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TRIPPER DRIVING IN MULTIPLES

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TRIPPER DRIVING IN MULTIPLES

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1. OVERVIEW

2. RECAP; "TRIPPER DRIVING BY TENSION CONTROL"

3. LESSONS TO BE LEARNT FOR THE QUANTUM LEAP
   TO MULTIPLE TRIPPER DRIVING

4. ACKNOWLEDGEMENTS

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OVERVIEW

1.1 Applications for longer underground conveyors, higher capacity, rapid installation and more importantly, - rapid retreat and removal have never before, been quite so prominent.

1.2 The rapid advance - rapid retreat longwall maingate or breaker line support panel section conveyor, in many underground coal mining cases is required to be longer as part of the overall plan to spend less time and effort in mechanical and electrical capital and setup, and more time and effort mining coal.

1.3 In some cases currently in Australia, such longwall and B.L.S. panels are reaching 3500 to 4000 metres, targeting continuity of production, without panel relocation and subsequent costly interruption for periods of twelve to eighteen months.

1.4 Typically, the underground panel conveyor that would service this application would invariably require such parameters as:-

- Capacity up to 4000 metre centres.
- Be modular, light and compact in componentry.
- Be quick to assemble and super quick to disassemble.
- Adhere to the "kiss" principle.

1.5 Invariably, a conveyor of such type would involve a 1000 series solid woven, belt or similar classification thereby inhibiting "wildly" extended length through limitations set by the belt carcass ultimate tensile strength and its applicable safety factor.

This situation becomes more prevalent where the conveyor is inclined, thereby shortening the conveyors length and requiring sometimes two and three "in-line" complete conveyors all with their separate individual support equipment, to reach the desired 4000 metre length.

This method certainly follows the "kiss" principle, however, in the case where the centre line of the conveyor is constant, the multiple in-line conveyor system is over capitalized and involves two fold the rotating components, transfer control and take up componentry than it should have.

1.6 "Linear" boosting conveyor systems have been installed to allow for greater distances to be covered by a single flight of conveyor by single strand utilising a lower rated belt carcass, and while in most cases, present and excellent solution, do not suit the rapid advance, more rapid retreat conveying application, in fact become painfully time consuming with rather large loss of production on retreat, as demonstrated at Ulan Coal Mine, Mudgee, Australia in 1991 where the sheer length and bulk of the booster became prohibitive for rapid retreat.

The linear booster conveyor is therefore more suited to a permanently installed main line or trunk conveyor where degradation of product conveyed must be kept to a minimum.

1.7 Through this course of learning in Australia, the Queensland and N.S.W. Coal mines have now settled into the use of Tripper Driveheads to boost the ever - longer rapid advance and retreat conveyor.

The distinct advantages of the tripper, especially in the case of the tension and speed control methodology are;-

* Speed and ease of installation (three shifts)
* Speed of tripper pullout (two shifts)
* Compact size
* Possibly the greatest advantage is to "independently" add or subtract the tripper drive to the conveying system and gain its full controllable power-to-the-belt value with only one interaction command with the rest of the conveyors control drive and take up system, that being to start the trippers main motor, off load.

1.8 Material degradation across a tripper is minimized by reasonably elaborate chute work, however, given flow, direction velocity of production and belt, trough angle and contact surface are all the same, conveyed material degradation is minimal

It is certainly fair to say that tripper driving is in Australia to stay and is considered an excellent and growing solution to extending the length of the rapid advance and retreat conveyor, rather than duplicating a more extensive and laborious system two or three times in a row.

However, In line with this conference theme, it has not been without problems.

Section two of this paper re-visits briefly; "Tripper driving by tension control" as I described at Beltcon 7, and is pertinent to the single tripper assisted system.

Section three of this paper deals with a multiple tripper system, one host drivehead and two equally spaced trippers.

When considering "CONVEYING OF MATERIAL AND THE PROBLEMS ENCOUNTERED" with a single tripper system, the root message of this paper is when designing to convey with two trippers, the "problems encountered" don't just double, they increase by the square of the drives installed in the conveyor!

However!, I have it on good authority, that having mastered the dual "host" plus two dual tripper system,...... then three, four and five trippers in one conveyor system becomes a breeze!

The essence of this paper is to explain a few of the traps, limitations and points to avoid when designing and commissioning a multiple tripper driven conveyor system.

SINGLE TRIPPER DRIVING
BY TENSION CONTROL

2.1 Tripper driving by tension control involves installing one "host" conventional drive, in the conventional location and ensuring that its mechanism to accelerate to full speed is extremely smooth and shock free.

A sinusoidal or linear ramp can be selected however, no more than 120% F.L.T. should be applied throughout the conveyor acceleration.

An additional valuable consideration, is for the "host" drive to be capable of "jogging" before full acceleration for a measured period, such that the carry strand of the conveyor can be fully elongated prior to acceleration to full speed.

2.2 Approximately one third of the conveyor length, towards the loading end, I would locate the tripper drivehead.

Further calculus and charting would disclose an optimum "window" to locate the tripper, however, for this example, I locate the tripper 1200 metres inbye of the conveyor delivery point.

The total 1:8 safety factored conveyor belt carcass carrying capacity would extend from the delivery point, to a point well inbye of the tripper location, but not as far as the tail piece or loading point of the tripper assisted conveyor.

For example; I have given a "subject" conveyor profile 3000 metre centres with no lift, at 1700 tonnes per hour on 1200 wide 1000 series solid woven conveyor belt.

The demand power requirement for this conveyor would be 550 kilowatts and if this power were installed at the host alone, a T.max of 170 kilonewtons would be generated, thereby dictating a considerably higher class of belt.

However, by installing two by 200 kilowatts at the "host" drivehead and one by 200 kilowatts at the tripper the distribution of high tension is spread and shared, and now, with two high tension points of 106 kilonewtons each, the conveyor becomes a comfortable prospect.

* If this installation were two in-line conveyors, I have avoided the capital cost, installation, maintenance of one loop take up, winch, winder, delivery point, transfer chute, associated electronics and electrics.

* If this installation had 600 kilowatts installed at the conventional drive only, I have avoided the capital cost of a belt selection requiring some 60% greater working capacity in waft strength.

2.3 The tripper drive tension control device is located on the T2 point of the belt carry strand, after driving but before re-loading, and is designed primarily to sense and report single strand T2 belt tension to the tripper drive "PLATINUM BOSS" 300 speed control transmission.

2.4 Under normal running conditions the trippers "PLATINUM BOSS" transmission is slipping at 4% continuously, such that, - should "over T2" tension dictate, the tripper belt speed can be increased by the tripper BOSS, thereby gently out running the "host" belt speed, and as a result, sharing demand power between the host and the tripper driveheads.

2.5 A key point to "tension controlling" with "response by velocity change" is that the belt tension itself dictates and limits the delivery point belt high tension to the designers requirements by calling for transmitted tripper drive torque, as, and only when required.

2.6 To reiterate the conveyor "system" operation, - On acceleration of a fully loaded, tripper assisted-by-tension-control conveyor, the "host" conventional drivehead is "attempting" to accelerate the full length of conveyor, however, as the delivery point belt tension tries to pass 106 kilonewtons, its counter part T2 tripper belt tension "tries" to exceed 62 kilonewtons (or the "TARGET" T2 value), - preset for application of torque at the tripper.

The tension control unit then induces tripper drive transmitted torque, "holding down" the tripper T2 belt tension to 62 kilonewtons by drawing current on the tripper drive motor.

Hunting of belt velocity and magnification of transient dynamic waves in the belt length must be avoided at the tripper. Neglect in this area results in the tripper transmission device perpetually "chasing" the T2 target set point, due to lack of sensitivity that the tripper transmission itself has created.

TRIPPER DRIVING IN MULTIPLES

3.1 Our company has now had considerable experience in the multiple tripper driving field of design, manufacture and support expertise, and, as previously mentioned, many design and practicality problems were encountered.

I list the sub components for attention summarily and then return to each there after to highlight and detail their significance and role when specifying for a multiple tripper driven conveyor. The sample conveyor drives are noted, HOST,. TRIPPER #1 AND TRIPPER #2

3.2

a. Conveyor belt

b. Conveyor belt fastening

c. Electric main motors

d. Transmission device for "host" drivehead.

e. Transmission device for "tripper" driveheads.

f. Tripper driveheads percentage-of-speed advantage over the host drivehead.

g. Communications (for central monitoring) between all drive stations.

h. Method of control of tripper transmission device.

i. Acceptable tolerance of trippers belt velocity and T2 tension.

j. Commissioning in the true sense.

3.3 CONVEYOR BELT

The conveyor belt itself must have no higher allowance in the worst acceptable case of 1.4% stretch at 10% U.T.S. (or normal maximum working tension). In cases of multiple tripper installation currently being installed in Australia, solid woven 1400 series belt is being specified and produced with a limitation of 0.8% maximum stretch at 10 % U.T.S.

Ignorance of this specification gives the double tripper tension controls a lack of positive stiffness to the entire system.

In all cases of multiple tripper driving, worldwide to my knowledge belt stiffness ranges from 11,000 KN/M width to 15,000 KN/M width and would not be specified under 9000 KN/M width. Rule of thumb dictates the heavier and stiffer the conveyor system is, the smoother and less difficult to control it will be.

3.4 CONVEYOR BELT FASTENING

A multiple tripper system would be best spliced or, at lease be allowed 80% of the belts U.T.S. by the fastening system. By sheer nature of unusual length, mechanical fasteners (or weak joints) are multiplied.

Multiple tripper assisted conveyors in a rapid retreat installation are generally vulcanized spliced with one mechanical fastening in the belt length. As the conveyor belt length is shortened and belt removed from the system, the mechanical clip joint is entirely replaced.

Where multiple mechanical joints are used in such a conveyor system, they are month colour-coded and timeously replaced prior to deterioration on a standard maintenance programme.

3.5 ELECTRIC MAIN MOTORS

It is essential that the host drive and tripper drive motors be matched sets and their minimum pull-down speed be cross matched against, and added to the resulting pull down speed of elongation (belt stretch) between the host and first tripper, and then re-examined against unloaded motor maximum speed at tripper #2.

The net effect in speed advantage to tripper #2 must then be re-cross examined against the maximum mechanical speed advantage predetermined (or transmission slip) and offered to the multiple trippers, over the host drive.

For example, should section one of the sample conveyor (figure 6) be partially loaded, and section three be fully loaded, then tripper #2 must at all times be allowed a minimum of one percent speed advantage over the "host" drivehead. Failure to consider these four speed variables, and closure of the speed advantage envelope will of course unbalance the entire conveyor system.

3.6 HOST DRIVE RAMPING DEVICE

The ramping control system, is at least, the trigger for control at the trippers, therefore the ramp delivered by the "host" drivehead must be gentle and separate carry strand elongation (with jog prior to ramp) from conveyor acceleration.

Any contraction of the carry strand during belt ramp to full speed will be seen by the tension controls at the trippers as a low tension "back off" signal, which would be, of course totally contrary to the exact needs of the accelerating belt.

Oaky Creek Mine demonstrated the obvious need for a gentle slow ramp when their first violently accelerated, single tripper-assisted maingate conveyor repeatedly snapped the carry strand, three times a week for eight weeks, - always 200 metres outbye of the tripper; - always just after start up.

Now affectionately known around tripper driving circles in Australia as the push-me-pull-me or the great Queensland Black Hole Kangaroo effect.

3.7 TRANSMISSION DEVICE FOR SLIP CONTROLLING THE TRIPPER DRIVES

Probably amongst the most important considerations to tripper driving, certainly regarding multiple tripper driving is the accuracy and control with which 200 to 300 kilowatts can be transmitted in 4% slip, and then, capable of controlling slip to plus / minus 1% in order to predictably and gently de-tension and hold at the required set point, the tripper T2 belt tension.

Smooth operation, especially in multiple tripper driven conveyors is paramount as, if tripper one "grabs" or displays any instability, the resulting dynamic belt tension wave will, of course, upset and unsettle tripper two somewhat magnifying the tension wave and resulting belt tension / speed oscillation back to tripper one and so on, until the entire conveyor is suffering something not unlike the "Great Queensland Black Hole Kangaroo Effect", just prior to disintegrating.

There are however one or two excellent controlled and purpose designed slip devices produced and designed specifically for this purpose.

3.8 TRIPPER DRIVES SPEED ADVANTAGE

It is essential that the tripper or multiple trippers, when "locked up" at full speed hold a significant, pre-calculated (ref 3.5) speed advantage over the "host" drivehead.

Although this characteristic should be individually designed to suit, this speed value typically falls between 3.5% and 5% over "host" speed.

Should the intolerance of selected belt, tripper slip device, electric motors and speed advantage have to exceed 6%, then I strongly suggest you avoid multiple trippers.

3.9 CENTRAL MONITORING OF ALL THREE DRIVES (MULTIPLE TRIPPERS)

It is of paramount importance to provide, when commissioning and maintaining multiple tripper driveheads, a central, and extensive trending data system.

Such a system should be capable of monitoring and trending three points on each drivehead and superimposing the result simultaneously.

Without this important data, it is near impossible to successfully tension and load share tune each of the three drives equally.

Feed back and trended data should include motor currents, proportional torque to each drive pulley, T2 tension at the two trippers and at the "host" drivehead along with carry strand belt velocity at each drivehead and pulley surface speed at each drive pulley.

In the case of a maingate or similar rapid retreat conveyor, load sharing and minor software changes must be made, as a matter of daily routine as the conveyor centres shorten, however, this can not be accurately done without the "tools" to do so.

3.10 METHOD OF CONTROL OF TRIPPER TRANSMISSION, AND RAMPING DEVICE

In all cases, in single or multiple tripper installations we now specify and use only 504 programmed control logic given its flexibility and its capacity for trimming and load sharing changes "on-the-run".

Although my company provides the tripper driving software on commissioning, we are all painfully aware that every conveyor is different and, "its" tripper will require minor changes and sometimes complex adjustments prior to the conveyor settling down. These "complexities" are made almost "child proof easy" with the aid of a 504, and can be conveniently ironed out within an hour of the conveyor being started up.

3.11 SPECIFICATIONS AND TOLERANCE

When contemplating the installation of a multiple tripper driven conveyor, conventional specifications to the conventional equipment should apply.

However, additional criteria should be considered.

A minimum / maximum carry belt strand velocity change allowable should be pre-stated, and a maximum rate of change expected.

Similarly, a plus / minus tolerance to the target T2 tripper tension allowable, for example target T2 tension = 60 kilonewtons plus / minus three kilonewtons.

The above values of course, effect each other, at each tripper drive in a multiple tripper system, and although a three percent slip tripper system may be requested for use, its operator can be quite disturbed watching belt velocity sink to 94% for considerable periods of time during the conveyors operation.

Similarly, and probably more important to the human senses is the sudden awareness of a multiple tripper driven - plus - host conveyor, of being "alive". Unlike a conventional conveyor, the tripper drives in a multiple system are continually gently accelerating - holding-and-decelerating with the changing demand (or load) on the carry strand.

Given that the human ear can detect 0.5% carry strand velocity change, a plus / minus 3% velocity tolerance can sound to the uninitiated, like this conveyor is taking a walk on the "wild side", however, as was mentioned earlier in this paper, ... In order to have true control, the tripper(s) must be able to accelerate as well as decelerate.

3.12 COMMISSIONING, IN THE TRUE SENSE

My company has been involved in many new conveyor installations, and with tripper assisted, ... and multiple tripper assisted conveyors, more than ever before, the supplier / installer must be provided the opportunity to correctly commission the conveyor.

As with most conveyor installations, initial start up and "empty" or no load commissioning always is offered clear opportunity.

However, due to the nature-of-the-beast, a multiple tripper assisted conveyor system will be quite long, and predictable and reliable end to end full loading in preparation for full load start, stopping and load sharing tests may be erratic at best.

In these cases, where continuity of load demand is repeatedly broken, the rapid retreat multiple tripper driven conveyor may not be truly fully commissioned for some time, however, at the earliest point in time, when demand by conveyed product can be guaranteed end to end of the conveyor, true reverence and opportunity must be provided to effectively commission in the fully loaded condition.

In closing, "CONVEYING OF MATERIALS, AND THE PROBLEMS ENCOUNTERED" by utilising, multiple tripper driveheads, are complex, but not insurmountable.

Possible problems are many, but can be isolated, examined and engineered out of the system.

The "PROBLEMS ENCOUNTERED" in such a system, unless professionally approached and prepared, can be huge, but the capital and operational benefits will be huge "to the square".

With the same conclusions as our "introduction to tripper driving" paper at Beltcon 7,... make no mistake, mine managers and coal companies will push for more tonnes but engineers, budgets will be leaner. We have to be smarter, with less money to spend.

Tripper assisting and multiple tripper driving, provide for these requirements admirably, although it has not been without its share of "problems encountered" along the way.

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	- K. Simpson
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Fig 2

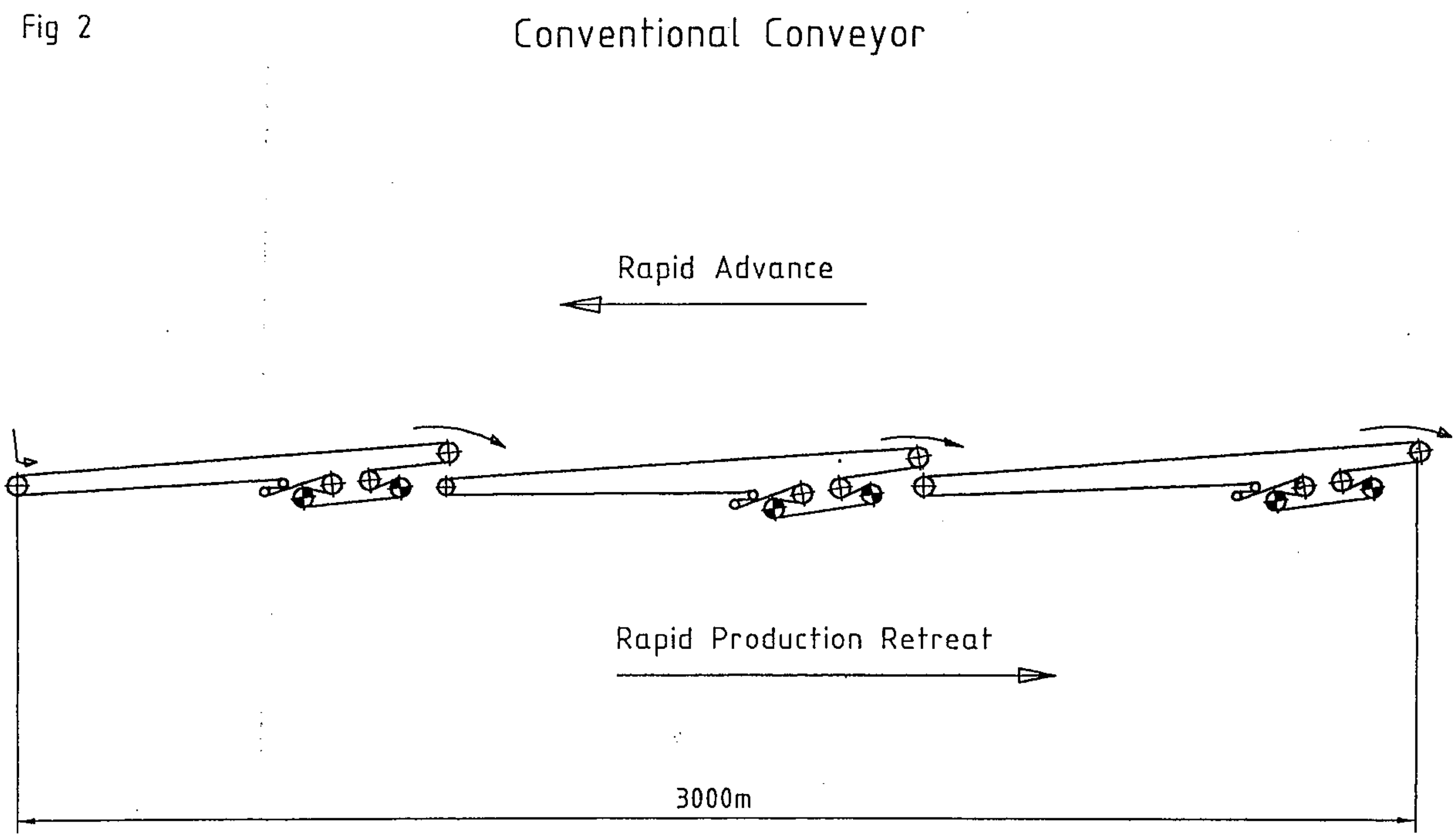

Conventional Conveyor
Rapid Advance
Rapid Production Retreat
3000m

Fig 3

Linear BOOSTER conveyor

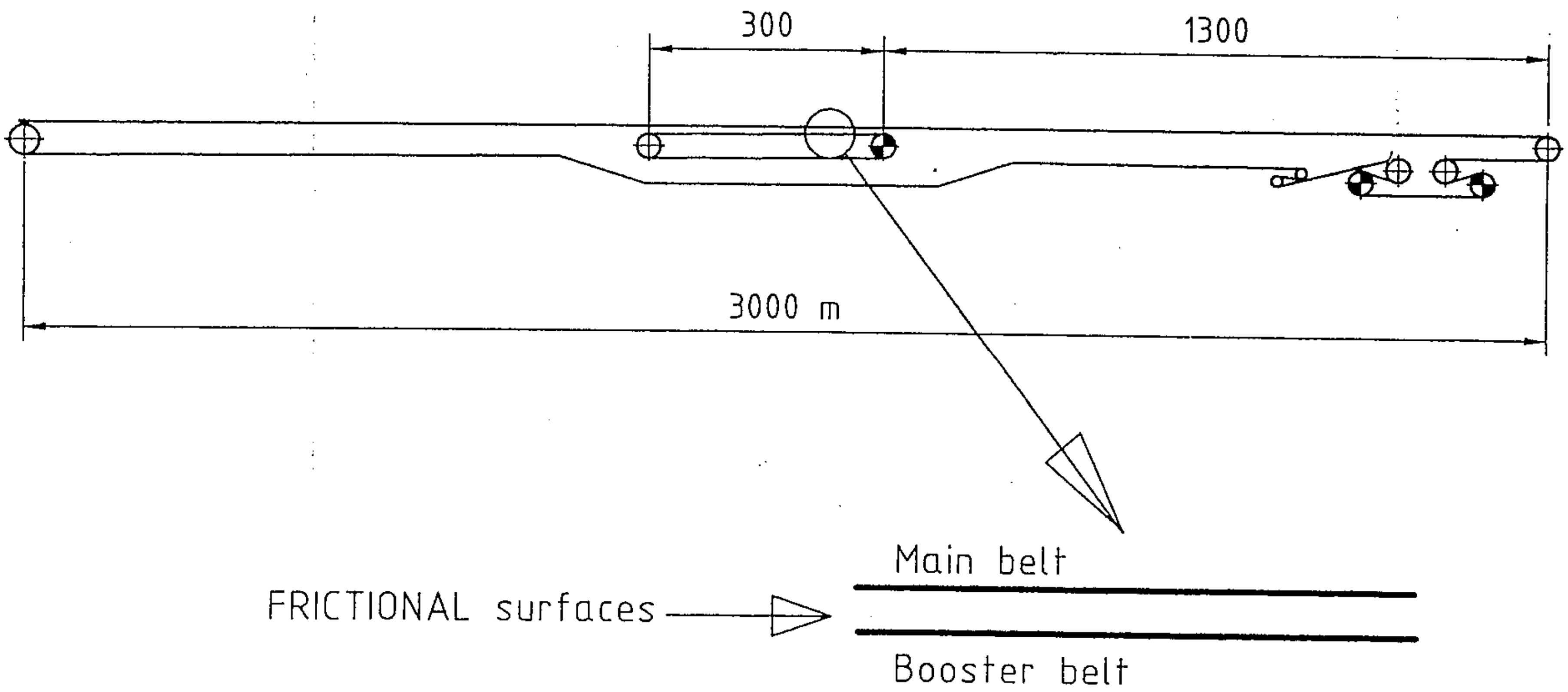
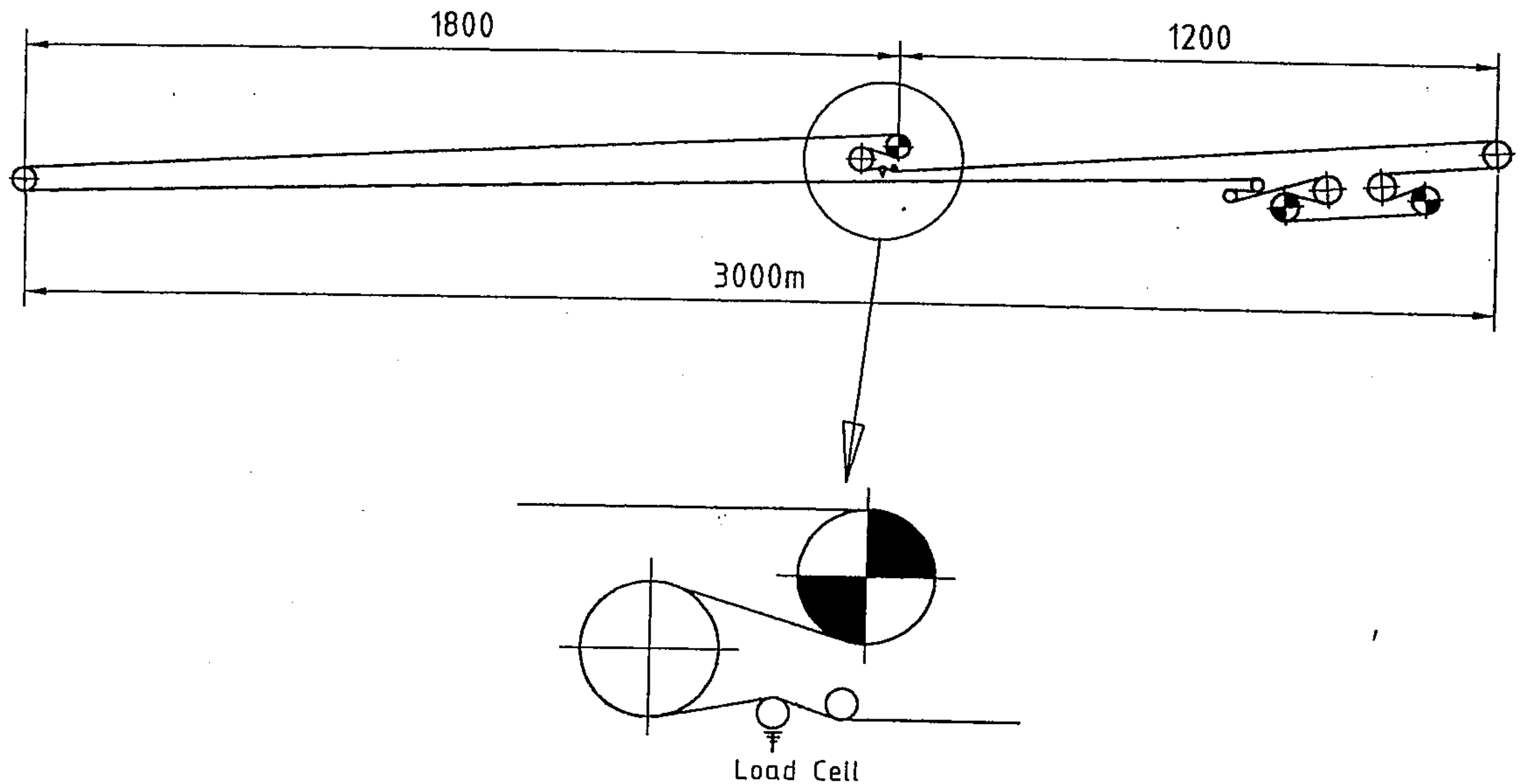


Fig 4 Single Drive TRIPPER ASSISTED conveyor



Tension Control

Fig 5

HEAD and TRIPPER belt TENSIONS during acceleration (fully loaded)

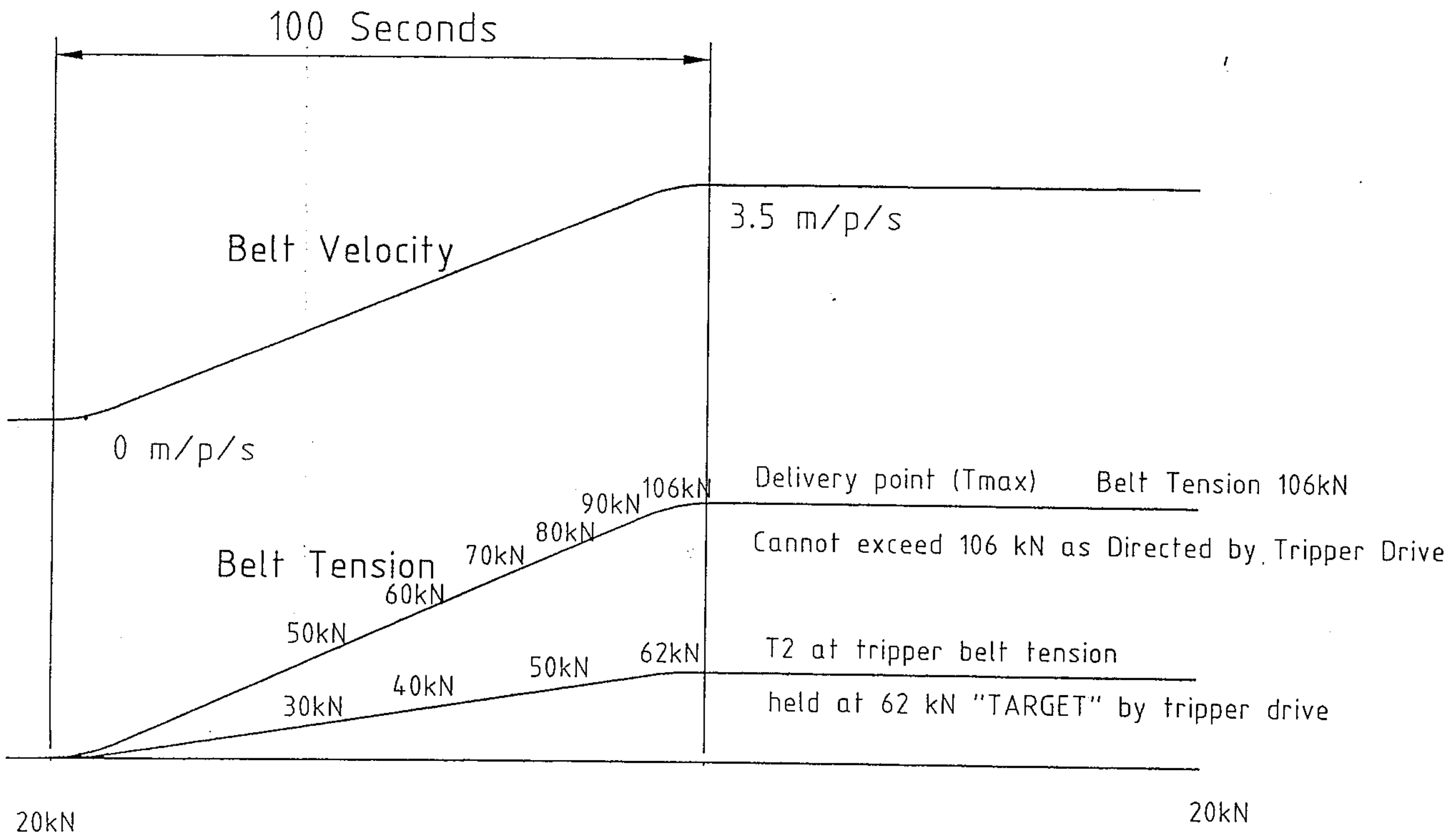


Fig 6

MULTI TRIPPER assisted conveyor