angle is not too steep, in fact she is sitting correctly with the knee right over the centre of the pedal on the downward stroke. Lady riders were criticized recently after the Leicester track championships for their bad riding positions. Most ladies are shorter in the leg than men and generally smaller build all round, so it is often impossible for them to get a good riding position on a frame which is built like a cut-down large frame.

All my theories are based on frames actually built and ridden in all types of competition. I am still experimenting and may come up with other ideas in the future. This experimentation is a lengthy and costly business; it takes a whole season's riding to evaluate the benefits of a new design, and one cannot expect top riders to change to a newly designed frame in mid-season, which may affect their performance. Although I have found that in most cases a slightly steeper seat angle has had the effect of the rider going faster and doing a storming ride first time out on a new frame.

The steeper seat angle gives the same feeling of power that one gets when riding out of the saddle but without the strain and instability of being out of the saddle. I have had no reports of discomfort on long stage races for example; as I said earlier the rider's upper body is in the same position as with a shallower seat angle.

With regard to head angles, I find 73 degree ideal for the road, with 1¼-inch fork rake. This gives a slight degree of oversteer on corners, which is beneficial. Understeer you don't want, which means you swing wide on corners. Slight oversteer means you take the corner tight and by going slightly faster the oversteer is compensated.

On a track bike a head angle of 74 degree or a maximum of 75 degree, fork rake 1⅛ to ¾-inch makes for a bike that will hold a straight line in all conditions, and a steering which is sensitive but not over sensitive.

The last time I wrote an article for CYCLING I received a letter from a gentleman who said that my head angles and fork rakes were wrong, and that he had a formula taken from Cycling 1950 proving it. A few weeks later another article by Mike Mullett appeared quoting a similar formula. Am I to be criticized for putting forward ideas other than those that have been with us for over 25 years?

Many things in all walks of life that were correct 25 years ago are not necessarily so today.

The progress of cycle frame design seems to be hampered by traditions that lose sight of the practical.

Is it worth £82.50?

Bernard Thompson looks in on Mercian Cycles

SPEAKING as an ancient bike-rider who can remember quite vividly handing half-a-dozen old-fashioned green bank notes over to the late Freddy Scott of Ealing, and taking possession of my very first hand-built racing frame, it is perhaps understandable that I walk the glittering arrays of equipment at the Harrogate Show in a permanent state of shock, unable to accept the price tags that adorn them, more with pride than embarrassment.

So you want to indulge in a specialist-built hand-made frame of the very best quality and precision, what will you get for your £82.50? That tag, I discovered, is the price of Mercian Cycles' "top-four" namely the Professional Road, Vincitore Road, Superlight Road and the Strada Special, and as Mercian's workshop at Derby was dead in line on my route to the national hill-climb championship at Llangollen it was a good chance to find out where the customer's money went to.

Mercian Cycles' owner Bill Betton employs 12 people, of whom four are actual frame builders, and they turn out 1,000 frames per year. Of these 300-400 are for export to such countries as the USA, West Indies and South Africa.

There are also two apprentices in the workshop, a status that Bill Betton once held 20 years ago, learning the intricate and delicate ways to produce a thing of beauty that will carry a racing man at speeds of 30mph plus.

The four men in the process of filing elegant lug designs, brazing tubes to lugs — a crucial operation this — and tickling away at the lugwork filigree at a later stage like surgeons with lancets, are highly skilled. A set of lugs could take up to three hours of careful drilling, sawing, filing and sweat to produce in readiness for assembly pre-brazing.

Betton admits that it took him 18 months during his apprenticeship to fully master the art of cutting out those intricate lugs.

He handed me a couple of lugs in the rough, just as they are handed to the frame builder, and I walked over to a finished frame hanging like a pearl necklace in a jeweller's shop window. Holding the lug alongside its finished companion it was beginning to dawn upon me where the money was going!

Derek Land was welding a partly built Vincitore Road frame, and playing a flame around the head lug in the process of brazing. The lugs were secured to the tubes with brazing pins and the frame's alignment is held in check step by step throughout each operation of lug brazing. It all looked easy, but like most things that are difficult

A STEADY hand, a steady eye for painting.

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they *are* easy, but only if you have practiced a thousand times before.

Take the oxy-acetylene torch for instance, a fine lance of flame that Derek applied to the thin tubes in brazing such extras as gear-lever bosses, cable eyes and gear-cable channels; one lapse in concentration on that job and he would burn a neat hole through a piece of virgin 531.

I asked Bill Betton why he leaned towards brazed-on fittings of this kind when the fashion among European racing men appeared to be for bare frames with bolt-on fittings.

"Money and skill," he answered. "It is more expensive in that it is a highly skilled job as you can see, using the big flames that consist of compressed air and natural gas is comparatively safe and easy, but a lot of damage can be caused by that oxy-acetylene torch if it gets into the wrong hands." In other words, the hallmark of a highly skilled frame builder is the neat set of gear bosses etc on his finished article, they could not have been put there by some ham-fisted iron-fighter, only by a man of long experience with a touch of a watchmaker.

With 12 employees and 1,000 frames per annum output, Betton thinks he has reached the limit at which he can control quality to his high standards. Thus his big problem is not to grow too big; any new equipment he buys is to aid efficiency and help raise that standard. He was awaiting delivery of £3,000-worth of shot-blasting equipment to replace his old set-up, shot blasting being a vital process during building, cleaning off the scale and later, when the final overall "blast" creates the ideal key for spraying. Not many "small" lightweight builders can boast an efficient spray shop, with two booths and two capacious ovens set in a large airy room.

Betton talked at length about finish, but not of temperature control; that apparently is something of a trade secret learned the hard way over many long years, a case of having something good and hanging on to it!

'A LOT of damage if it gets into the wrong hands.' A Mercian comes under the torch.

A touch of the Continent

THERE'S more Continental atmosphere to Emperor Sport than the white station-wagon with Roger De Vlaeminck supporters' club stickers and Flemish plates that usually stands outside.

Inside the tiny shop run by one of the south's best-known double-acts are books, posters and photographs bringing giants of the road to a Surrey public — that's if you can spot them among the welter of equipment, bicycles, frames and wheels in the crammed quarters.

The influence extends to the service provided by Tony Mills and Mick Coward, who, after a rigorous pair of careers of over 25 years as amateur, independent and professional riders, set up the business about three years ago.

They are permanently on the look-out for new, bigger premises that could include space for the crowd of "regulars" to idle away their training hours. Until they find them, Tony carries on wheel and bike-building either side of the counter and Mick is banished to his shed in the yard, where all day, some weeks every day, he builds frames.

Coward started his career in 1950 with the Nomads, in 1958 joined VC Sacchi and two years later became an independent for Fred Dean. Spells with Stan Saunders, Ken Ryall-Raxar and Ernie Witcomb followed. Then on to Geoffrey Butler-Coventry Eagle, later to become Geoffrey Butler-Sun, with Tony Mills as manager.

"We used to go and race in Belgium quite often" said Mick. "One weekend with the pros in Britain involved a 15-mile event in Wavertree playground, Liverpool, then a 15-mile race on the Lydden circuit. So often there was less travelling involved if we went to Belgium."

Appetite whetted for the Continental scene when he decided to have one last season "To live like a real pro for a year!" He moved over to Belgium and the Ruberg team for a season of kermesses. The next year was '71; no transport; back to Britain.

He had been trained as a surgical-instrument maker and had often asked to try his hand at frame building while whiling away hours bikie-fashion in Geoffrey Butler's. "You can start if you like," they told him.

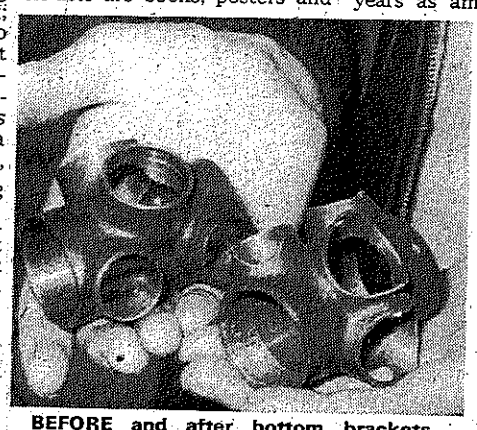
He took two weeks off from work — and went to work as a frame-builder. There was no one to show him the ropes, no ready-made jigs, no tools, so it took him a while to get going. The result was what he calls a "green monstrosity" — still in use — and an offer to "Start when you like."

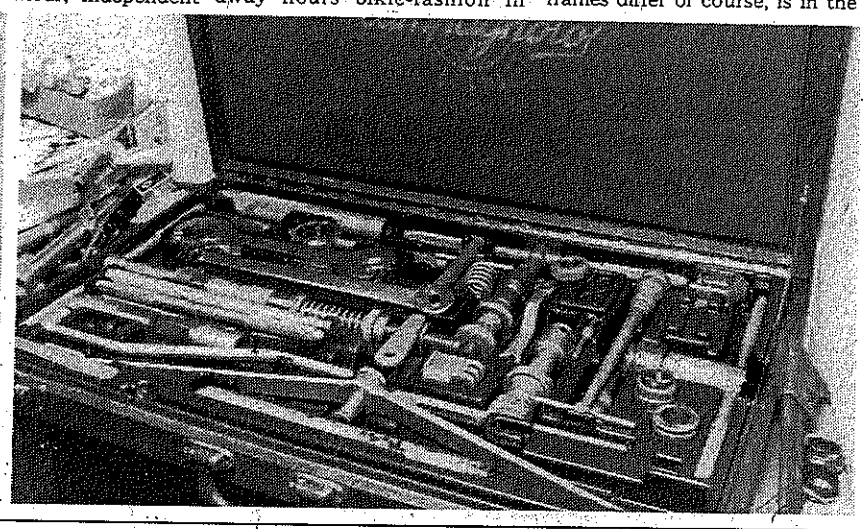
He worked as a full-time builder for "GB" and so the progress to the Emperor Sport set-up in Sutton. Tony Mills handles the retail and over-the-counter business, while Mick does all the frame-building in the large shed at the back of the shop, a set-up that despite its apparent deficiencies and primitive look, works quite efficiently.

"It's even worse when you're building in a shop," says Mick, "with having to serve customers as well," a sentiment surely echoed by hundreds of builders up and down the country hunched over their work in shabby outhouses.

Working on his own, uninterrupted, Mick builds three frames a week, keeping "semi-normal" hours. If there's a rush on, then days off and Sundays go by the board, and when the hot spell was with us he started work at 6am to catch some cool hours.

"Yes, I designed the jig and most of the tools myself. Most of us do, and we all seem to arrive at much the same thing." Where the frames differ of course, is in the





BEFORE and after bottom brackets. Right, an expensive but time-saving frame and wheel building accessory, Mick Coward's £600 Campagnolo tool kit.

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individual skills and experience which the builder brings. And with Coward that's over 25 years of first-hand racing experience, much of it at professional level, which makes him highly sceptical.

"Testing bikes with the tyres touching are for straight-line cycling; we'll build them if they want them, but they don't look anything like the ones Merckx or Maertens are riding."

"Six-day bikes with road ends" he dubs them. They do have a use if they are purely racing machines, but too often they are commissioned by riders aping the successful, riders who will then train on them and wonder why the aches start.

"Road-racing frames should be at least 73 degrees parallel; bigger frames can be a bit steeper, up to 75. We don't do a stock frame. We like riders to bring in their old bike and also any photographs of themselves racing then we can talk it over.

"You can't have set angles. Your seat angle determines where your knees bend, so a rider with long thighs will need a totally different frame."

Although his workshop looks like an illuminated junkyard, and you have to be careful where you put your feet, Mick reckons its only drawback is the time wasted moving from one stage of the job to another and the subsequent re-arrangements of the piles.

"I build three frames a week at the most. If you are doing batches of stock frames, all the same size, then you can do about five a week. But with "specials" every setting is different, the jig has to be reset, measured and checked after each one."

Super Vitus-super tested

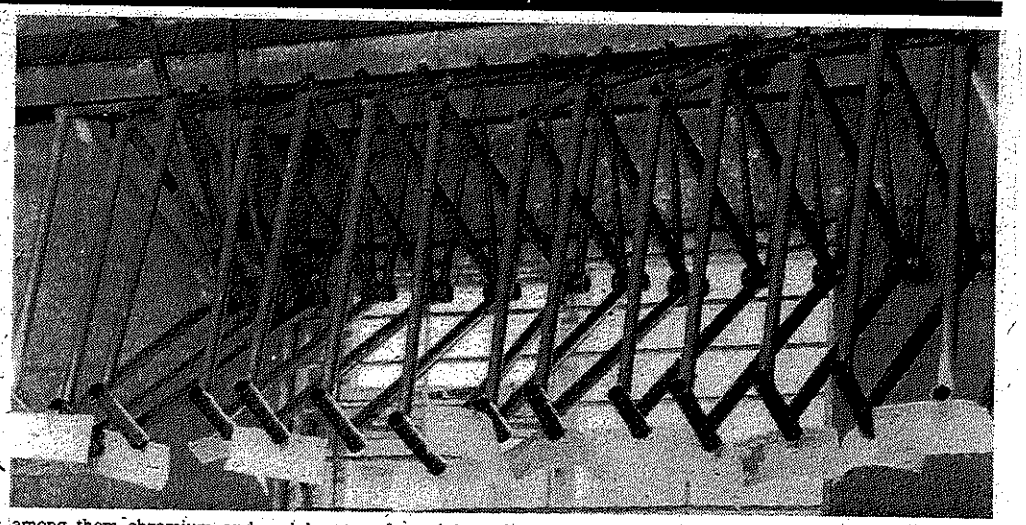
A FRENCH answer to the British, Italian and Japanese tubing on the market is the Ron Kitching-distributed range which is topped with Super Vitus 971.

Supplying tubing of sufficiently high quality to make bicycles is no hit and miss affair. Tubing is tested chemically and metallurgically before being passed on for use, and, in the case of Super Vitus, the lightest of this particular range and the one of "Professional" standard, stringent tests are continued throughout production.

The Vitus tubing was chosen after a long hard look at the stresses imposed by bike-riding. It must have resistance to the flexing imposed by a hill-climber weaving upwards as well as being able to cope with the continuous wearing vibration of a bad road surface and the sudden, wrecking shock of a pothole.

But at the same time, bicycle tubing must be light and rigid enough that it doesn't impair the transmission of the rider's power to his wheels.

Vitus was chosen as a "low-percentage alloy of great purity and evenness" according to the Kitching technical report. Certain metals, among them chromium and molybdenum will weaken the original metal when added. The tubing must also be "pure", to guard against cracks, said to usually develop from non-metallic additions.



Microscopic inspection and even a check on the size of the tubing's particles and the iron-carbon conversion is carried out. This helps to ensure that weakening ferrite is totally absent.

When the tubing has been produced three checks are made to ensure exact specifications, dimensions, texture and mechanical characteristics.

The tubes must be of different thicknesses depending where they are to be used on the bike. Frame tubes are 0.6mm thick, butted to 0.9mm; chainstays and seatstays 0.8mm thick and fork blades 1.2mm thick.

By various mechanical and heat treatments the metal is gradually transformed into the ideal. Just as important as the thickness is the actual composition of the metal, or the texture.

The manufacturers have made certain there is no ferrite, then the iron atoms are transformed into cementite and martensite and the material develops a fine crystalline structure of close-knit grains, all of which goes towards making the finished tubes resistant to "fatigue and fracture."

In this way the manufacturers have changed their basic material, originally called XC 35, through their own process into high-grade bicycle tubing they dub Legeres Super Vitus 971.

The Kitching technical report felt that only a "fatigue test" could give worthwhile data, and that the best form of testing should be carried out on the road. But the Union Technique de L'Automobile du Motorcycle et du Cycle (UTAC), based in Paris, tested Super Vitus with an 800lb loading on the seat tube. Distortion (and fractures) were nil.

When your neighbourhood bike-builder takes delivery of his consignment, he doesn't just unpack it and braze away. In the winter it should be kept in the workshop for a while to warm to room temperature; brazing must be carried out at low-pressure, low temperature, on the thickest part of the tubes only — and as quickly as possible, so that no heat travels down the tube.

The Geffac-produced tubing is available in three qualities: Super Vitus 971, the long-distance touring tubing Vitus 172, and touring Durifort.

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New business for the New Year

WALLACE SPORT is Wallace McNaul's new frame-building business opening in the New Year in Ballymoney, Co Antrim, Northern Ireland. Already he has designed the prototypes upon which he will base his framesets.

It will be something of a comeback for Wallace, for in 1960, when he formed the Club Route Wheelers, later to become Team Route, he built a few framesets in the local technical college, and they were named Wallace Sport.

Time didn't permit him to build both frames and run a team, so the frame building stopped.

Illness kept Wallace out of the sport for a while, but recently a meeting with an old friend rekindled the interest in frames, especially as there was offer of help.

The range should include three framesets, a road model with 73-74-degree angles, new Campagnolo Super Record short ends, rear brake bridge with Allen key fitting, flush bottle-cage bosses, and an Allen key seat bolt, and time-trial model with the new Zeus 2000 track ends and fork crown.

The third model will be constructed from the new Reynolds 531 special lightweight tubing, and all frames will have transfers designed by a local firm.

NOT all finicky work, this frame-building! Mick Coward takes the first steps in shaping a pair of front forks.

Exclusive

EXCLUSIVE to the W. F. Holdsworth branches at Putney, Penge and the new Welling, Kent, shop are a £62-£115 range of frames designed by and bearing the name of Roy Thame, the Holdsworth Campagnolo team manager.

The all-round Competizione is a standard 73-degree parallel road or touring frame, or 75-degree track frame at the bottom of the range at £64 (road) or £62.50 (track). Campagnolo or Shimano front and rear ends, Italian fork crown, wrap-over top eyes and lugs with small windows cut in

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them are features of this off-the-peg frameset.

At the other end of the scale is the Roy Thame Campionissimo Superlite, the pursuiting or time trialling frame built in Reynolds 531 Superlite to customers' specification.

Ordinary road or time trial Campionissimo frames are £94, the Superlite is £115. Common to all are the Prugnat lugs handcut and filed by top short-distance man Bob Donington into Ace of Clubs design.

The road-racing frame uses the Campagnolo Super Record short ends, fluted chainstays and seat stays butted to the seat lug with the Thame arrowhead design. The time trial model is built with vertical drop-outs which are finely drilled and shaped, and has very short rake forks and rear triangle with seat stays butted on to the Allen-key seat bolt housing. Special design for the track frame means chunky seat and chainstays, shallow rake forks and a high bottom bracket.

In between the two extremes are the Roy Thame Italia frames, a few of which are carried in stock. The standard model is 73 degrees parallel has new pattern cut-out and filed lugs and a variety of top eye designs, including drilling.

Silver Superlite

IF you make a mistake the tube will ripple, the frame is ruined, and that's one reason why ordinary brazing won't do when working with Reynolds Superlite tubing.

Harry Quinn uses this in making the 3¾lb frame that adds up to a bike costing £595, the Super Time Trial 75, which visitors to the Harrogate Show will have seen.

Although its name ties in the company's 75th anniversary, the model will be available to order when the year is up, but you will wait 10 weeks, such is the time needed to perfect such an exquisite model.

Helping Harry on the filing and cutting of lugs is Billy Whitcomb, and because these lugs compare in thinness to the Superlite tubes the extra care in assembling the frame is an absolute necessity.

Silver-soldered because silver has a low melting point, seven-foot long sticks of silver at £1.50 a time are used in each frame. Silver soldering is very strong, and the low temperature means the tubes cannot overheat.

The forks are oval section, the rear ends vertical dropouts; and contributing to its lightness the fork column is drilled.

If there's still doubt as to the frame's purpose, the worked-on equipment proves it to be for time trialling only.

Campagnolo brakes have stirrups hollowed out, the brake levers slotted — all hand done, and not a flaw to be detected.

The stem is slotted, Harry Quinn's name engraved inside; and Campagnolo Super Record equipment, including seat pillar, pedals and chainset, speaks for itself. Every bolt is titanium. The wheels are radial-spoked, 24 front and 24 tangent rear — but back to the frame. The finish is in a new Italian flam, which needs no lacquer. The whole bike weighs under 16½lb.

Bird at the back

"I'M not cut out to be a shopkeeper, I'm a mechanic and a frame builder," said Alec Bird who, for those very reasons, has left his shop at Welling, Kent, to concentrate on the sole job of building frames.

But he's not gone far, to the back of the very same premises in fact, and the shop itself is taken by W. F. Holdsworth.

"I'd like to be able to concentrate on building the super special jobs," said Alec, who prided himself this season on building an especially light time-trialling bike for one of Britain's short-distance stars.